EUROPEAN CENTRAL BANK

WORKING PAPER SERIES

NO. 436 / FEBRUARY 2005

MEASURING MARKET AND INFLATION RISK PREMIA IN FRANCE AND IN GERMANY

by Lorenzo Cappiello and Stéphane Guéné

EUROPEAN CENTRAL BANK

WORKING PAPER SERIES

NO. 436 / FEBRUARY 2005

MEASURING MARKET AND INFLATION RISK PREMIA IN FRANCE AND IN GERMANY [1]

by Lorenzo Cappiello [2]
and Stéphane Guéné [2]

In 2005 all ECB publications will feature a motif taken from the €50 banknote.

1 Comments by Olli Castren, Philipp Hartmann, Hans-Joachim Klöckers, Stelios Makrydakis, Simone Manganelli, Oreste Tristani and participants at an ECB internal seminar are appreciated. The usual disclaimer applies. All views expressed are those of the authors alone and do not necessarily reflect those of the ECB or the Eurosystem.

2 European Central Bank, Kaiserstrasse 29, D-60311 Frankfurt am Main, Germany; tel.: +49 69 1344 8765 and +49 69 13 44 8790; fax: +49 69 1344 6514; e-mail addresses: lorenzo.cappiello@ecb.int and stephane.guene@ecb.int

Address
Kaiserstrasse 29
60311 Frankfurt am Main, Germany

Postal address
Postfach 16 03 19
60066 Frankfurt am Main, Germany

Telephone
+49 69 1344 0

Internet
http://www.ecb.int

Fax
+49 69 1344 6000

Telex
411 144 ecb d

ISSN 1561-0810 (print)
ISSN 1725-2806 (online)

CONTENTS

Abstract

This paper studies the role of inflation in the determination of financial asset prices. We estimate an Intertemporal Capital Asset Pricing Model *à la* Merton (1973), with inflation as an independent source of risk, for France and Germany. Our study also allows us to evaluate how the different nature of the French and German monetary policies before 1999 as well as the convergence process towards the single currency might have affected the role of inflation in the pricing of financial assets. We find that inflation is a significant explanatory factor for the pricing of stocks and government bonds in the two countries. Moreover, while there seems to be no clear structural break in the impact of inflation on asset prices after Stage Three of Economic and Monetary Union, such an impact has been increasingly similar in the two countries after 1999.

Keywords: Intertemporal CAPM, business cycles, GARCH-in-Mean

JEL classification: C32, C61, E44 and G12

Non-technical summary

Among the models developed to explain asset pricing, the Capital Asset Pricing Model (CAPM) has received great attention. It states that investors will require a premium over the risk-free rate on risky securities whose return is positively correlated with the return on a market portfolio. While both practitioners and academics have extensively used this model, its performance has been relatively limited. Indeed, in addition to their co-movements with the market portfolio return, security returns may also be explained by their co-movements with macroeconomic and/or financial variables that might affect other revenues of the investors (housing revenues, labour revenues, etc.). The Intertemporal CAPM (henceforth ICAPM) proposed by Merton (1973) allows the identification of additional pricing factors, beyond the market portfolio return, as independent sources of risk and measurement of the implied time-varying intertemporal risk premium. In this paper, we estimate a conditional version of Merton's ICAPM for France and Germany since the mid-1980s and until June 2003 with inflation as an independent source of risk. Within this framework, excess returns for stocks, short and long-term government bonds are explained by the sum of a market risk premium and an inflation risk premium.

The first conclusion is that inflation had a significant impact on the pricing of equities as well as short and long-term bonds for France and Germany over the period under review. Moreover, inflation risk premia explain a larger fraction of short and long-term bonds' excess returns than market risk premia. As expected, inflation risk premia are higher for long-term bonds than for short-term bonds.

The second important result is that no noticeable break can be observed in inflation risk premia in the late 1990s, when euro area countries converged towards a common monetary policy. However, inflation had a more similar impact on the pricing of financial assets in the two countries after 1998, as evidenced by the substantial increase in the correlation of the two inflation risk premia. Among other reasons, this may reflect the increased interrelation of financial markets in the euro area and the disappearance of certain macroeconomic sources of uncertainty, such as exchange rate fluctuations.

The third finding is that market risk premia on short and long-term bond returns significantly declined after the turning point in global stock markets in March 2000, while being broadly stable before. These developments may reflect a flight-to-quality phenomenon. After having reached a trough in October 2002, these premia increased significantly thereafter to stand at levels close to their historical average in June 2003.

1. Introduction

Among the models developed to explain the evolution of financial asset prices, the Capital Asset Pricing Model (CAPM) of Sharpe (1964), Lintner (1965), Mossin (1966) and Black (1972) has received great attention. It states that investors will require a premium over the risk-free interest rate on financial assets whose return is positively correlated with the return on a market portfolio. Such correlation represents the risk exposure which cannot be diversified away and hence does not hedge the investor against bad outcomes of the market portfolio. While practitioners and academics alike have intensively used this model to price different categories of financial assets, its performance has been relatively limited (see, for example, Scruggs, 1998, Bekaert and Wu, 2000, Cappiello, 2000, and Gerard and Wu, 2004). It is clear that the co-movements of financial asset returns with the returns on a market portfolio may be important in explaining the excess returns investors demand to hold these securities. However, the co-movements between the returns of these assets with macroeconomic and/or financial variables that might affect other revenues of the investors (housing revenues, labour revenues, etc.) could also be of importance when explaining security returns. Hence the need for additional pricing factors (see, for example, Campbell, 2000, and Cochrane, 2001).

This idea has been formalised in the Intertemporal CAPM (henceforth ICAPM) of Merton (1973), where pricing factors other than returns on a market portfolio receive a prominent role. Unfortunately, since the model has a partial equilibrium nature, it does not permit the identification of the relevant additional pricing factors to be considered. The subsequent literature has then focused on finding out which (economic) variables may play a role in explaining asset prices.

In this paper, we estimate an ICAPM *à la* Merton for France and Germany from February 1985 to June 2003, where the only macroeconomic factor chosen to explain asset prices is inflation. The analysis is carried out over a portfolio composed of three securities: stocks, short- and long-term government bonds.

The choice of the inflation rate as the only additional pricing factor has the following rationale. First, there is a need to keep the analysis empirically tractable with a limited number of additional pricing factors. Second, the two parallel studies of France and Germany enable the size and the sign of the inflation risk premium in the pricing of financial assets for the two largest euro area countries to be estimated. It also allows the comparison of the relative importance of the inflation premium in two countries that could have had in the past relatively different monetary policies. While German monetary policy "has been consistently geared towards price stability through the pursuit of an intermediate target for monetary growth" (Convergence Report, 1998), French monetary policy had aimed at maintaining price stability as well as the external value of the French franc relatively to the Deutsche Mark. Through the two-country approach, it is also possible to analyse how the change from two independent monetary policies with potentially different goals to a common monetary policy with the goal of maintaining price stability has affected the role of inflation as an economic factor to explain asset returns. Third, it might be interesting to check whether the decrease in the uncertainty surrounding interest rates owing to the adoption of a common monetary policy has generated lower market risk premia for government fixed-income securities.

We find that the inflation risk premium may explain a significant fraction of the financial asset returns and, in the cases of short and long-term bonds, even more than the market risk premium. As expected, the inflation risk premium is larger for long-term bonds than short-term bonds. No structural break is visible for the inflation risk premium after the adoption of a common monetary policy. Finally, we find that the inflation risk premia for France and Germany are significantly more correlated since early 1999, implying some degree of harmonisation in the impact of inflation on financial asset returns.

The paper is organised as follows. Section 2 describes Merton's (1973) ICAPM, while the empirical methodology to test the model is examined in section 3. Section 4 describes the data used. The empirical results and their interpretation are presented in Section 5, whereas Section 6 concludes the paper.

2. Intertemporal Capital Asset Pricing Model

The asset pricing model that drives investors' optimal portfolio choices is assumed to be Merton's (1973) continuous-time Intertemporal CAPM.[1] While the static CAPM is derived under the assumption that investors live for only one period, in the real world consumption and investment decisions span longer horizons. In such a dynamic economy, the set of investment opportunities changes over time; these changes are governed by one or more state variables, $X_l, l = 1, \ldots, m$. Risk-averse rational agents will thus anticipate and hedge against the possibility that investment opportunities may adversely change in the future. Because of this hedging need, the equilibrium expected returns on securities depend not only on "systematic" or "market" risk (as in the traditional CAPM), but also on "intertemporal" risks. As is well known, the market risk premium is measured by the covariance of asset returns with market portfolio returns. Similarly, the intertemporal risk premium is given by the covariance of security returns with the state variables. In the two following sub-sections, the intuition behind a dynamic CAPM is provided; next the pricing equations will be formally derived.

2.1. The Rationale for Using Multiple Factors Models

The need for additional sources of priced risks to explain expected asset returns has been recognised at least since Merton (1971, 1973). While the representative CAPM investor dislikes wealth uncertainty and is assumed to maximise a one-period utility function whose arguments are the expected mean and

[1] Long (1974) and Fama (1996) provide discrete-time versions of the model.

variance, the average Intertemporal CAPM agent cares also about *future* consumption-investment opportunities. The outcome of such intertemporal optimising behaviour, with inflation as the only additional pricing factor, can be better understood through the following example (see also Cochrane, 1999a, 1999b): consider two assets, *A* and *B*, with the same sensitivity to market movements, but possessing different elasticities with respect to inflation. Assume that investors dislike inflation (because it decreases the real return of some of their nominal revenues) and that asset *A* provides a better hedge than asset *B* against inflation, meaning that asset *A* pays off better than asset *B* when inflation is high. Since investors, on average, desire to smooth their lifetime consumption path and hedge against the inflation risk, they will prefer asset *A* to *B*. As a consequence, asset *A*'s price will go up, while asset *B*'s price will go down, or, equivalently, investors will hold asset *A* at a lower average expected return than asset *B*. The ICAPM allows us to identify inflation as an independent source of risk and to measure the implied time-varying inflation risk premium. In our example, such a premium may even be negative for asset *A*, while it should be positive for asset *B*. Within the traditional CAPM framework, instead, only the market risk premium is taken into account, whereas other pricing factors are omitted. Therefore, securities *A* and *B* would have the same expected return and price, which, in fact, is not the case.

2.2. Formal Derivation of the Pricing Equations

Assume that both asset rate of returns and state variables follow a standard Brownian motion. Following Merton (1973), the risk-averse representative agent maximises his expected intertemporal utility function subject to a wealth constraint. Let $J(W(t),X(t),t)$ be the derived utility function of wealth, i.e. $J(W,X,t)= \max E\int_t^T U(C(s),s)ds$, where *W* is the wealth value, *X* the state variable, and $C(t)$ the instantaneous consumption flow. The solution of the optimisation problem yields the set of pricing restrictions:

$$E(R_{i,t+1}|\Im_t)=\lambda_{M,t}\sum_{j=1}^{n}Cov(R_{i,t+1},R_{j,t+1}|\Im_t)w_{j,t}+\sum_{l=1}^{m}\lambda_{Fl,t}Cov(R_{i,t+1},X_{l,t+1}|\Im_t), \tag{1}$$

for $i=1,\dots,n$. All returns are in excess of the risk-free interest rate. $E(\cdot|\Im_t)$ is the expectation of excess returns on security *i*, $Cov(R_{i,t+1},R_{j,t+1}|\Im_t)$ and $Cov(R_{i,t+1},X_{l,t+1}|\Im_t)$ are, respectively, the covariance between returns on asset *i* and *j*, and the covariance between returns on security *i* and the state variable X_l. Both first and second moments are conditional on the current information set $\Im_t$. $w_{j,t}$ is the optimal wealth share of each risky asset. $\lambda_{M,t}\equiv -J_{WW,t}W_t/J_{W,t}$ is the Arrow-Pratt coefficient of relative risk aversion (provided that $J_{WW,t}<0$), where $J_{W,t}$ and $J_{WW,t}$ denote the first and second derivatives, respectively, of $J(W,X,t)$ with respect to *W*. Since $\lambda_{M,t}$ measures how sensitive expected excess returns are to changes in the market risk, it is interpreted as the price of market risk. Similarly, since $Cov(R_{i,t+1},X_{l,t+1}|\Im_t)$ measures the exposure of asset *i* to the risk stemming from changes in the investment opportunity set, $\lambda_{Fl,t} \equiv -J_{WX_l,t}W_t / J_{W,t}$, $l = 1,\ldots,m$, can be interpreted as the price of intertemporal risk. As before, $J_{WX_l,t}$ is the derivative of the marginal utility of wealth with respect to the state variable X_l. Both $\lambda_{M,t}$ and $\lambda_{Fl,t}$, $\forall l$, are aggregate measures, in that they are harmonic means of the prices of risk of each investor.

Note that the conditional multi-factor model nests the traditional CAPM as a special case: if the marginal utility of wealth is state-independent, i.e. $J_{WX_l,t} = 0$, which occurs for agents with one period life, Merton's Intertemporal CAPM reduces to the classical CAPM. The terms grouped under the second sum of the left-hand side of equation (1) reflect the need to hedge against adverse shifts in the investment opportunity set. A change in X_l such that future consumption will decrease given future wealth represents an "unfavourable" shift in investment opportunities.

As long as $J_{W,t} > 0$ and investors are risk-averse, i.e. $J_{WW,t} < 0$, the price of market risk must be always positive. However, the model does not impose any sign restriction on the price of intertemporal risk. For instance, if $J_{WX_l,t} > 0$ (<0) then $\lambda_{Fl,t}$ is negative (positive). When $\lambda_{Fl,t}$ and $Cov\left(R_{i,t+1}, X_{l,t+1} \middle| \Im_t\right)$ have the same sign, the risk premium required to hold asset *i* increases; vice-versa, if the price of intertemporal risk and the covariance between the return on security *i* and the state variable X_l have different signs, the required total risk premium should decrease.

As with the traditional CAPM, Merton's Intertemporal CAPM suffers from the drawback that it is a partial equilibrium model in its nature. Therefore, it offers little guidance in the choice of pricing factors and it is silent about the forces that determine factor risk prices. Identification of the priced state variables is worth a separate study (see, for instance, Chen, Roll, and Ross, 1986, and Fama, 1998). However, Merton's model itself can give some indications (Cochrane, 1999a). In a nutshell, Merton's intertemporal asset pricing theory builds a bridge between consumption smoothing and asset returns: a security should pay low average returns if it performs better than other assets during "bad times", which are periods characterised by a decline in consumption. Variables such as industrial production, oil price, inflation, business cycle proxies, term structure or interest rates are related to consumption and, therefore, are good candidates for additional priced factors. In this paper, we consider the inflation rate as the only extra priced factor. Other possible candidates are not analysed for the following two reasons: on one hand the goal of this study is to measure the time-varying inflation risk premium that investors require to holding stocks and nominal government bonds. On the other hand, there is the need of keeping the analysis empirically tractable, which limits the number of pricing factors.

3. Empirical Methods

The set of pricing restrictions (1) provides the following statistical model:

$$\mathbf{R}_{t+1} = \lambda_{M,t} \sum_{j=1}^{n} \mathbf{h}_{j,t+1} w_{j,t} + \sum_{l=1}^{m} \lambda_{Fl,t} \mathbf{h}_{n+l,t+1} + \boldsymbol{\varepsilon}_{M,t+1}, \tag{2}$$

where $\mathbf{R}_{t+1}$ represents the $n\times1$ vector of security excess returns, $\mathbf{h}_{j,t+1}$ is the $n\times1$ vector of conditional variance/covariances of each asset with itself/others, $\mathbf{h}_{n+l,t+1}$ the $n\times1$ vector of conditional covariances of each security with the state variables, and $\boldsymbol{\varepsilon}_{M,t+1}$ the $n\times1$ vector of conditional error terms. As before, $\lambda_{M,t}$ and $\lambda_{Fl,t}$ are, respectively, the prices of market and intertemporal risk, while $w_{j,t}$ is the optimal wealth share of each risky asset. Note that $\sum_{j=1}^{n} h_{j,t+1} w_{j,t} = Cov\left(R_{i,t+1}, R_{M,t+1} \middle| \Im_t\right)$, $i=1,\ldots,n-1$, i.e. the conditional covariance between the return on each asset and the market portfolio, $R_{M,t+1}$.

The theoretical model does not impose any restrictions on the parameterisation of the dynamics of the additional factors. Therefore, one can choose a functional form of the kind:

$$\mathbf{F}_{t+1} = \mathbf{K}\mathbf{y}_t + \boldsymbol{\varepsilon}_{F,t+1}, \tag{3}$$

where $\mathbf{F}_{t+1}$ is the $m\times1$ vector of priced factors, $\mathbf{y}_t$ is a $k\times1$ vector of predetermined variables (that may include lagged values of the factors) which have predictive power with respect to factors, $\mathbf{K}$ is the associated $m\times k$ matrix of parameters, and $\boldsymbol{\varepsilon}_{F,t+1}$ is the $m\times1$ vector of conditional error terms.

The $(n+m)\times1$ disturbance vector $\boldsymbol{\varepsilon}_{t+1} = \left[\boldsymbol{\varepsilon}_{M,t+1}\ \boldsymbol{\varepsilon}_{F,t+1}\right]'$ is assumed to be conditionally Normally distributed

$$\boldsymbol{\varepsilon}_{t+1} \middle| \Im_t \sim N\left(\mathbf{0}, \mathbf{H}_{t+1}\right),$$

where $\mathbf{H}_{t+1}$ is the $(n+m)\times(n+m)$ conditional covariance matrix of asset returns and priced factors. Note that $\mathbf{h}_{j,t+1}$, $j=1,\ldots,n$, and $\mathbf{h}_{n+l,t+1}$, $l=1,\ldots,m$, are, respectively, the first n and the last m columns of $\mathbf{H}_{t+1}$. Economic theory does not suggest any hypothesis about conditional second moment evolution, nor about their relation with economic fundamentals. Therefore, one has to rely on *ad hoc* assumptions and on specific statistical models. GARCH processes are among the most widely used parameterisation to model conditional second moments. It is assumed that the conditional covariance matrix follows a multivariate diagonal covariance-stationary GARCH(1,1) process, according to Ding and Engle (1994):

$$\mathbf{H}_{t+1} = \mathbf{H}_0 \odot \left(\mathbf{11}' - \mathbf{aa}' - \mathbf{bb}'\right) + \mathbf{aa}' \odot \boldsymbol{\varepsilon}_t'\boldsymbol{\varepsilon}_t + \mathbf{bb}' \odot \mathbf{H}_t, \tag{4}$$

where $\mathbf{1}$ represents the unit vector, $\mathbf{a}$ and $\mathbf{b}$ are $(n+m)\times1$ vectors of unknown parameters, while $\odot$ denotes the Hadamard (element by element) matrix product. $\mathbf{H}_0$, though unknown, can be evaluated recursively during the optimisation procedure, according to the methodology suggested by De Santis and Gerard (1997, 1998a).[2]

The unknown parameters of the model, which are included in the $\boldsymbol{\theta}$ vector, are estimated by maximising the following likelihood function with respect to $\boldsymbol{\theta}$:

---

[2] At the first iteration $\mathbf{H}_0$ is set equal to the unconditional covariance matrix. It is then updated at the end of each iteration.

$$L\left(\mathbf{G}_{t+1}\middle|\Im_t;\boldsymbol{\theta}\right)=\sum_{t=1}^{T} ln\,\phi\left(\mathbf{G}_{t+1}\middle|\Im_t;\boldsymbol{\theta}\right) \tag{5}$$

where $\mathbf{G}_{t+1}=\left[\mathbf{R}_{t+1}\ \mathbf{F}_{t+1}\right]'$ is the vector of asset returns and factors and T the sample size. The conditional density function $\phi\left(\mathbf{G}_{t+1}\middle|\Im_t;\boldsymbol{\theta}\right)$ is assumed to follow a multivariate normalised Normal distribution:

$$\phi\left(\mathbf{G}_{t+1}\middle|\Im_t;\boldsymbol{\theta}\right)=-\frac{nT}{2}ln(2\pi)-\frac{1}{2}\sum_{t=1}^{T} ln\left(\left|H_{t+1}(\boldsymbol{\theta})\right|\right)-\frac{1}{2}\sum_{t=1}^{T}\boldsymbol{\varepsilon}_{t+1}(\boldsymbol{\theta})'\mathbf{H}_{t+1}(\boldsymbol{\theta})^{-1}\boldsymbol{\varepsilon}_{t+1}(\boldsymbol{\theta}). \tag{6}$$

The vector of unknown parameters $\boldsymbol{\theta}$ is estimated by combining two numerical algorithms of optimisation: The Newton-Raphson and the BHHH (Berndt, Hall, Hall and Hausman, 1974) methods. The former, though more primitive, has proved useful in identifying the optimal region in the parameter space; the latter is a refinement of the first and is widely used in the empirical GARCH literature. The maximisation is performed using the Constrained ML module in GAUSS software.

4. Data

This section describes the data we have used to estimate Merton's (1973) ICAPM. For both France and Germany, the market portfolio is composed of three assets: a broad stock market index, an index of short-term government bonds and an index of long-term government bonds. This allows for the inclusion of a large variety of different liquid investment opportunities. All observations are from the last trading day of the month, and cover a period from February 1985 to June 2003, for a total sample size of 221. All returns are in excess of a 1-month risk-free rate as computed by the 1-month euro-mark and 1-month euro-franc.

To measure total (excess) stock returns, the broad market-value-weighted stock indices published by Datastream are used. Returns for short-term bonds are calculated from the Datastream index of bonds with maturity included between one and three years, while return on long-term bonds is calculated from the Broad Datastream index (all maturities) from which bonds of one to three-year maturity are excluded. For the three asset classes, we have used total return indices, which include dividends for stocks and coupons for bonds. To aggregate these three indices and build the market portfolio, market values provided by Datastream have been used.

The additional priced factor used here is inflation, defined as the monthly increase in the consumer price index (not seasonally adjusted). For France, the source is INSEE (base 100 in 1998). For Germany, the source is the Statistisches Bundesamt (base 100 in 1995).

Descriptive statistics for the three assets and inflation are given in Table 1 for France and Table 2 for Germany.

In Panels 1B (France) and 2B (Germany), autocorrelation functions are reported for lags from 1 to 6 and 12. The pattern is broadly similar in both countries. Equity excess returns exhibit very little autocorrelation. As for the excess holding returns on short and long-term bonds, autocorrelation is somewhat more relevant, with the autocorrelation of lag one being significantly different from zero. Inflation rates show a significant autocorrelation at lags one and twelve, the latter coming from the fact that we use non-seasonally adjusted series of prices.

Unconditional correlations among assets are reported in Panels 1C (France) and 2C (Germany). As expected, there is a high positive correlation between short and long-term bonds in both countries. While stock returns show no significant correlation with bond returns in Germany, these correlations are significant and positive for France. Correlations of inflation with each financial asset are negative in both countries. However, while these correlations are not significantly different from zero in France, in Germany the correlation between inflation and both short and long-term bonds is significant. This is already a sign of the different impact of inflation in the two countries, which could be due to the relatively different nature of the monetary policies. This might also lead to a higher predictive power of inflation with respect to short and long-term bonds in Germany.

Panels 1D (France) and 2D (Germany) present autocorrelation of squared excess asset returns and the inflation rate. The serial correlation is particularly pronounced for stocks and the inflation rate in both countries, while there is only little evidence for the short and long-term bonds. A GARCH process should be able to capture this second order dependence.

Out of the six unconditional contemporaneous correlations between squared series, two are significant for France (see Panel 1E) and only one for Germany (see Panel 2E). This indicates that volatility spillovers between financial markets as well as between assets and the inflation rate are limited, making a diagonal GARCH parameterisation fully appropriate for this sample.

5. Empirical Results

5.1. General Results

This section presents the empirical results obtained applying the econometric methodology described in section 3. Equation (2) is tested for two countries, France and Germany, with three securities for each country, and the inflation rate as the additional priced factor:[3]

---

[3] In CAPM-type models it is often assumed that, in addition to rate of returns, also the inflation rate, π, follows a Brownian motion:

$$\frac{dI}{I} = E(\pi)dt + \sigma_{\pi} dz_{\pi},$$

where I is the general price index and $E(\pi)$ and σ_{π} are, respectively, the instantaneous expected value and standard deviation of π, while, z_{π} follows a standard Wiener process. In this case the set of pricing restrictions for expected nominal returns for a CAPM with a deterministic investment opportunity set should read as follows:

$$\mathbf{R}_{t+1}^{F} = \lambda_M^F \sum_{j=1}^{3} \mathbf{h}_{j,t+1}^{F} w_{j,t}^{F} + \lambda_\pi^F \mathbf{h}_{4,t+1} + \boldsymbol{\varepsilon}_{M,t+1}^{F}, \tag{7}$$

$$\mathbf{R}_{t+1}^{G} = \lambda_M^G \sum_{j=1}^{3} \mathbf{h}_{j,t+1}^{G} w_{j,t}^{G} + \lambda_\pi^G \mathbf{h}_{4,t+1} + \boldsymbol{\varepsilon}_{M,t+1}^{G}. \tag{8}$$

The superscripts *F* and *G* stand for France and Germany, respectively. $\mathbf{R}_{t+1}^{k}$, *k=F*, *G*, is a 3×1 vector of excess asset returns, which includes excess returns on stocks, as well as excess holding returns on short and long-term bonds. For the sake of simplicity, the prices of risk, λ_M^k and λ_π^k, *k=F*, *G*, are assumed to be constant over time. Moreover, to avoid the price of market risk becoming negative, which would be inconsistent with the theory and would deliver biased market risk premia, non-negativity restrictions are incorporated into the specification of λ_M^k, following Merton (1980). In particular, it is assumed that λ_M^k is approximated by an exponential function:[4]

$$\lambda_M^k = exp\left(\gamma_M^k\right), k=F, G.$$

No restrictions, on the other hand, are imposed on the specification of λ_π^k, as the theoretical model does not require a specific sign for the price of intertemporal risk.

Since the inflation rate is quite a persistent variable, its dynamic is assumed to be driven by its own lagged values. In particular, equation (3) takes on the two following specifications for France and Germany, respectively:[5]

$$\pi_{t+1}^F = \alpha_0^F + \alpha_1^F \pi_t^F + \alpha_2^F \pi_{t-5}^F + \alpha_3^F \pi_{t-11}^F + \varepsilon_{\pi,t+1}^F, \tag{9}$$

$$\pi_{t+1}^G = \alpha_0^G + \alpha_1^G \pi_t^G + \alpha_2^G \pi_{t-11}^G + \varepsilon_{\pi,t+1}^G. \tag{10}$$

$$E\left(R_{i,t+1}|\Im_t\right) = \lambda_{M,t} \sum_{j=1}^{n} Cov\left(R_{i,t+1}, R_{j,t+1}|\Im_t\right) w_{j,t} + \left(1-\lambda_{M,t}\right) Cov\left(R_{i,t+1}, \pi_{t+1}|\Im_t\right), \quad i=1,\ldots,n,$$

where $Cov\left(R_{i,t+1},\pi_{t+1}|\Im_t\right)$ is the conditional covariance between returns on asset *i* and the inflation rate. Adler and Dumas (1983) define the above equation "nominal CAPM". In empirical asset pricing studies it is usually assumed that the inflation rate is not random (this is the so-called "Solnik's special case – Solnik, 1974) and therefore $Cov\left(R_{i,t+1},\pi_{t+1}|\Im_t\right)$ is supposed to be equal to zero. In this piece of research, inflation is considered the state variable driving the dynamics of the investment opportunity set and, as such, its stochastic component cannot be neglected. Therefore, in an intertemporal economy the previous equation becomes:

$$E\left(R_{i,t+1}|\Im_t\right) = \lambda_{M,t} \sum_{j=1}^{n} Cov\left(R_{i,t+1}, R_{j,t+1}|\Im_t\right) w_{j,t} + \left(1-\lambda_{M,t}+\lambda_{\pi,t}\right) Cov\left(R_{i,t+1}, \pi_{t+1}|\Im_t\right), \quad i=1,\ldots,n.$$

With an abuse of notation we define the price of intertemporal risk as equal to the three terms $1-\lambda_{M,t}+\lambda_{\pi,t}$.

[4] Among others, Bekaert and Harvey (1995) and De Santis and Gerard (1997, 1998a, 1998b) adopt this parameterisation for the price of market risk.

[5] The choice of the lags in equations (9) and (10) is motivated by the significance of the associated coefficients.

π^F_{t+1}, the French inflation rate, depends on its own past values lagged once, six and twelve times; similarly, π^G_{t+1}, the German inflation rate, is a function of its own past values lagged once and twelve times.

The disturbance vector $\boldsymbol{\varepsilon}^k_{t+1} = \left[\boldsymbol{\varepsilon}^k_{M,t+1}\ \varepsilon^k_{\pi,t+1}\right]'$, k=F, G, is assumed to be conditionally normally distributed:

$$\boldsymbol{\varepsilon}^k_{t+1} \middle| \Im_t \sim N\left(\mathbf{0}, \mathbf{H}^k_{t+1}\right),$$

where $\mathbf{H}^k_{t+1}$, k=F, G, is a 4×4 GARCH(1,1) process described by (4). Maximum likelihood estimation provides the vector of parameters $\boldsymbol{\theta}^k$, k=F, G, being the density function $\phi\left(\mathbf{G}_{t+1} \middle| \Im_t; \boldsymbol{\theta}\right)$ given by equation (6).

The results for the estimation of models (7) – (9) and (8) – (10) are shown in Table 3. Both γ^k_M, k=F, G, are significantly different from zero at the 5% level.[6] λ^F_π is significantly different from zero at the 5% level and λ^G_π is significantly different from zero at around the 10% level, indicating that the inflation rate is a significant priced factor. Moreover, all the parameters entering the GARCH model as well as those of the inflation rate specification, with the exception of α^G_1, are again significant.

In Figures 1, 2 and 3 the market (MRP), intertemporal (IRP), and total (TRP) risk premia, for each asset are plotted. For each premium, the formulae are given by equation (11), (12), and (13), respectively:

$$MRP^k_{i,t+1} = \lambda^k_M \sum_{j=1}^{3} Cov\left(R^k_{i,t+1}, R^k_{j,t+1} \middle| \Im^k_t\right) w^k_{j,t}, \tag{11}$$

$$IRP^k_{i,t+1} = \lambda^k_\pi \sum_{j=1}^{3} Cov\left(R^k_{i,t+1}, R^k_{j,t+1} \middle| \Im^k_t\right) w^k_{j,t}, \tag{12}$$

$$TRP^k_{i,t+1} = MRP^k_{i,t+1} + IRP^k_{i,t+1}, \tag{13}$$

for k = F, G, and i = *stocks*, *short-term bonds*, *long-term bonds*.

From Table 3, it can be seen that the price of intertemporal risk is negative for both countries. This means that the elasticity of marginal utility of wealth with respect to the inflation rate is positive, i.e. $J^k_{W\pi,t} > 0$. When the inflation rate goes up, the marginal utility of wealth increases as well: one more unit of wealth is worth more inasmuch as it helps to smooth consumption. Since λ^k_π is constant, the sign of the intertemporal premium will depend on the sign of the covariance between the returns on each asset and the inflation rate. If this covariance is positive, the total premium that investors require for each security will decrease; conversely, when the covariance is negative, investors will require a higher compensation, in terms of expected returns, to hold that security.

---

[6] Standard errors are computed with second derivative estimates of the information matrix.

As far as France is concerned (see Table 5), standardised error terms in level and squared pertaining to returns on equities as well as to the inflation rate are well-behaved, while those associated to short- and long-term bond mean equations still show autocorrelation. Unlike France, all standardised residuals regarding German pricing equations exhibit no autocorrelation. Interestingly, the GARCH parameterisation we adopt permits us to capture second moment dependence for both France and Germany.

5.2. Results for Excess Returns on Stocks

5.2.1 Market Risk Premium

Over the period under review, the market risk premia were positive in both France (see Figure 1A) and Germany (see Figure 1B). On average, they were equal to around 20 and 35 basis points respectively. The patterns of the market risk premia for the two countries are highly similar. After hovering around relatively high values between early 1985 and early 1993, the market risk premia had remained broadly stable at low levels until early 1997. Thereafter, they have moved back to relatively high levels and have remained there ever since.

The similarity in the developments in the market risk premia in France and Germany can be explained by the fact that the main driving factor of these premia is the conditional volatility of stocks (since stocks represent more than 40% of the market portfolio), which has been largely similar in France and Germany since the mid-1980s.

The peaks in the market risk premia occurred in periods of turmoil on financial markets. Over the period ranging from 1985 to 1992, the two stock market premia are seen to increase on three occasions: (a) in the first half of 1986, which was a turbulent time for the Exchange Rate Mechanism (ERM) that translated into several realignments for some European currencies; (b) when stock markets crashed in October 1987, and (c) in the second half of 1990/beginning of 1991, when the Gulf crisis erupted. In the latest period of high market risk premia, four distinct peaks occurred: (a) in 1997 and 1998, when markets worldwide were hit by the Asian crises, the Latin America crisis, the LTCM collapse, and the Russian government bond default; (b) in March 2000, when the alleged equity bubble started to burst; (c) at the time of the terrorist attacks in the United States on September 2001 and; (d) in the second half of 2002, in the aftermath of the accounting scandals in the US.

5.2.2. Inflation Risk Premium

The French and, to a less extent, the German intertemporal risk premia are almost always positive. Since λ_{π}^{F} is negative, the covariance between returns on stocks and the inflation rate is negative most of the time.

Interestingly, in parallel with the Gulf crisis, the inflation risk premia became negative, decreasing the total premium investors demand to hold equities. Such a pattern may have an appealing interpretation. The beginning of the 1990s was characterised by low levels of growth: in times of business cycle troughs, investors might be willing to hold equities even at a premium, indicating that stocks may be considered good hedges against business cycle downturns.

For both France and Germany, when the total and market risk premia are presented together, the former seems to fluctuate around the latter. Finally, the correlation between the two inflation premia increased from 28% before December 1998 to 75% afterwards. This could mean that the role of inflation in the pricing of stocks has become increasingly similar in France and Germany after Stage Three of EMU. However, due to the absence of a sufficiently long period after 1998, it has not been possible to implement econometrical tests in order to detect the presence of a structural break.

5.3. Results for Excess Returns on Short-term Bonds

Figure 2 shows the decomposition of the total premium for short-term bonds in France (Figure 2A) and Germany (Figure 2B). This decomposition is quite similar for the two countries and the total risk premium is almost exclusively driven by the inflation risk premium in both.

5.3.1. Market Risk Premium

Over the period under review, market risk premia for France and Germany were predominantly positive. Before the end of the 1990s, they had remained broadly stable around a level a little above their historical average. Thereafter, they clearly followed a declining trend that has only reversed since the beginning of 2003.

Over 2001 and 2002, the portfolio rebalancing from stocks to bonds owing to declining stock prices could explain why the market risk premium for bonds declined and moved into negative territory. This premium can be negative since, owing to the large weight of equities in the market portfolio, the contribution of the conditional covariance between short-term bond and stock excess returns can be higher than the contribution of the conditional variance of short-term bond excess return in the calculation of the market risk premium. Moreover, in periods of flight-to-safety, the covariance between short-term bond and stock excess returns becomes negative.

These flight-to-safety effects are particularly easy to detect at times of high turmoil on financial markets. For example, they explain the significant troughs observed in the market risk premia in the two countries in October 1998 (when the LTCM hedge fund went bankrupt), and in September 2001 (at the time of the terrorist attacks in the United States). The recent reversal of these flows might also explain the rebound of the market risk premium since early 2003.

It is also interesting to note that the correlation between the market risk premium for France and Germany increased significantly after 1998. While this correlation was equal to 29% between February 1985 and December 1998, it reached 76% thereafter. The major driving force of this increase might be the relatively high integration of the short-end of the yield curves for France and Germany after the adoption of a common monetary policy and the introduction of the single currency.

5.3.2 Inflation Risk Premium

Inflation risk premia show a relatively similar pattern for France and Germany. The French premium has an historical average of 4 basis points while the average is of 3 basis points for Germany. Although these figures seem small, it should be kept in mind that they refer to monthly excess returns. Indeed, in both countries the inflation risk premium explains almost all the variation in the monthly excess returns in short-term bonds.

The correlation between the inflation risk premia for France and Germany increased from 35% for the period 1985-1998 to 67% for the period after 1999. As in the case of stocks, it seems that the impact of inflation on the pricing of short-term bonds has become more similar in France and Germany after 1998.

5.4. Results for Excess Returns on Long-term Bonds

Figure 3 shows the decomposition of the total premium for long-term bonds in France (Figure 3A) and Germany (Figure 3B). The patterns of market risk premia for long-term bonds in the two countries are similar to the patterns of market risk premia for short-term bonds, but with a higher historical average. As expected, inflation risk premia are higher than those for short-term bonds.

5.4.1. Market Risk Premium

Similar to the pattern seen for short-term bonds, market risk premia for France (2 basis points on average) and Germany (1 basis point) are, most of the time, positive. From 1985 to 1997-1998, they had remained broadly stable around a level a little above their historical average. Thereafter, they clearly followed a declining trend, which only reversed in early 2003.

Similar to short-term bonds, the portfolio rebalancing from stocks to bonds during the equity bear market period may be one of the driving forces of the decline in the market risk premia observed between 2000 and early 2003. Interestingly, the short-term bond market premia reacted differently from the premia on the long-term bond market on several occasions. For example, the terrorist attacks on September 2001 triggered a significant trough for short-term bond market risk premium, but not for long-term bonds. This reflects the fact that market participants moved into short-term bonds rather than long-term bonds: they were persuaded that a loose monetary policy would follow, which, in turn, would have generated higher expected returns for short-term bonds. On the contrary, when financial turmoil occurred in October 1987 and 1998, the behaviour of short and long-term bond markets was more similar, at least in Germany.

The differences in the long-term bonds' market risk premium between France and Germany are mainly observed in the first half of the period under review. While the market risk premium reached its highest level in Germany during the triggering of the Gulf war (summer 1990), the highest level for France was reached in 1986. This reflects the fact that 1986 was a year of high uncertainty for France as the French franc went through a series of realignments within the ERM (in fact until January 1987).

This difference is also shown when we calculate the correlation between the market risk premia for France and Germany before and after 1999. While this correlation was equal to 66% between February 1985 and December 1998, it has been equal to 92% since then. Contrary to the short end of the yield curve, the long end of the yield curve has not gone through a complete harmonisation. Nevertheless, some degrees of convergence, especially on the institutional side (delegation of the issuance of the debt to an independent debt management office) and on the issuing side (move towards the issuance of benchmarks), have been observed.

5.4.2. Inflation Risk Premium

As expected, the long-term bonds' inflation risk premia for France (21 basis points on average) and Germany (9 basis points) are higher than those of short-term bonds (on average 4 and 3 basis points respectively). As in the case of short-term bonds, the inflation risk premium explains the bulk of the variation in the total risk premium for Germany.

For the other premia, a similar pattern is shown for France and Germany. While the correlation between the inflation risk premia for France and Germany was approximately equal to 44% between February 1985 and December 1998, it reached 55% thereafter.

6. Summary of Results and Conclusions

In this paper, we estimate an ICAPM *à la* Merton (1973) for France and Germany since the mid-1980s until June 2003. Beyond market portfolio returns, we use only one additional pricing factor to explain excess returns on stocks, short and long-term bonds, i.e. the inflation rate.

We find that for both France and Germany inflation risk premia are significantly priced, suggesting that inflation is important in explaining excess returns on the financial assets under consideration. In the case of short and long-term bonds, we also show that the inflation risk premium is higher than the market risk premium. Interestingly, the inflation risk premia for long-term bonds are higher than the inflation risk premia for short-term bonds, which is in line with the notion that inflation is a more important source of risk in the long run.

The behaviour of the inflation risk premia before and after the formation of Monetary Union does not seem to show a structural break. However, this result needs to be interpreted with caution, due to the lack of a sufficient number of observations after 1998, which would allow the visual inspection to be backed up with a more rigorous econometric test. Nevertheless, the impact of inflation on asset prices has been increasingly similar after the adoption of a common monetary policy, since the correlation between the inflation risk premia for France and Germany is seen to increase.

As far as directions for future research are concerned, there is at least one avenue that could be explored. In this paper, we explain changes in risk premia through time-varying second moments, while keeping the prices of risk constant. A different approach would allow the prices of risk to vary over time as well. How this can be achieved is an issue requiring further investigation. Two approaches could be followed: prices may be modelled according to the dynamics of some information variables, or, alternatively, they could be assumed to evolve over time according to a regime-switching model *à la* Hamilton (1989, 1994; see Cappiello, 2000).

References

Adler, M., and B. Dumas, 1983, "International Portfolio Selection and Corporation Finance: A Synthesis," *Journal of Finance*, 46, pp. 925-984.

Bekaert, G., and G. Wu, 2000, "Asymmetric Volatility and Risk in Equity Markets**,"** *Review of Financial Studies*, 13, pp. 1-42.

Bekaert, G., and C. R. Harvey, 1995, "Time-Varying World Market Integration," *Journal of Finance*, 50, pp. 403-444.

Berndt, E. K., B. H. Hall, R. E. Hall, and J. A. Hausman, 1974, "Estimation and Inference in Non-Linear Structural Models," *Annals of Economic and Social Measurement* 3, pp. 653-665.

Black, F., 1972, "Capital Market Equilibrium with Restricted Borrowing," *Journal of Business*, 45, pp. 444-455.

Campbell, Y. J., 2000, "Asset Pricing at the Millennium", *Journal of Finance*, 55, pp. 1515-1567.

Cappiello, L., 2000, "A Conditional Multi-Asset Intertemporal CAPM with Switching Prices of Risk", *paper included in the Ph.D. dissertation*, International Economics Section, Graduate Institute of International Studies, University of Geneva.

Chen, N.-F., R. Roll, and S. A. Ross, 1986, "Economic Forces and Stock Market," *Journal of Business*, 59, pp. 383-403.

Cochrane, J. H., 1999a, "New Facts in Finance," *NBER working paper*, # 7169.

Cochrane, J. H., 1999b, "Portfolio Advice for a Multi-factor World," *NBER working paper*, # 7170.

Cochrane, J. H., 2001, "Asset Pricing," Princeton University Press, Princeton NJ.

Convergence Report, 1998, "Report required by Article 109j of the Treaty establishing the European Community, *European Monetary Institute*.

D'Agostino, R. B., A. Belanger, and R. B. D'Agostino Jr., 1990, "A Suggestion for Using Powerful and Informative Tests of Normality," *The American Statistician*, 44, pp. 316-321.

De Santis, G., and B. Gerard, 1997, "International Asset Pricing and Portfolio Diversification with Time-Varying Risk," *Journal of Finance*, 52, pp. 1881-1912.

De Santis, G., and B. Gerard, 1998a, "How Big is the Premium for Currency Risk?," *Journal of Financial Economics* 49, pp. 375-412.

De Santis, G., and B. Gerard, 1998b, "Conditional Asset Pricing with Market and Inflation Risk," *working paper*, Marshall School of Business, University of Southern California.

Ding, Z., and R. F. Engle, 1994, "Large Scale Conditional Covariance Matrix Modelling, Estimation and Testing," *working paper*, University of California, San Diego.

Fama, E. F., 1996, "Multi-factor Portfolio Efficiency and Multi-factor Asset Pricing," *Journal of Financial and Quantitative Analysis*, 31, pp. 441-465.

Fama, E. F., 1998, "Determining the Number of Priced State Variables in the ICAPM," *Journal of Financial and Quantitative Analysis*, 33, pp. 217-231.

Gerard, B., and G. Wu, 2004, "How Important Is Intertemporal Risk for Asset Allocation?," Working Paper, University of Michigan Business School.

Hamilton, J. D., 1989, "A New Approach to the Economic Analysis of Non-Stationary Time Series and the Business Cycle", *Econometrica*, 57, pp. 357-384.

Hamilton, J. D., 1994, *Time Series Analysis*, Princeton University Press.

Lintner, J., 1965, "The Valuation of Risk Assets and the Selection of Risky Investments in Stock Portfolios and Capital Budgets," *Review of Economics and Statistics*, 47, pp. 13-37.

Long, J. B., 1974, "Stock Prices, Inflation, and the Term Structure of Interest Rates," *Journal of Financial Economics*, 1, pp. 131-170.

Merton, R. C., 1971, "Optimum Consumption and Portfolio Rules in a Continuous Time Model," *Journal of Economic Theory*, 3, pp. 373-413.

Merton, R. C., 1973, "An Intertemporal Capital Asset Pricing Model," *Econometrica*, 41, pp. 867-887.

Merton, R. C., 1980, "On Estimating the Expected Return on the Market: An Explanatory Investigation," *Journal of Financial Economics*, 8, pp. 323-361.

Mossin, J., 1966, "Equilibrium in a Capital Asset Market," *Econometrica*, 34, pp. 768-783.

Scruggs, J. T., 1998, "Resolving the Puzzling Intertemporal Relation between the Market Risk Premium and Conditional Market Variance: A Two-Factor Approach," *Journal of Finance*, 58, pp. 575-603.

Sharpe, W. F., 1964, "Capital Assets Prices: A Theory of Market Equilibrium under Conditions of Risk," *Journal of Finance*, 19, pp. 425-442.

Solnik, B. H., 1974, "An Equilibrium Model of the International Capital Market," *Journal of Economic Theory*, 8, pp. 500-524.

Figure 1: Components of stock excess returns for France and Germany

The scale along the vertical axes is in units of percent.

Figure 1A: France

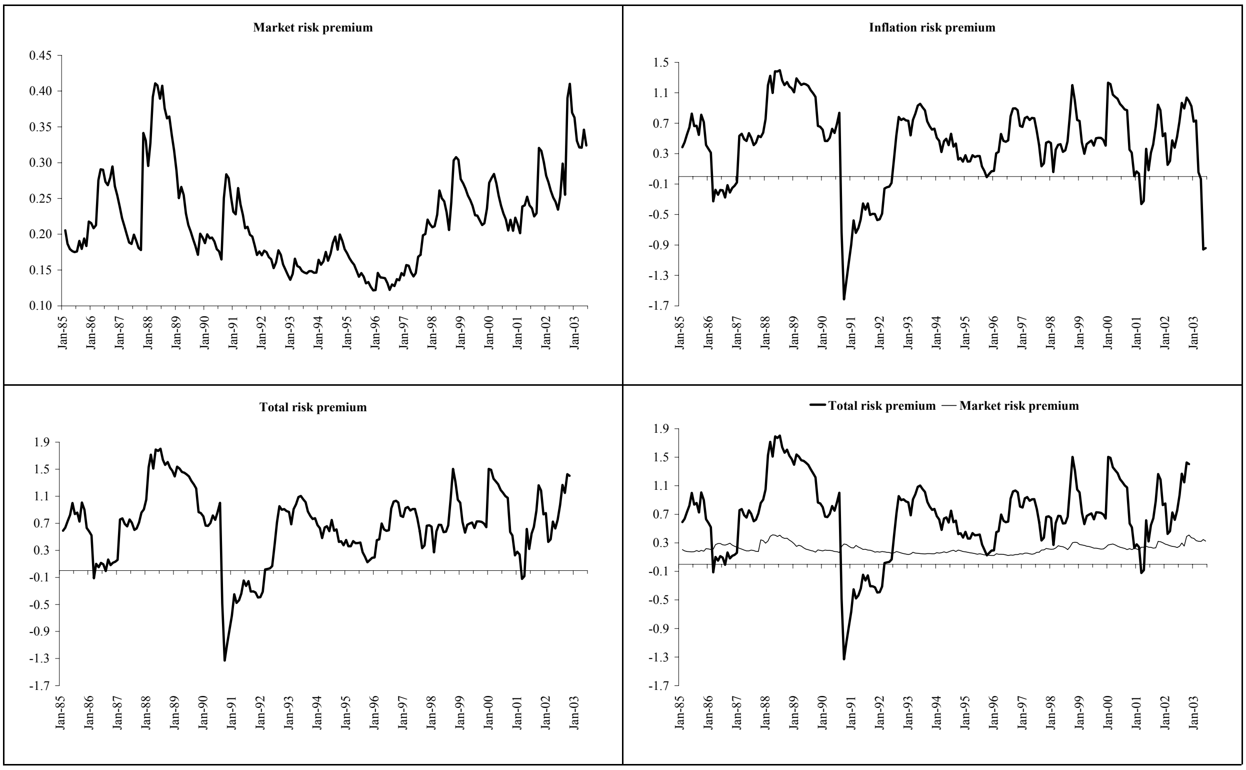

Figure 1B: Germany

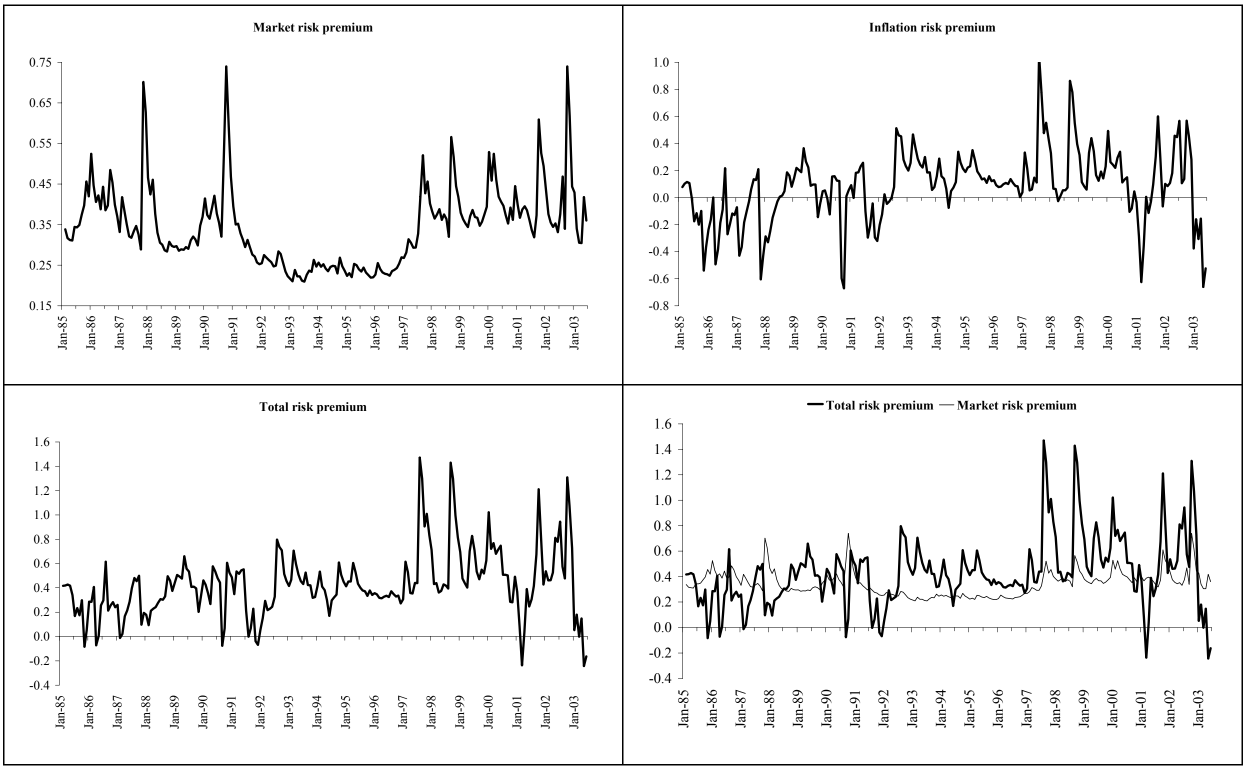

Figure 2: Components of short-term bond excess returns for France and Germany

The scale along the vertical axes is in units of percent.

Figure 2A: France

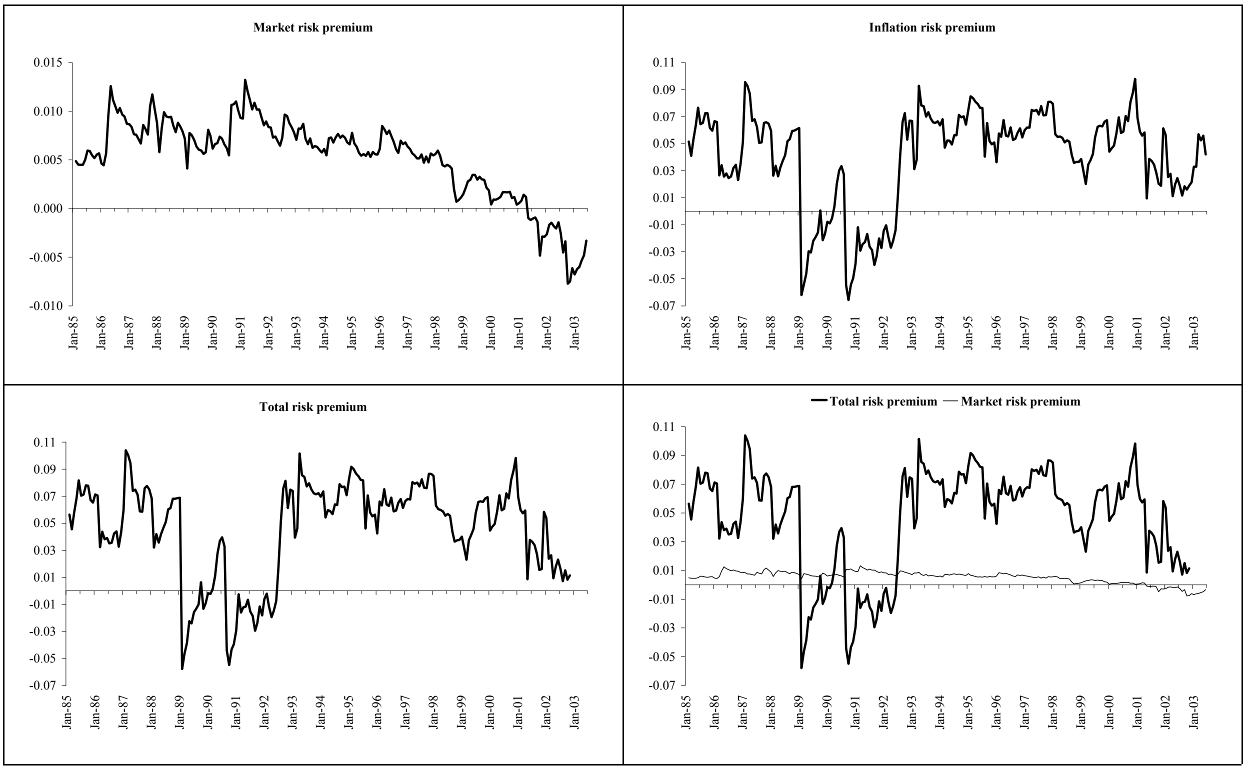

Figure 2B: Germany

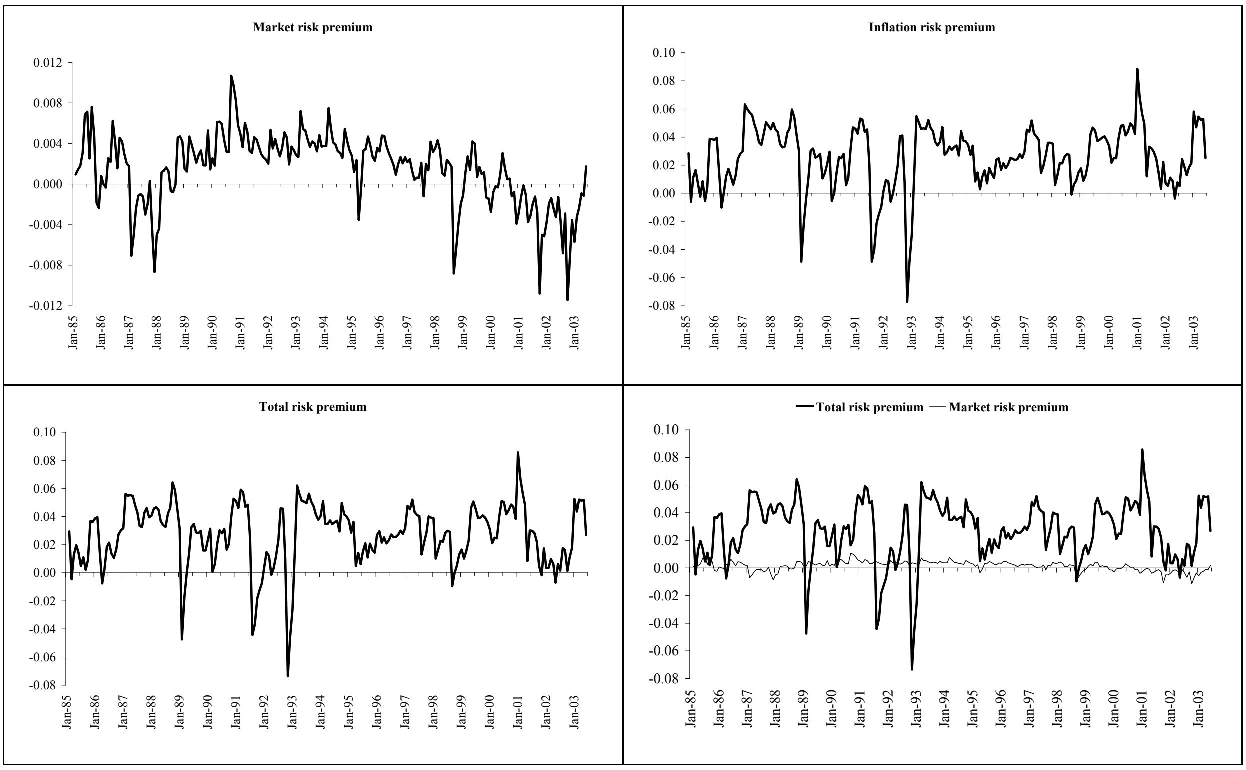

Figure 3: Components of long-term bond excess returns for France and Germany

The scale along the vertical axes is in units of percent.

Figure 3A: France

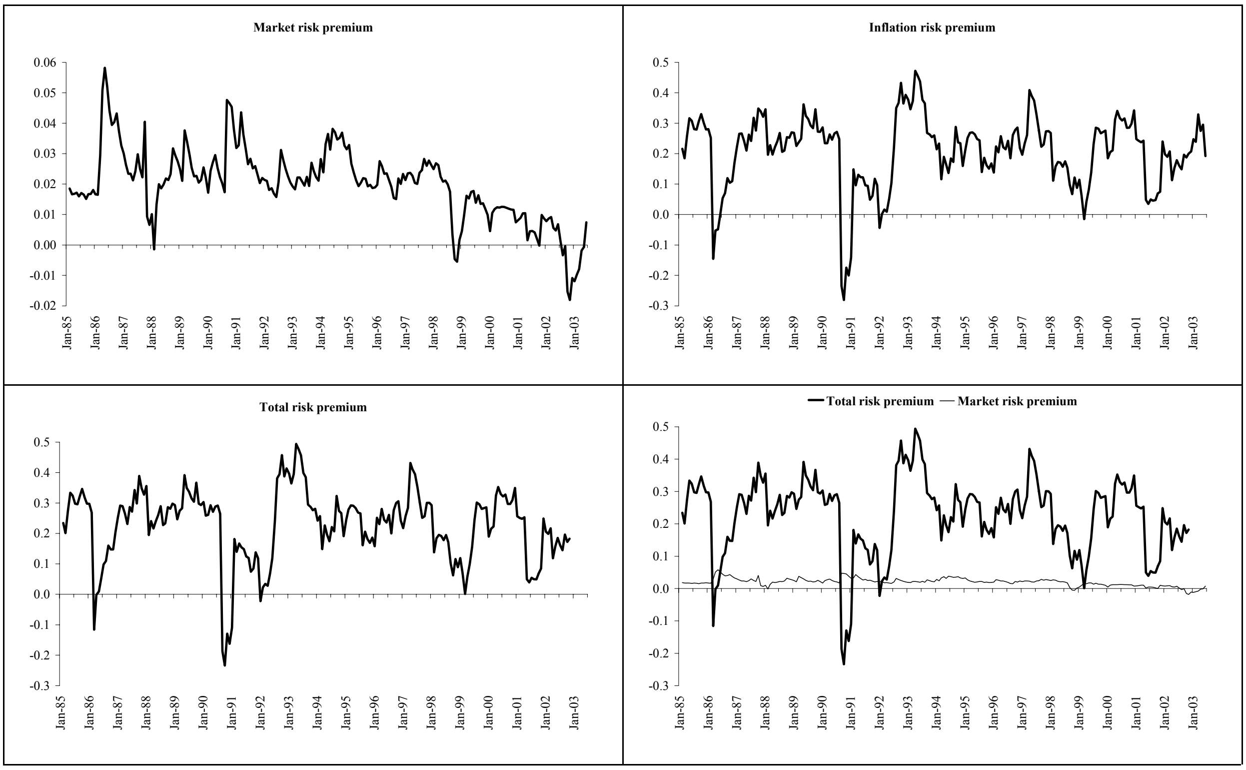

Figure 3B: Germany

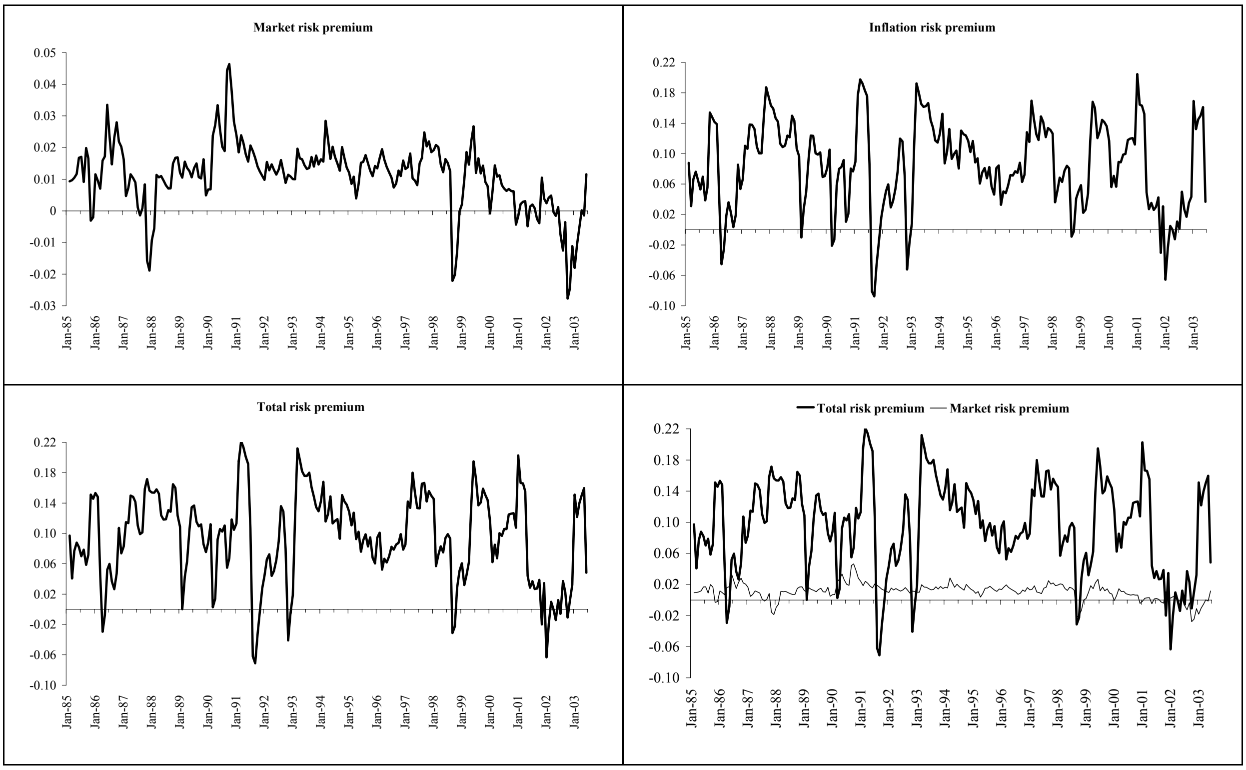

Table 1

Descriptive statistics for excess returns on stocks, holding period returns on short- and long-term bonds, and the inflation rate for France

Panel 1A: Distributional statistics

	Stock	ST Bond	LT Bond	Inflation
Mean	0.44	0.03	0.22	0.18
Min.	-24.70	-2.56	-3.96	-0.39
Max.	18.59	1.67	3.33	0.91
Std. Dev.	6.03	0.53	1.42	0.22
Skew.	-0.52*	-0.84*	-0.21*	0.25*
Kurt.	4.07*	6.48*	2.8*	3.53*
J-B	21.00*	138.30*	1.94	5.00**

**denotes 1% significance level.

Stock, ST bond, LT bond and Inflation represent the excess returns on stocks, the excess holding period returns on short- and long-term bonds and the inflation rate, respectively.

Mean, min., max. and standard deviation are in percentage.

The significance level for skewness (skew.) and excess kurtosis (kurt.) is based on the test statistics developed by d'Agostino, Belanger and D'Agostino (1990). The Jarque-Bera (J-B) test for normality combines excess skewness and kurtosis, and is asymptotically distributed as χ^2_m with m=2 degrees of freedom.

Panel 1B: Autocorrelations of excess returns and inflation rate

	Stock	ST Bond	LT Bond	Inflation
ρ_1	0.11	0.23*	0.16**	0.22*
ρ_2	-0.01	0.00	0.00	-0.05
ρ_3	0.09	-0.04	0.13	0.03
ρ_4	-0.02	0.05	0.12	-0.05
ρ_5	0.00	0.02	-0.09	0.04
ρ_6	-0.04	0.08	-0.02	0.24*
ρ_{12}	0.00	-0.11	-0.14**	0.29*

* and ** denote 5% and 1% significance levels, respectively.

ρ_k is the autocorrelation function at lag k.

Panel 1C: Unconditional correlations of excess returns and the inflation rate

	Stock	ST Bond	LT Bond	Inflation
Stock	1.000	0.153**	0.248*	-0.050
ST Bond		1.000	0.742*	-0.076
LT Bond			1.000	-0.117
Inflation				1.000

* and ** denote 5% and 1% significance levels, respectively.

Panel 1D: Autocorrelations of squared excess returns and inflation rate

	Stock	ST Bond	LT Bond	Inflation
ρ_1	0.16**	0.12	0.10	0.20*
ρ_2	0.04	0.04	0.00	0.01
ρ_3	0.08	0.00	-0.05	0.04
ρ_4	0.21*	-0.01	0.04	0.02
ρ_5	0.03	-0.01	0.05	-0.01
ρ_6	0.02	0.04	0.11	0.06
ρ_{12}	-0.01	0.05	0.01	0.10

* and ** denote 5% and 1% significance levels, respectively.

ρ_k is the autocorrelation function at lag k.

Panel 1E: Unconditional correlations of squared excess returns and inflation rate

	Stock	ST Bond	LT Bond	Inflation
Stock	1.000	0.039	0.275*	0.003
ST Bond		1.000	0.329*	0.049
LT Bond			1.000	-0.081
Inflation				1.000

* and ** denote 5% and 1% significance levels, respectively.

Table 2

Descriptive statistics for excess returns on stocks, holding period returns on short- and long-term bonds, and the inflation rate for Germany

Panel 2A: Distributional statistics

	Stock	ST Bond	LT Bond	Inflation
Mean	0.20	0.07	0.17	0.16
Min.	-24.72	-1.24	-4.11	-0.41
Max.	15.14	1.58	2.29	1.71
Std. Dev.	6.11	0.45	1.16	0.31
Skew.	-0.93*	-0.07	-0.49*	1.46*
Kurt.	5.33*	3.69*	3.14*	7.09*
J-B	81.72*	4.57	8.99**	232.95*

**denotes 1% significance level.

Stock, ST bond, LT bond and Inflation represent the excess returns on stocks, the excess holding period returns on short- and long-term bonds and the inflation rate, respectively.

Mean, min., max. and standard deviation are in percentage.

The significance level for skewness (skew.) and excess kurtosis (kurt.) is based on the test statistics developed by d'Agostino, Belanger and D'Agostino (1990). The Jarque-Bera (J-B) test for normality combines excess skewness and kurtosis, and is asymptotically distributed as χ^2_m with m=2 degrees of freedom.

Panel 2B: Autocorrelations of excess returns and inflation rate

	Stock	ST Bond	LT Bond	Inflation
ρ_1	0.07	0.28*	0.16**	0.15**
ρ_2	0.05	0.03	-0.02	0.04
ρ_3	0.01	0.02	0.10	0.13
ρ_4	0.01	0.06	0.09	-0.03
ρ_5	-0.04	-0.01	-0.09	0.11
ρ_6	0.03	-0.02	-0.06	0.12
ρ_{12}	0.05	-0.03	-0.08	0.49*

* and ** denote 5% and 1% significance levels, respectively.

ρ_k is the autocorrelation function at lag k.

Panel 2C: Unconditional correlations of excess returns and inflation rate

	Stock	ST Bond	LT Bond	Inflation
Stock	1.000	-0.050	0.043	-0.028
ST Bond		1.000	0.839**	-0.137**
LT Bond			1.000	-0.166**
Inflation				1.000

* and ** denote 5% and 1% significance levels, respectively.

Panel 2D: Autocorrelations of squared excess returns and inflation rate

	Stock	ST Bond	LT Bond	Inflation
ρ_1	0.14**	0.13**	0.03	0.06
ρ_2	-0.03	0.07	-0.01	-0.03
ρ_3	0.05	0.05	-0.01	0.18*
ρ_4	0.00	0.04	-0.03	0.00
ρ_5	0.00	0.12	0.05	-0.01
ρ_6	-0.03	0.10	0.08	0.10
ρ_{12}	0.08	0.02	0.03	0.26*

* and ** denote 5% and 1% significance levels, respectively.

ρ_k is the autocorrelation function at lag k.

Panel 2E: Unconditional correlations of squared excess returns and inflation rate

	Stock	ST Bond	LT Bond	Inflation
Stock	1.000	0.044	0.548**	-0.001
ST Bond		1.000	0.087	-0.045
LT Bond			1.000	-0.040
Inflation				1.000

* and ** denote 5% and 1% significance levels, respectively.

Table 3

Estimation results for the Intertemporal CAPM

For the two countries, the estimated model is:

$$\mathbf{R}_{t+1} = \lambda_M \sum_{j=1}^{3} \mathbf{h}_{j,t+1} w_{j,t} + \lambda_\pi \mathbf{h}_{4,t+1} + \boldsymbol{\varepsilon}_{M,t+1}, \text{ where } \lambda_M = \exp(\gamma_M)$$

The inflation equations are

$$\pi^F_{t+1} = \alpha^F_0 + \alpha^F_1 \pi^F_t + \alpha^F_2 \pi^F_{t-5} + \alpha^F_3 \pi^F_{t-11} + \varepsilon^F_{\pi,t+1} \text{ for France and}$$

$$\pi^G_{t+1} = \alpha^G_0 + \alpha^G_1 \pi^G_t + \alpha^G_2 \pi^G_{t-11} + \varepsilon^G_{\pi,t+1} \text{ for Germany}$$

The error terms for the two countries are conditionally normal distributed, i.e. $\boldsymbol{\varepsilon}_{t+1} | \Im_t \sim N(\mathbf{0}, \mathbf{H}_{t+1})$. The conditional covariance matrix follows the multivariate GARCH(1,1) process proposed by Ding and Engle (1994):

$$\mathbf{H}_{t+1} = \mathbf{H}_0 \odot (\mathbf{11}' - \mathbf{aa}' - \mathbf{bb}') + \mathbf{aa}' \odot \varepsilon'_t \varepsilon_t + \mathbf{bb}' \odot \mathbf{H}_t$$

	France		Germany	
	Estimates	Std. Err.	Estimates	Std. Err.
γ_m	-4.5768	1.9929	-4.1072	1.1692
$\lambda_{m=\exp(\gamma m)}$	0.0103		0.0165	
λ_f	-5.7354	2.2687	-1.3719	0.8814
a_1	0.2505	0.0454	0.2946	0.0855
a_2	0.2058	0.0346	0.2822	0.0579
a_3	0.3290	0.0476	0.2993	0.0534
a_4	-0.1332	0.0474	-0.3220	0.052
b_1	0.9407	0.0297	0.7866	0.1193
b_2	0.9680	0.0099	0.8236	0.0669
b_3	0.8621	0.0499	0.8645	0.056
b_4	0.9860	0.0110	0.9198	0.0257
α_0	0.0688	0.0209	0.0531	0.0189
α_1	0.1447	0.0616	0.0603	0.061
α_2	0.1879	0.0648	0.5357	0.0524
α_3	0.2527	0.0602		

Table 4:

Summary statistics on the risk premia for France and Germany

	All period	**1985-1998**	**1999-2003**
France			
Stock returns			
Market risk	0.220	0.205	0.265
Inflation risk	0.437	0.419	0.491
Short-term bond returns			
Market risk	0.005	0.007	-0.001
Inflation risk	0.040	0.038	0.044
Long-term bond returns			
Market risk	0.020	0.024	0.006
Inflation risk	0.207	0.210	0.199
Germany			
Stock returns			
Market risk	0.345	0.325	0.404
Inflation risk	0.082	0.074	0.106
Short-term bond returns			
Market risk	0.001	0.002	-0.002
Inflation risk	0.026	0.024	0.032
Long-term bond returns			
Market risk	0.011	0.014	0.003
Inflation risk	0.085	0.087	0.078
Correlation France / Germany			
Stock returns			
Market risk	0.622	0.562	0.577
Inflation risk	0.388	0.281	0.747
Short-term bond returns			
Market risk	0.627	0.289	0.763
Inflation risk	0.394	0.352	0.670
Long-term bond returns			
Market risk	0.792	0.695	0.925
Inflation risk	0.454	0.436	0.547

Table 5

Diagnostic statistics for the standardised residuals

Panel 5A: France

	Stock	ST Bond	LT Bond	Inflation
Mean	-0.04	0.00	0.00	-0.02
Std. Dev.	1.02	0.98	1.08	1.09
L-B$_{12}$ $\left(\varepsilon^*_{i,t+1}\right)$	12.98	9.05	18.66	14.29
L-B$_{12}$ $\left(\varepsilon^{*2}_{i,t+1}\right)$	4.77	2.61	3.87	2.7

Panel 5B: Germany

	Stock	ST Bond	LT Bond	Inflation
Mean	-0.03	0.12	0.06	0.04
Std. Dev.	1.00	1.18	1.08	1.26
L-B$_{12}$ $\left(\varepsilon^*_{i,t+1}\right)$	9.78	22.01*	21.27*	11.15
L-B$_{12}$ $\left(\varepsilon^{*2}_{i,t+1}\right)$	5.01	1.31	5.30	4.07

* and ** denote 5% and 1% significance levels, respectively.

Standardised residuals are computed as follows: $\boldsymbol{\varepsilon}^*_{t+1} = \mathbf{H}^{-1/2}_{t+1}\boldsymbol{\varepsilon}_{t+1}$.

The Ljung-Box$_m$ (L-B$_m$) statistics tests the null hypothesis that all autocorrelation coefficients are simultaneously equal to zero up to m lags. It is asymptotically distributed as χ^2_m. m=12 has been chosen for which the critical values at 95% and 99% confidence level are 21.03 and 26.22, respectively.

European Central Bank working paper series

For a complete list of Working Papers published by the ECB, please visit the ECB's website (http://www.ecb.int)

402 "Forecasting euro area inflation using dynamic factor measures of underlying inflation" by G. Camba-Méndez and G. Kapetanios, November 2004.

403 "Financial market integration and loan competition: when is entry deregulation socially beneficial?" by L. Kaas, November 2004.

404 "An analysis of systemic risk in alternative securities settlement architectures" by G. Iori, November 2004.

405 "A joint econometric model of macroeconomic and term structure dynamics" by P. Hördahl, O. Tristani and D. Vestin, November 2004.

406 "Labour market reform and the sustainability of exchange rate pegs" by O. Castrén, T. Takalo and G. Wood, November 2004.

407 "Banking consolidation and small business lending" by E. Takáts, November 2004.

408 "The great inflation, limited asset markets participation and aggregate demand: FED policy was better than you think" by F. O. Bilbiie, November 2004.

409 "Currency mismatch, uncertainty and debt maturity structure" by M. Bussière, M. Fratzscher and W. Koeniger, November 2004.

410 "Do options-implied RND functions on G3 currencies move around the times of interventions on the JPY/USD exchange rate? by O. Castrén, November 2004.

411 "Fiscal discipline and the cost of public debt service: some estimates for OECD countries" by S. Ardagna, F. Caselli and T. Lane, November 2004.

412 "The real effects of money growth in dynamic general equilibrium" by L. Graham and D. J. Snower, November 2004.

413 "An empirical analysis of price setting behaviour in the Netherlands in the period 1998-2003 using micro data" by N. Jonker, C. Folkertsma and H. Blijenberg, November 2004.

414 "Inflation persistence in the European Union, the euro area, and the United States" by G. Gadzinski and F. Orlandi, November 2004.

415 "How persistent is disaggregate inflation? An analysis across EU15 countries and HICP sub-indices" by P. Lünnemann and T. Y. Mathä, November 2004.

416 "Price setting behaviour in Spain: stylised facts using consumer price micro data" by L. J. Álvarez and I. Hernando, November 2004.

417 "Staggered price contracts and inflation persistence: some general results" by K. Whelan, November 2004.

418 "Identifying the influences of nominal and real rigidities in aggregate price-setting behavior" by G. Coenen and A. T. Levin, November 2004.

419 "The design of fiscal rules and forms of governance in European Union countries" by M. Hallerberg, R. Strauch and J. von Hagen, December 2004.

420 "On prosperity and posterity: the need for fiscal discipline in a monetary union" by C. Detken, V. Gaspar and B. Winkler, December 2004.

421 "EU fiscal rules: issues and lessons from political economy" by L. Schuknecht, December 2004.

422 "What determines fiscal balances? An empirical investigation in determinants of changes in OECD budget balances" by M. Tujula and G. Wolswijk, December 2004.

423 "Price setting in France: new evidence from survey data" by C. Loupias and R. Ricart, December 2004.

424 "An empirical study of liquidity and information effects of order flow on exchange rates" by F. Breedon and P. Vitale, December 2004.

425 "Geographic versus industry diversification: constraints matter" by P. Ehling and S. B. Ramos, January 2005.

426 "Security fungibility and the cost of capital: evidence from global bonds" by D. P. Miller and J. J. Puthenpurackal, January 2005.

427 "Interlinking securities settlement systems: a strategic commitment?" by K. Kauko, January 2005.

428 "Who benefits from IPO underpricing? Evidence form hybrid bookbuilding offerings" by V. Pons-Sanz, January 2005.

429 "Cross-border diversification in bank asset portfolios" by C. M. Buch, J. C. Driscoll and C. Ostergaard, January 2005.

430 "Public policy and the creation of active venture capital markets" by M. Da Rin, G. Nicodano and A. Sembenelli, January 2005.

431 "Regulation of multinational banks: a theoretical inquiry" by G. Calzolari and G. Loranth, January 2005.

432 "Trading european sovereign bonds: the microstructure of the MTS trading platforms" by Y. C. Cheung, F. de Jong and B. Rindi, January 2005.

433 "Implementing the stability and growth pact: enforcement and procedural flexibility" by R. M. W. J. Beetsma and X. Debrun, January 2005.

434 "Interest rates and output in the long-run" by Y. Aksoy and M. A. León-Ledesma, January 2005.

435 "Reforming public expenditure in industrialised countries: are there trade-offs?" by L. Schuknecht and V. Tanzi, February 2005.

436 "Measuring market and inflation risk premia in France and in Germany" by L. Cappiello and S. Guéné, February 2005.