# THE SINGLE EUROPEAN CURRENCY AND WORLD EQUITY MARKETS

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97/122/FIN

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*This version:* November 19, 1997

# The Single European Currency and World Equity Markets

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Abstract

The objective of this study is to analyze the impact on world financial markets of the adoption of the Single Currency and the contemporaneous elimination of intra european currency risk. We estimate the EMU and non-EMU components of aggregate currency risk using a conditional version of the international CAPM of Adler and Dumas (1983). Our results indicate that investors are rewarded for their exposure to both sources of currency risk. The premium for EMU risk is mostly positive, but has decreased over the years. The non-EMU currency risk is consistently negative and is much larger, in absolute value, than its EMU counterpart. This suggests that the adoption of a single currency is likely to have a limited impact. European financial markets will still be exposed to the large and dominant impact of the non-EMU currency risk.

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The 1991 Treaty on European Union (Maastricht Treaty) set January 1, 1999 as the starting date for the final stage in the creation of the European Monetary Union (EMU). If the European Council decides to confirm the 1999 deadline, the exchange rates between EMU participants will be irrevocably fixed to start the transition toward a unique currency, the euro, which is expected to become the legal tender for EMU participants by the year 2002.

Most advocates of the EMU describe the introduction of the euro not as a major currency reform, but rather as a currency changeover which will simplify international transactions and increase market liquidity by eliminating conversion costs and exchange rate risk. This, in turn, should provide a boost to international investments and to the overall level of economic activity.

Although the arguments in favor of a unique European currency are intuitively appealing, a more thorough analysis of the concept of currency risk may be useful to better appreciate the relevance of the EMU to investors. In general, it is well known that the existence of uncertainty in financial markets is not necessarily bad. First, because it is often possible to hedge against it, at least in part. Second, because efficient financial markets reward investors for their exposure to systematic risk. In addition, despite the elimination of currency fluctuations within the EMU, European consumers will still be exposed to exchange rate uncertainty toward non-EMU currencies like the U.S. dollar, the Japanese yen and the British pound.[1] The price sensitivity of their consumption baskets with respect to such currencies is also an important factor in determining the effects of adopting the euro. Surprisingly, very limited empirical evidence is available on these issues.

The main objective of this study is to analyze the impact on world financial markets of the adoption of a single European currency and the subsequent elimination of intra-European currency risk. We estimate the EMU and non-EMU components of aggregate currency risk using a conditional version of the international CAPM of Adler and Dumas (1983). Our results indicate that investors are rewarded for their exposure to both sources of exchange risk. The premium for EMU risk is mostly positive, but has decreased over the years. The non-EMU risk is consistently negative and is much larger, in absolute value, than its EMU counterpart. This suggests that the adoption of a single currency is likely to have a limited impact. European financial markets will still be exposed to the large and dominant impact of the non-EMU currency risk.

In addition, the adoption of a single currency is likely to have a significant impact also on European equity markets and, in particular, on their correlation structure. For example, it is often argued that the convergence of economic structures and policies, the existence of a unique currency and identical interest rates will increase correlations and, as a consequence, reduce the benefits of portfolio diversification (see, among others, Frankel (1995)). Although our paper does not address these

[1] We treat the British pound as a non-EMU source of currency risk because the United Kingdom (and Denmark) have decided to keep their option to join the EMU open through an opt-in clause.

issues directly, it yields interesting insights on the way European investors are likely to adjust their portfolio holdings under the EMU and on the home-bias phenomenon.

The rest of the paper is organized as follows. In Section 1 we briefly review some basic concepts in the theory of portfolio choice and then present a model of international asset pricing which includes both market and currency risk. In Section 2 we describe the data set. In Section 3 we present the empirical evidence. In Section 4 we discuss our results and present concluding remarks.

# 1 Portfolio Choice and Currency Risk

Modern portfolio theory suggests that investors should hold internationally diversified portfolios to improve the reward-to-risk ratio of their asset holdings. The attractiveness of international diversification is mostly due to the low level of correlation among national markets, which has been documented in a large number of studies (see, for example, Levy and Sarnat (1970), Solnik (1974a,b, 1995), French and Poterba (1991) and Elton and Gruber (1992)).

It is often argued, however, that standard mean-variance analysis does not necessarily apply when investors can allocate their wealth across assets traded in different national markets. In addition to market risk, one can think of a variety of sources of uncertainty that may be of concern to investors who are internationally diversified. For example, the risk of political turmoil in foreign countries may lead to restrictions on the repatriation of capital. Other deterrents may be differences in accounting procedures and, more generally, the costs involved in acquiring information in foreign markets. Typically, however, currency (or exchange rate) risk is the factor most commonly used to explain investors' resistance to international diversification.

The return on any foreign stock fluctuates not only because of asset-specific risk, but also because of unpredictable fluctuations in the exchange rate. Loosely speaking, the latter effect is often referred to as currency risk. Although apparently obvious, this interpretation may lead to largely overstate the relevance of currency risk for several reasons.[2]

First, the sources of total return volatility differ among asset classes. For example, in panel a of Table 1 we decompose the monthly return volatility of some national stock-indices as well as Eurocurrency deposits, taking the perspective of a German investor. For the stock markets in our sample the data show that at most 36.5 per cent of the total volatility is due to exchange rate fluctuations. For the European equity markets that we consider this value is even lower at 14 per cent. Panels b and c confirm this result over subsamples. Therefore, in the case of stock returns, total volatility is mostly due to fluctuations of the domestic stock market rather than to exchange rate volatility. On the other hand, the same volatility decomposition for returns on Eurocurrency deposits shows that most of the volatility is due to exchange

[2] See Solnik (1996) for a thorough discussion of these issues.

rate fluctuations.

Second, for most developed markets, a large part of currency risk can be hedged by using derivative securities or, even more simply, by trading on foreign bond markets.[3] Obviously, hedging involves a cost; but as long as exposure to currency risk can be eliminated (or significantly reduced) at a cost that is lower than the expected benefits of international diversification, investors should include foreign assets into their optimal portfolios.

Third, and most important, the practical relevance of currency risk can be appropriately measured only within the context of an international asset pricing model. For example, in the domestic CAPM we know that asset-specific volatility is not a proper measure of risk, since a possibly significant part of it can be diversified when the asset is included in a portfolio. In that framework, the appropriate measure of risk–usually referred to as systematic risk–is given by the covariance of each asset return with the return on the market portfolio. In equilibrium, investors should be rewarded for their exposure to systematic risk with a premium in excess of the risk free rate. Intuition suggests that a similar idea should apply when investors can purchase assets traded in different national markets. The volatility of the return on a foreign asset (or market index) contains a country-specific component and a currency component. However, neither component should be interpreted as a measure of risk, since they can be diversified, at least in part, by including the asset in an internationally diversified portfolio. In the next section we build on this intuition to discuss an international version of the traditional CAPM which is carefully derived in Adler and Dumas (1983).

## 1.1 The Model

The traditional version of the CAPM of Sharpe (1964) and Lintner (1965) can be rescued in an international framework only by introducing two strong assumptions: investors from different countries consume the same basket of goods, and relative purchasing power parity (PPP) holds exactly at any point in time.[4] Examples of this literature are Grauer, Litzenberger and Stehle (1976) and Hodrick (1981). Collecting empirical evidence on the first assumption can be rather difficult, although some work on this issue is discussed in Adler and Dumas (1983). The evidence on the second assumption, on the other hand, is rather compelling. Even if there is still an ongoing debate on whether PPP holds in the long-run, the consensus is that the parity condition is violated in the short-run, even in its relative form. As a consequence, investors from different countries have a different perception of the real return from

[3]It is well known, from interest rate parity relations, that the payoff of a forward contract in a foreign currency can be replicated by purchasing the domestic bill and shorting the foreign bill.

[4]Absolute PPP states that, given two countries, the ratio of their price indices must be equal to the exchange rate. The relative form of PPP requires instead that the change in the exchange rate be equal to the inflation differential between the two countries.

the same asset and, because of this heterogeneity, the domestic CAPM does not hold in an international framework. Fortunately, the tools of standard mean-variance analysis can still be applied on a country-by-country basis and the results used to derive implications for optimal portfolio allocation and asset pricing restrictions in equilibrium.

Assume that, in each country, investors maximize the expected utility of future real consumption and that domestic inflation in nonstochastic.[5] The ICAPM predicts that, in equilibrium, all investors hold a combination of two risky portfolios, in addition to the risk-free asset. The first one, usually referred to as the *universal logarithmic portfolio*, is the world portfolio of all assets, partially hedged against currency risk.[6] As indicated by its definition, this portfolio is common among investors from all countries. The second portfolio, referred to as the *personalized hedge portfolio*, is country-specific, and only includes the bill denominated in the home currency[7]. The relative allocation across assets determines the optimal hedge ratio which does not have to be equal to one since it is not necessarily optimal for investors to fully hedge their exposure to currency risk.

In addition to providing optimal portfolio weights, the model also yields pricing restrictions for all assets. These restrictions need to be expressed in a common currency but, as shown by Sercu (1980), the results are invariant to the choice of the reference currency. In equilibrium, the expected return on any asset is equal to the return on the risk free asset, denominated in the reference currency, plus a premium for exposure to market and currency risk. The size of market risk is given by the covariance of the asset return with the return on the world-wide portfolio of all traded assets, whereas exchange rate risk, with respect to a given currency, is measured by the covariance of the asset return with the relative change in the corresponding exchange rate. Formally, if the Deutsche mark (DM) is used as the reference currency, the model imposes the following pricing restrictions

$$E\left(R_i^{DM}\right) - R_f^{DM} = \gamma \; cov\left(R_i^{DM}, R_M^{DM}\right) + \sum_{j=1}^{n} \delta_j \; cov\left(R_i^{DM}, \nu_j^{DM}\right) \quad \forall i \tag{1}$$

where $R_i^{DM}$ is the DM-denominated return on asset $i$, $R_f^{DM}$ is the return on the

[5]The model can be solved without the assumption that inflation is nonstochastic. In this case, however, it is hard to disentangle inflation and currency risk. Since the evidence suggests that the volatility of inflation in most developed markets is negligible compared to exchange rate volatility, we proceed with this assumption. This allows us to focus on the empirical relevance of currency risk alone.

[6]The hedging portion of this portfolio derives from the fact that it contains bills denominated in the currencies of the various national markets. As mentioned earlier, combinations of local and foreign bills can be used to replicate the payoffs of forward contracts and, therefore, as hedging instruments against currency risk.

[7]The model thus predicts that a significant fraction of an investor's assets will be invested in domestic securities, through the hedge portfolio, and therefore generates "home bias". However the model does not necessarily justify the extent of equity home bias documented in practice (see Tesar and Werner (1995))

DM-denominated bill, $R_M^{DM}$ is the DM-denominated return on the world-wide market portfolio and $\nu_j^{DM}$ is the relative change in the DM price of currency $j$. The coefficient $\gamma$ measures the trade-off between the expected return on the asset and its market risk and, for this reason, can be interpreted as the shadow price of market risk. Using the same argument, each coefficient $\delta_j$ in equation (1) is usually referred to as the price of exchange rate risk for currency $j$.

To better understand the nature of currency risk in this model, consider the following example. Assume there exist only two countries, the U.S. and Germany, and that investors hold well diversified portfolios (e.g. country funds) for both countries. Take the point of view of a German investor and use the DM as the measurement currency. The model predicts that the expected DM return on the U.S. fund, in excess of the return on the DM-denominated bill, should be proportional to the covariance of the return on the fund with the return on the world portfolio (i.e. market risk), and to the covariance of the fund with the relative change in the exchange rate between the DM and the U.S. dollar (i.e. currency risk). If $R_{US}^{DM}$ is the DM-denominated return on the U.S. fund and $\nu_{\$}^{DM}$ the relative change in the DM/dollar exchange rate, then equation (1) can be written as follows[8]

$$E\left(R_{US}^{DM}\right) - R_f^{DM} = \gamma \ cov\left(R_{US}^{DM}, R_M^{DM}\right) + \delta \ cov\left(R_{US}^{DM}, \nu_{\$}^{DM}\right) \tag{2}$$

The U.S. fund is held by both U.S. and German investors. Obviously, U.S. investors are not concerned with currency risk for a fund that contains U.S. assets; therefore, the currency risk component in equation (2) is justified by the fact that a fraction of the fund is held by German investors. If returns are continuously compounded, the return on the U.S. fund, measured in DM, is equal to the return on the fund, measured in U.S. dollars, plus the relative change in the DM/dollar exchange rate. As a consequence, the covariance between the DM return on the U.S. fund and the relative change in the exchange rate is equal to the sum of the covariance between the dollar return on the U.S. fund and the change in the exchange rate, plus the variance of the change in the exchange rate

$$cov\left(R_{US}^{DM}, \nu_{\$}^{DM}\right) = cov\left(R_{US}^{\$}, \nu_{\$}^{DM}\right) + var\left(\nu_{\$}^{DM}\right). \tag{3}$$

This shows that, in this model, exchange rate volatility alone is not an appropriate measure of currency risk. Consider, for example, a scenario in which the covariance between $R_{US}^{\$}$ and $\nu_{\$}^{DM}$ is negative. This implies that when the DM gains value vis-á-vis the U.S. dollar ($\nu_{\$}^{DM}$ is negative), the dollar-denominated return on the U.S. fund is positive. Therefore, the German investor who holds the U.S. fund, loses from the devaluation of the dollar, but profits from the capital gain on the fund. In this sense, the U.S. fund itself is, at least in part, a hedge against exchange rate fluctuations. As

[8]Similarly, the expected return on the German fund will be proportional to its market and currency risk exposures. Here, we focus on the U.S. fund to interpret its currency risk component.

a consequence, the appropriate measure of currency risk exposure for the U.S. fund is lower than the volatility of the DM/dollar exchange rate.

Two specific cases are of interest. First, in the unlikely case in which $cov\left(R^{\$}_{US}, \nu^{DM}_{\$}\right)$ is negative but equal, in absolute value, to $var\left(\nu^{DM}_{\$}\right)$, then the U.S. fund has no DM currency risk exposure. Second, if the covariance is negative and larger, in absolute value, than the variance, then the currency risk associated with the U.S. fund becomes negative, since the fund is more than a hedge against fluctuations of the DM/dollar exchange rate[9]. Obviously, equation (3) also implies that currency risk is larger than the volatility in the exchange rate changes if the dollar-denominated return on the U.S. fund is positively correlated with $\nu^{DM}_{\$}$ (i.e. the dollar return on the fund is positive when the DM depreciates vis-á-vis the U.S. dollar). Finally, exchange rate volatility is the appropriate measure of an asset exposure to currency risk only when the return on the asset, denominated in the domestic currency, is uncorrelated with exchange rate changes.

In a multicurrency world, the expected return on any asset is affected by multiple premia for exposure to currency risk. For instance, if Japan is added to U.S. and Germany in the previous example, the appropriate measure for currency risk for the U.S. fund would include the covariance between the DM return on the fund and the relative change in the DM/dollar exchange rate as well as the covariance between the DM return on the fund and the relative change in the DM/yen exchange rate.

The preceding discussion implies that ultimately, the relevance of currency risk in international financial markets is an empirical issue. Unfortunately, many authors have tried to approach this question in the past with inconclusive results. Examples are contained in Solnik (1974a), Stehle (1977), Eun and Resnick (1988) and Korajczyck and Viallet (1989). Arguably, the reason why the evidence has been inconsistent across studies is that most authors have used an unconditional approach for different sampling periods.[10] As pointed out by De Santis and Gerard (1997a), this type of analysis can be very misleading if the conditional distribution of asset returns changes over time. For example, they find that although currency risk is priced and economically relevant, both its size and sign change significantly over the 1973-1994 period. Interestingly, they estimate that the average premium for currency risk is close to zero for most markets, when looking at the overall sample. Over subperiods, however, its size and persistence are often nontrivial. Since, unconditional analysis essentially amounts to averaging the conditional premia, one may learn very little from applying it to long sampling periods. On the other hand, an analysis based on a short sample, as in Eun and Resnick (1988), can be misleading if the period being investigated displays unusual characteristics.

[9]Implicit in this discussion is the assumption that the German investor consumes goods denominated in DM.

[10]In practice, this amounts to assuming that the distribution of asset returns does not change with changing economic conditions, and thus that exposures to market and currency risks and their premia are invariant to market conditions and institutional changes.

In light of these issues, we focus on the conditional version of the model. When new information becomes available, investors may update their beliefs with respect to both expected returns and volatility in equity and currency markets. In addition, they may change their attitude toward risk.[11] In practice, choosing a conditional specification of the model amounts to specifying how the moments of the asset return distribution change over time. To accommodate these dynamics into the model, we modify the notation in equation (1) as follows. Let $R_{i,t}^{DM}$ be the DM-denominated return on asset $i$ between time $t-1$ and time $t$; also let $E_{t-1}(\cdot)$ and $cov_{t-1}(\cdot)$ denote the expectation and covariance operators, respectively, conditional on the information available at the end of time $t-1$. Equation (1) in its conditional form can be written as

$$E_{t-1}\left(R_{i,t}^{DM}\right)-R_{f,t}^{DM}=\gamma_{t-1}\, cov_{t-1}\left(R_{i,t}^{DM}, R_{M,t}^{DM}\right)+\sum_{j=1}^{n}\delta_{j,t-1}\, cov_{t-1}\left(R_{i,t}^{DM}, \nu_{j,t}^{DM}\right). \quad (4)$$

It is obvious from the equation that the choice of the dynamics for the first and second moments is not independent. Because the asset pricing model postulates a relation between expected returns and covariances among returns, one can freely parameterize only the first or the second moments. Here, we follow the approach of De Santis and Gerard (1997a,b) who use a parsimonious generalized autoregressive conditionally heteroskedastic (GARCH) specification for the dynamics of the second moments[12]. We also assume that the price of market risk ($\gamma_{t-1}$) as well as all the prices of currency risk ($\delta_{j,t-1}$) can change over time. We estimate the model using the quasi-maximum likelihood (QML) methodology discussed in Bollerslev and Wooldridge (1992). A detailed discussion of the empirical methods can be found in De Santis and Gerard (1997a,b) and De Santis, Gerard and Hillion (1997).

## 2 Data

We use monthly returns on stock indices for five countries (U.S., France, Germany, Netherlands and U.K.) plus a value-weighted world index. All the indices are obtained from Morgan Stanley Capital International (MSCI) and the sampling period covers 280 observations from January 1974 through April 1997. The geographical composition of our sample is the result of a compromise between two objectives: first, we want to cover a nonnegligible portion of the international equity markets, both within and outside the EMU; second, we want to limit the size of the system to keep the estimation feasible. All MSCI indices are available with and without dividends reinvested so that we can compute returns that include both capital gains and dividend yields. The monthly dividend yield is equal to 1/12 of the ratio between the previous year dividend and the index at the end of each month.

[11] For example, an asset which provides only a limited hedge against exchange rate risk may become much more attractive when investors expect an increase in exchange rate uncertainty.

[12] See Bollerslev, Chou and Kroner (1992) for an overview of the GARCH litterature.

To estimate the currency risk component of the model, we use Eurocurrency rates offered in the interbank market in London for one-month deposits in U.S. dollars. Japanese yen, French francs, Dutch guilder and British pounds. The Eurocurrency rates are from Data Resources Incorporated (DRI) and the Bank of International Settlements (B.I.S.) in Basel.

Returns on both equity and Eurodeposits are measured in Deutsche marks, based on the closing European interbank currency rates from MSCI. We compute the monthly excess returns by subtracting the conditionally risk-free rate from the monthly return on each security. Given the choice of the measurement currency, an obvious candidate for the conditionally riskless asset is the one-month Eurocurrency deposit denominated in Deutsche marks and quoted in London on the last day of the month.

The summary statistics reported in Table 2 reveal a number of interesting facts. The excess returns on the stock indices have higher means, but also higher volatility than the excess returns on the Eurodeposits. In most cases the index of kurtosis and the Bera-Jarque test statistic strongly reject the hypothesis of normally distributed returns, which supports our decision to use QML to estimate and test the model. Panel b in the table contains also the unconditional correlations among markets. The values are relatively low, especially if compared to the average correlation among sectors of the U.S. market.[13] Interestingly, the correlation between the returns on Eurodollar and Europound deposits is very high, thus implying a potentially high correlation between U.S. dollar and British pound risk.

Panel c in the table reports autocorrelations for the excess returns and panel d autocorrelations for the excess returns squared. The predominant lack of autocorrelation in the return series reveals that, in our analysis, we do not need to correct for the possibility of autocorrelation in the market indices. On the other hand, autocorrelation is detected, at short lags, in the squared returns, thus suggesting that a GARCH specification for the second moments might be appropriate, at least for the stock return series.

Finally, for the squared returns, panel e in the table contains the cross-correlations, at different leads and lags, between the world index and the other assets. We report these statistics to determine whether we should use a GARCH parameterization which can accommodate cross-market dependence in volatility. With few exceptions, only the contemporaneous correlations are statistically significant. Although this is only a subsample of all the relevant cross-correlations, when we analyze the cross-correlations with at most two leads and two lags, only 23 out of 264 are statistically significant at the 5% level. In this sense, the diagonal GARCH parameterization that we use is not too restrictive.

In choosing the instruments that describe the investor's information set, we are guided by previous research (Ferson and Harvey (1993), Dumas and Solnik (1995),

[13]For example, Elton and Gruber (1992) document that during the 1980-1988 period, the correlation between the value-weighted index of the 1000 largest stocks traded in the U.S. and the value-weighted index of the next 2000 largest stocks is 0.92.

De Santis and Gerard (1997a)) and by economic intuition. The instruments include: a constant, the dividend yield on the world equity index in excess of the one-month Euromark rate, the change in the one-month Eurodollar deposit rate and the U.S. default premium, measured by the yield difference between Moody's Baa and Aaa rated bonds. In addition to these common variables, we also use one country specific variable to predict changes in currency risk premia. We hypothesize that the relative attractiveness of each currency and the reward required to bear its associated risk is affected by the difference between the real return on the local short term deposit and the real return on the short term deposit in the reference currency, which we refer to as the real risk-free rate differential. Real returns are computed by deflating local nominal one-month Eurocurrency rates by the change in the local CPI index. Inflation data are from the International Financial Statistics (IFS) database. All variables are used with a one-month lag, relative to the excess return series. The summary statistics in Table 3 show that the correlations among the instruments are low, which indicates that our proxy of the information set does not contain redundant variables.

# 3 Empirical Evidence

The ICAPM described in Section 1 offers a number of testable implications which are of primary interest in our study. First, we can determine whether world-wide market risk and currency risk are priced factors in international financial markets. Second, we can separately identify and test the relevance of EMU-specific currency risk. However, some additional considerations are necessary before we proceed to analyze the empirical evidence. As mentioned earlier, we assume that all prices of risk are time-varying. The parameterization that we choose is inspired to previous work (see, in particular, De Santis and Gerard (1997a)). For each price, we assume that the dynamics can be described by a set of instrumental variables. Moreover, in each case we have to choose both the set of relevant instruments and the functional form.[14] For the price of market risk the vector of instruments $z_{M,t-1}$ includes a constant, the dividend yield on the world equity index in excess of the one-month Euromark rate ($XDPR$), the change in the one-month Eurodollar rate ($\Delta Euro\$$) and the U.S. default premium ($USDP$), measured by the yield difference between Moody's Baa and Aaa rated bonds. In choosing the functional form for $\gamma_{t-1}$ we take into consideration the implications of the theoretical model. The price of market risk is a weighted average of the coefficients of risk aversion of all national investors;[15] therefore, under the assumption that all investors are risk averse, $\gamma_{t-1}$ must be always positive. To guarantee that this restriction is satisfied, we assume that $\gamma_{t-1}$ is an

[14] Unfortunately, in the absence of a general equilibrium model, the choice of relevant instruments is inevitably ad-hoc. In general, there is no reason to assume that the same set of instruments should be used for all prices of risk.

[15] See Adler and Dumas (1983).

exponential function of the instruments in $z_{M,t-1}$

$$\gamma_{t-1} = \exp\left(\kappa'_M z_{M,t-1}\right).$$

On the other hand, the theory does not impose any restriction on the sign of the prices of currency risk. For this reason, we adopt a linear specification for each $\delta_{j,t-1}$ in the model

$$\delta_{j,t-1} = k'_j z_{j,t-1}.$$

The vector $z_{j,t-1}$ includes a constant, two variables which are common to all prices ($\Delta Euro\$$ and $USDP$, as defined above) and a currency specific variable measured by the difference between the real interest rate of country $j$ and the real Euromark rate.[16]

## 3.1 The Statistical Relevance of Currency Risk

Table 4 contains parameter estimates and a number of diagnostic tests for the model. In panel a we report point estimates and QML standard errors for the individual parameters of the model, whereas in panel b we use robust Wald test statistics to evaluate joint hypotheses. All the statistics in panel b support the ICAPM discussed earlier in the paper. In particular, the price of world-wide market risk $\gamma_{t-1}$ is statistically significant and time-varying, since the null hypothesis that all the $k_M$ coefficients are equal to zero is strongly rejected. Even more interesting for our purposes is the result that currency risk is also a priced factor. In fact, the null hypothesis that the $k_j$ coefficients for all currencies are equal to zero is rejected at any standard level.

Having established the empirical relevance of currency risk, it is useful to disaggregate it into EMU and non-EMU components. Obviously, since the Deutsche mark is used as the measurement currency, the two sources of currency risk which are bound to disappear with the inception of the EMU are French franc and Dutch guilder risk. On the other hand, currency risk associated with the U.S. dollar, the Japanese yen and the British pound is not going to be eliminated by the adoption of the unique currency. For this reason, in panel b of Table 4 we include two additional tests on the relevance of currency risk. Under the null hypothesis that EMU (non-EMU) currency risk is not priced, all the $\kappa_j$ coefficients for the relevant currencies must be equal to zero. The results for these test show that both EMU and non-EMU currency risk are priced, at least at the 5% level.

Finally, the statistics in the table also show that the GARCH parameterization that we propose adequately describes the dynamics of the conditional second moments. However, since this is not the main focus of the paper, we do not expand this part of the analysis here.

[16] We use the term country $j$ to indicate the country whose goods are denominated in currency $j$.

## 3.2 The Economic Relevance of Currency Risk

The fact that currency risk is a priced factor, both in its EMU and non-EMU components, has interesting implications. In fact, as long as exposure to exchange rate fluctuations is rewarded by the market in the form of a risk premium, it may not be optimal to eliminate multiple currencies, since this would only eliminate potentially attractive assets from the menu of choices available to investors. A more educated assessment of this issue requires an explicit measure of the premium associated with each source of risk, which can be easily done using our approach. Specifically, the premium for market risk for asset $i$ is simply computed as the product between the price of market risk $\gamma_{t-1}$ and the conditional covariance $cov_{t-1}\left(R_{i,t}^{DM}, R_{M,t}^{DM}\right)$. Since both quantities are explicitly parameterized in the model, the premium for market risk can be computed for any asset included in the system of equations (4). For the same asset, the aggregate measure of currency risk, as well as its components, can be obtained from the expression $\sum_{j=1}^{n} \delta_{j,t-1}\, cov_{t-1}\left(R_{i,t}^{DM}, \nu_{j,t}^{DM}\right)$. In Tables 5 and Figures 1a-6b, we report information on the estimated premia, using the following definitions

- Market Premium: $MP = \gamma_{t-1}\, cov_{t-1}\left(R_{i,t}^{DM}, R_{M,t}^{DM}\right)$
- Aggregate Currency Premium: $ACP = \sum_{j=1}^{n} \delta_{j,t-1}\, cov_{t-1}\left(R_{i,t}^{DM}, \nu_{j,t}^{DM}\right)$
  - EMU Currency Premium: $ECP = \sum_{j=1}^{n_1} \delta_{j,t-1}\, cov_{t-1}\left(R_{i,t}^{DM}, \nu_{j,t}^{DM}\right)$
  - Non-EMU Currency Premium: $NECP = \sum_{j=n_1+1}^{n} \delta_{j,t-1}\, cov_{t-1}\left(R_{i,t}^{DM}, \nu_{j,t}^{DM}\right)$
- Total Premium: $TP = MP + ACP$

where we assume that of the $n$ sources of currency risk in the model, the first $n_1$ are EMU-specific.

We focus on the equity markets. The data in Table 5 show that for both the U.S. and the World equity index, the average premium for currency risk is negative and, in absolute terms, represents a non-negligible fraction of the total premium. For example, the average market premium for holding U.S. equities over the 1974-1997 period is equal to 8.17 per cent on an annual basis. Yet, since the average aggregate currency premium over the same period is equal to -3.32 per cent, the total premium is reduced to 4.85 per cent. The evidence is qualitatively similar for the World equity index. For the remaining equity markets in our sample, the statistics in the table should be interpreted more carefully. In most instances, the average market premium is the dominant component of the average total premium. However, using this evidence to conclude that currency risk is economically negligible in most markets could be misleading, for at least two reasons. First, as argued earlier, the average premium can be close to zero when computed over the entire sample, while oscillating between positive and negative values for relatively long subperiods. Second.

the cross-sectional aggregation over different sources of currency risk may fail to reflect currency-specific premia of different sign which are economically significant.

Figures 1a-6a can be used to address the first issue. For France, Germany and the Netherlands, the graphs indicate that the aggregate currency premium fluctuates around zero within a rather narrow band. On the other hand, for the U.K. the same premium is often large in absolute value and persistent in sign during the first half of the sample. In Figure 7a we provide an alternative way of summarizing our findings by plotting the average aggregate currency premia and the corresponding confidence intervals, obtained using Newey-West (NW) standard errors.[17] The average premia for the U.S. and the World portfolio are clearly large and negative and more than two standard deviations away from zero. The average currency premia are much smaller, instead, for the other four equity markets in our sample.

The decomposition of the aggregate currency premium into the EMU and non-EMU components reveals some interesting regularities. Visual inspection of Figures 1b-6b suggests two main things. First, the premium for exposure to EMU currency risk is mostly positive whereas the premium for non-EMU risk is negative. Second, the premium for non-EMU risk is considerably larger in absolute value. These findings are confirmed by the average disaggregated premia reported in Table 5 and by the confidence intervals plotted in Figures 7b and 7c. The numbers in the table indicate that, in most cases, the non-EMU component of the currency premium attains rather large values. For example, the average non-EMU premium is equal -4.58 per cent per year for the U.S. equity market, -3.22 per cent for the World index and is four times as large as the EMU premium for the Dutch market. In the German case, both components are small, due to the fact that the Deutsche Mark is the reference currency. Finally, the French market is the only case in which the average premium for EMU risk (2 percent) is larger, in absolute value, than the non-EMU premium (-1.20 per cent).

Although not displayed here, the results for the five Eurocurrency markets, show that, not surprisingly in this case, the total risk premium is mostly driven by reward for exposure to currency risk.

The large negative premium for non-EMU currency risk is an interesting finding which requires an explanation. The definitions of risk premia introduced earlier in the paper imply that each premium is affected by two components: covariance risk and the corresponding shadow price. In Table 6 we report summary statistics for the estimated prices of risk. For the three non-EMU currencies it is obvious that the most relevant risk factor is the U.S. dollar, since its price is more than four times the price of either British pound or Japanese yen risk. In addition, the average price of dollar risk is statistically significant and negative. As a consequence, the negative premium for non-EMU currency risk stems from positive average covariance risk and negative average shadow prices. This suggests that investors are willing to forgo part of the market premium to hold assets whose DM-denominated return is

[17] See Newey and West (1987).

positively correlated with the relative change of the DM/U.S. dollar exchange rate.[18] In other words, investors are willing to pay a premium to hold assets which provide a good hedge against fluctuations of the U.S. dollar. This is possibly due to the fact that most investors include (directly or indirectly) dollar-denominated goods in their consumption basket.

## 3.3 European Liberalization and Currency Premia

One potentially interesting date to study in our sample is July 1, 1990. The European Community set that date as the deadline for its country-members to complete the process of financial liberalization.[19] It would be difficult to implement a direct test of structural change within the ICAPM that we estimate; therefore, in Table 5 and Figures 8a-8c we propose a simple, albeit not as general, test for the hypothesis that financial liberalization has affected the average premia for currency risk. For each asset, we test the null hypothesis of a structural change in the average currency premium (aggregate, EMU-specific and non-EMU) and we choose July 1990 as the shifting point. The results can be summarized as follows. The change in the average aggregate currency premium is statistically significant in five out of six cases. All significant changes are rather large in size and negative. In the most extreme cases, the average currency premium for the U.S. equity market reaches a value lower than minus six per cent per year after July 1990. The disaggregation between EMU and non-EMU currency premium is equally interesting. The average EMU premium is positive, but mostly rather low and in four out of six cases it is not statistically different after July 1990, relative to the earlier period. On the other hand, the non-EMU component of the premium is negative and significantly larger in the last part of the sample for five of the six equity indices.

These findings are better understood after looking at the evidence on the changes in the prices of currency risk reported in Table 6. Both the price of U.S. dollar and Japanese yen risk are significantly more negative in the post 1990 period, whereas the prices of risk for the two EMU currencies and the British pound are significantly more positive. In absolute terms, the combined change in price for the French franc and Dutch guilder is considerably larger than the change for the three remaining currencies. Yet, our results show that the change in premium associated with the EMU currencies is relatively smaller and statistically insignificant. Given the definition of currency risk that we use, this suggests that risk exposure to the EMU currencies has declined in the last part of the sample.

To summarize, also from this perspective, the elimination of EMU-specific currency risk appears to be of relatively little relevance to investors.

[18]We omit the British pound and the Japanese yen from this discussion due to their smaller relevance (see Table 6).

[19]See Carrieri (1997) for a study of the effects of European liberalization on the price of currency risk.

# 4 Discussion and Concluding Remarks

In this study, we analyze the impact of European Monetary Union and, more specifically, of a single European currency, on European and world equity markets. This requires an in-depth examination of currency risk and of its EMU and non-EMU components. We use the approach of De Santis and Gerard (1997a) to investigate the economic and statistical relevance of currency risk for both European and non-European equity markets, an issue that, surprisingly, has received little attention thus far.

It is clear that, in addition to the liquidity and transaction costs benefits, the adoption of the single currency will reduce the risk exposure of international investors. It is usually taken for granted that a decline in risk is always a desirable outcome. In fact, the issue of whether a decrease in risk is beneficial is complex. It depends on whether the risk that will be eliminated is fully diversifiable and, to the extent this risk is not diversifiable, on the reward investors receive for bearing it (i.e. the reward-to-risk ratio). The elimination of a source of risk, as will be the case under a single European currency, could have no impact, a positive impact or even, more surprisingly, a negative impact on investors' risk-return trade-offs. For example, if EMU currency risk is fully diversifiable, then the adoption of a single currency will have limited benefits for international portfolio investors. On the other hand, if EMU currency risk is not diversifiable but commands a premium, the adoption of a single currency will reduce the menu of assets available to investors and affect the expected returns of international portfolios.

In the context of the EMU, the relevant issues are: how important is the EMU currency risk both in absolute and relative terms, compared to its non-EMU counterpart, and by how much international investors have been rewarded for their exposure to EMU currency risk. These questions can only be addressed by looking at past evidence. We examine both equity and Eurodeposit markets over the last 23 years. Three main results emerge from our investigation:

1. Currency fluctuations induce a systematic source of risk in returns. However, the EMU component is small relative to the non-EMU component (Dollar, Yen and Pound). The most relevant currency risk factor is linked to the US dollar.

2. Currency risk is priced. The EMU currency risk commands a positive but small risk premium. The non-EMU currency risk premium is negative, which suggests that investors are willing to forgo part of their expected returns to hold assets that provide a hedge against currency risk.

3. Currency risk and its impact on returns varies over time as a function of changes in economic conditions and the institutional environment. In particular, the risk exposure of international equity markets to the EMU currencies has declined significantly since 1990.

What do these findings imply for the transition to a single currency? First, to the extent that exposure to EMU currency risk is systematic, asset return volatility is likely to decrease, both for European and non-European equity markets. Second, since investors are rewarded with a positive premium for being exposed to the EMU currency risk, its elimination will also reduce expected returns on international equities. However, it will still be the case that all markets will be subject to the large and dominant impact of the non-EMU currency risk. When combined with the recent decline in the EMU component of exchange risk, these results suggest that the adoption of a single currency will have a limited impact on international asset prices, risk and expected returns.

Our findings also yield interesting insights about the "home bias" phenomenon. Common wisdom and academic research suggest that European unification is likely to increase investments by EEC residents in stocks from non-EEC countries and decrease the "home bias." The existence of a single currency, the emergence of European pension funds, the reduction of informational and agency costs, the computerization and interconnection of trading centers are often quoted as the key drivers of such a change (see, for example, Biais (1997)). The results of our study challenge this view. Given its relative small size and the positive premium it commands, the EMU currency risk is unlikely to be responsible for the "home bias" observed in the past.

In addition, our findings suggest that if the home bias will indeed decrease in the future, European investors are more likely to diversify into non-European equities, for at least two reasons. First, as documented by Heston and Rouwenhorst (1994), the low correlations of European equity markets observed in the past can be explained by country-specific rather than industrial structure. This is because macroeconomic disturbances are shared by all firms within a country, but not across countries. In Europe, the country-specific components include local monetary and fiscal policies, differences in institutional and legal regimes, and regional economic shocks. Under the EMU, this heterogeneity is likely to disappear. Though the issue is not directly addressed in the paper, one would expect to observe an increase in the correlation of European equity markets and hence lower diversification benefits, forcing European investors to look at non-EMU equity markets to diversify risk.

The second reason is related to the currency risk associated with the consumption of foreign goods. A natural hedge for this risk is provided by an investment in foreign assets. The empirical evidence in this paper suggests that assets are used as a hedge for consumption-induced currency risk. For example, we document that investors are willing to forgo part of their expected returns, in the form a negative risk premium, to hold assets that provide a hedge against fluctuations of the U.S. dollar. This presumably stems from the fact that dollar-denominated goods constitute a significant fraction of their consumption basket. With the adoption of the Euro, the currency risk related to the EMU component of the consumption basket will disappear for European consumers. They will be left with the currency risk arising from the consumption of non-European goods only. Unless European consumers modify substantially their consumption basket (towards more European goods), this could reduce their incentives to hold European equities as a hedge and increase their incentives to hold non-EMU equities.

Overall, the investigation leads us to believe that, beyond the benefits of enhanced liquidity, lower transactions costs and improved transparency in cross-country investments, the adoption of the single currency will have limited impact on international asset prices, risk and expected returns. Further it is likely to increase the flow of investments toward markets outside the EMU.

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**Table 1: Volatility Decomposition for Monthly Asset Returns Measured in Deutsche Marks.**

Monthly Deutsche mark returns on the equity indices of five countries (U.S., Japan, France, Netherlands and the U.K.) are from MSCI. The Eurocurrency one-month deposit rates for the French franc, German mark, Dutch guilder, British pound, U.S. dollar and Japanese yen are from DRI Inc. and the B.I.S. All returns are continuously compounded. The sample covers the period January 1974 through April 1997 (280 observations). $R_i^{DM}$ is the DM return on asset $i$, $R_i^l$ is the return on asset $i$ measured in local currency, $\nu_l^{DM}$ is the relative change in the exchange rate between the DM and the local currency.

Panel a: Entire Sample (1974:1-1997:4)

| Asset | (a) $\mathrm{var}\left(R_i^{\mathrm{DM}}\right)$ | (b) $\mathrm{var}\left(R_i^l\right)$ | (c) $\mathrm{var}\left(\nu_i^{\mathrm{DM}}\right)$ | (d) $\mathrm{cov}\left(R_i^l, \nu_l^{\mathrm{DM}}\right)$ | (e) $\frac{\mathrm{b}}{\mathrm{a}}\%$ | (f) $\frac{\mathrm{c}}{\mathrm{a}}\%$ | (g) $\frac{2\mathrm{d}}{\mathrm{a}}\%$ |
|---|---|---|---|---|---|---|---|
| U.S. | 31.18 | 19.40 | 11.39 | 0.19 | 62.2 | 36.5 | 1.2 |
| Japan | 40.74 | 28.09 | 8.96 | 1.84 | 69.0 | 22.0 | 9.1 |
| France | 40.98 | 37.91 | 1.67 | 0.62 | 92.5 | 4.1 | 3.0 |
| Netherl. | 22.94 | 22.82 | 0.24 | -0.05 | 99.5 | 1.1 | -0.5 |
| U.K. | 50.79 | 40.34 | 7.04 | 1.71 | 79.4 | 13.9 | 6.7 |
| EurFr | 1.60 | 0.16 | 1.67 | -0.12 | 9.9 | 104.5 | -14.5 |
| EurNl | 0.34 | 0.05 | 0.24 | 0.02 | 15.5 | 72.9 | 11.6 |
| Eur£ | 7.16 | 0.10 | 7.04 | 0.02 | 1.3 | 98.2 | 0.4 |
| Eur$ | 11.68 | 0.09 | 11.39 | 0.10 | 0.8 | 97.5 | 1.7 |
| Eur¥ | 9.12 | 0.07 | 8.96 | 0.05 | 0.8 | 98.2 | 1.0 |

**Table 1: continued**

Panel b: First Half of the Sample (1974:1-1985:8)

| Asset | (a) $\text{var}\left(R_i^{DM}\right)$ | (b) $\text{var}\left(R_i^l\right)$ | (c) $\text{var}\left(\nu_i^{DM}\right)$ | (d) $\text{cov}\left(R_i^l, \nu_l^{DM}\right)$ | (e) $\frac{b}{a}\%$ | (f) $\frac{c}{a}\%$ | (g) $\frac{2d}{a}\%$ |
|---|---|---|---|---|---|---|---|
| U.S. | 27.83 | 20.41 | 10.95 | -1.76 | 73.3 | 39.3 | -12.7 |
| Japan | 27.52 | 15.23 | 9.88 | 1.21 | 55.3 | 35.9 | 8.8 |
| France | 45.67 | 39.96 | 2.82 | 1.28 | 87.5 | 6.2 | 5.6 |
| Netherl. | 25.13 | 25.16 | 0.45 | -0.22 | 100.1 | 1.8 | -1.7 |
| U.K. | 66.80 | 54.52 | 8.33 | 1.98 | 81.6 | 12.5 | 5.9 |
| EurFr | 2.70 | 0.18 | 2.82 | -0.15 | 6.8 | 104.3 | -11.1 |
| EurNl | 0.59 | 0.06 | 0.45 | 0.04 | 10.9 | 76.0 | 13.1 |
| Eur£ | 8.63 | 0.08 | 8.33 | 0.11 | 0.9 | 96.5 | 2.6 |
| Eur$ | 11.41 | 0.10 | 10.95 | 0.18 | 0.9 | 95.9 | 3.2 |
| Eur¥ | 10.07 | 0.07 | 9.88 | 0.06 | 0.7 | 98.1 | 1.1 |

Panel c: Second Half of the Sample (1985:9-1997:4)

| Asset | (a) $\text{var}\left(R_i^{DM}\right)$ | (b) $\text{var}\left(R_i^l\right)$ | (c) $\text{var}\left(\nu_l^{DM}\right)$ | (d) $\text{cov}\left(R_i^l, \nu_l^{DM}\right)$ | (e) $\frac{b}{a}\%$ | (f) $\frac{c}{a}\%$ | (g) $\frac{2d}{a}\%$ |
|---|---|---|---|---|---|---|---|
| U.S. | 34.74 | 18.42 | 11.85 | 2.24 | 53.0 | 34.1 | 12.9 |
| Japan | 54.00 | 40.94 | 8.10 | 2.48 | 75.8 | 15.0 | 9.2 |
| France | 36.53 | 36.13 | 0.48 | -0.04 | 98.9 | 1.3 | -0.2 |
| Netherl. | 20.91 | 20.64 | 0.04 | 0.11 | 98.7 | 0.2 | 1.1 |
| U.K. | 35.11 | 26.40 | 5.79 | 1.46 | 75.2 | 16.5 | 8.3 |
| EurFr | 0.50 | 0.05 | 0.48 | -0.02 | 9.6 | 97.6 | -7.2 |
| EurNl | 0.08 | 0.03 | 0.04 | 0.00 | 39.8 | 51.5 | 8.6 |
| Eur£ | 5.74 | 0.08 | 5.79 | -0.07 | 1.4 | 101.0 | -2.4 |
| Eur$ | 11.78 | 0.03 | 11.85 | -0.05 | 0.2 | 100.5 | -0.8 |
| Eur¥ | 8.20 | 0.04 | 8.10 | 0.03 | 0.5 | 98.7 | 0.8 |

## Table 2: Summary Statistics of Asset Excess Returns

Monthly Deutsche mark returns on the equity indices of six countries and the value-weighted world index are from MSCI. The Eurocurrency one-month deposit rates for the French franc, Dutch guilder, German mark, Japanese yen, British pound and U.S. dollar are from DRI Inc and the B.I.S. in Basle. Excess returns are obtained by subtracting the EuroDM one-month rate. All returns are continuously compounded and expressed in percentage per month. The sample covers the period January 1974 through April 1997 (280 observations).

### Panel a: Summary Statistics

| | Mean | Std. Dev. | Skewness | Kurtosis[a] | B-J[b] | $Q^c_{12}$ | Weights[d] |
|---|---|---|---|---|---|---|---|
| U.S. | 0.370 | 5.59 | -0.77** | 3.40** | 156** | 0.815 | 0.35 |
| Japan | 0.311 | 6.40 | -0.13 | 1.15** | 15.2** | 0.690 | 0.31 |
| France | 0.363 | 6.42 | -0.30* | 1.68** | 35.2** | 0.459 | 0.03 |
| Germany | 0.407 | 5.12 | -0.82** | 3.65** | 180** | 0.365 | 0.04 |
| Netherl. | 0.752 | 4.81 | -0.53** | 4.13** | 203** | 0.127 | 0.02 |
| U.K. | 0.518 | 7.14 | 0.02 | 5.58** | 348** | 0.162 | 0.11 |
| EurFr | 0.141 | 1.25 | -0.68** | 4.38** | 235** | 0.043 | |
| EurNl | 0.030 | 0.54 | -0.22 | 3.77** | 160** | 0.003 | |
| Eur£ | 0.385 | 6.08 | 0.12 | 0.99** | 11.2** | 0.522 | |
| Eur$ | 0.001 | 3.41 | 0.18 | 0.68* | 6.49* | 0.436 | |
| EurY | 0.076 | 3.02 | 0.31* | 0.34 | 5.48 | 0.191 | |
| World | 0.332 | 4.61 | -0.84** | 3.41** | 162** | 0.211 | 1 |

[a]Equal to zero for the normal distribution; [b]Bera-Jarque test statistic for normality; [c]P-values for Ljung-Box test statistic of order 12; [d]As of December 31, 1990.
* and ** denote statistical significance at the 5% and 1% levels, respectively.

### Panel b: Unconditional Correlations of $r_{it}$

| | Jpn. | Fr. | Ger. | Nl. | U.K. | EurFr | EurNl | Eur£ | Eur$ | Eur¥ | Wrld |
|---|---|---|---|---|---|---|---|---|---|---|---|
| U.S. | .321 | .473 | .374 | .667 | .564 | .178 | .064 | .568 | .609 | .240 | .884 |
| Jpn. | 1 | .337 | .255 | .372 | .346 | .113 | .066 | .141 | .214 | .566 | .664 |
| Fr. | | 1 | .508 | .549 | .529 | .287 | .040 | .087 | .126 | .146 | .591 |
| Ger. | | | 1 | .606 | .391 | -.046 | -.067 | .083 | .099 | .019 | .480 |
| Nl. | | | | 1 | .661 | .077 | .055 | .231 | .282 | .148 | .747 |
| U.K. | | | | | 1 | .257 | .168 | .082 | .250 | .202 | .696 |
| EurFr | | | | | | 1 | .348 | .183 | .275 | .282 | .188 |
| EurNl | | | | | | | 1 | .026 | .120 | .081 | .094 |
| Eur£ | | | | | | | | 1 | .917 | .358 | .416 |
| Eur$ | | | | | | | | | 1 | .442 | .506 |
| Eur¥ | | | | | | | | | | 1 | .386 |

Table 2: (Cntd.)

Panel c: Autocorrelations of $r_{it}$

| Lag. | 1 | 2 | 3 | 4 | 5 | 6 | 12 |
|---|---|---|---|---|---|---|---|
| U.S. | 0.045 | 0.039 | -0.001 | -0.004 | 0.061 | -0.112 | 0.044 |
| Jpn. | 0.053 | -0.002 | 0.081 | 0.079 | 0.041 | 0.014 | -0.060 |
| Fr. | 0.099 | -0.055 | 0.084 | 0.025 | 0.014 | -0.015 | -0.074 |
| Ger. | 0.077 | -0.045 | 0.079 | 0.050 | -0.103 | -0.054 | -0.028 |
| Nl. | 0.085 | -0.021 | 0.032 | -0.093 | 0.017 | -0.052 | 0.074 |
| U.K. | 0.114 | -0.100 | 0.038 | -0.024 | $-0.145^{*}$ | -0.024 | -0.042 |
| EurFr | 0.036 | 0.038 | 0.022 | -0.099 | -0.094 | -0.063 | -0.029 |
| EurNl | $0.139^{*}$ | 0.057 | -0.045 | -0.094 | $-0.140^{*}$ | $-0.121^{*}$ | 0.024 |
| Eur£ | 0.016 | 0.068 | -0.008 | -0.013 | 0.040 | -0.111 | -0.015 |
| Eur$ | 0.018 | 0.105 | 0.021 | -0.013 | 0.027 | -0.081 | 0.014 |
| Eur¥ | 0.073 | 0.091 | 0.071 | 0.050 | 0.076 | -0.107 | -0.051 |
| World | $0.122^{*}$ | 0.038 | 0.021 | 0.008 | 0.069 | -0.065 | -0.004 |

Panel d: Autocorrelations of $r_{it}^2$

| Lag. | 1 | 2 | 3 | 4 | 5 | 6 | 12 |
|---|---|---|---|---|---|---|---|
| U.S. | $0.149^{*}$ | 0.009 | 0.052 | -0.003 | -0.044 | 0.007 | 0.005 |
| Jpn. | 0.087 | $0.159^{*}$ | 0.045 | 0.046 | 0.063 | 0.094 | -0.038 |
| Fr. | 0.026 | -0.008 | 0.033 | $0.231^{**}$ | 0.019 | 0.056 | -0.041 |
| Ger. | $0.282^{**}$ | -0.018 | 0.063 | $0.163^{*}$ | 0.086 | -0.003 | -0.045 |
| Nl. | $0.129^{*}$ | -0.053 | -0.028 | 0.055 | 0.035 | -0.020 | -0.032 |
| U.K. | 0.112 | $0.182^{**}$ | 0.080 | 0.031 | $0.141^{*}$ | -0.008 | -0.040 |
| EurFr | $0.354^{**}$ | $0.330^{**}$ | $0.294^{**}$ | $0.291^{**}$ | $0.199^{**}$ | $0.177^{**}$ | 0.049 |
| EurNl | $0.145^{*}$ | $0.192^{**}$ | $0.120^{*}$ | $0.189^{**}$ | $0.152^{*}$ | 0.101 | $0.189^{**}$ |
| Eur£ | $0.158^{*}$ | -0.030 | -0.035 | 0.052 | 0.011 | -0.045 | -0.016 |
| Eur$ | $0.174^{**}$ | -0.006 | -0.021 | -0.034 | -0.029 | -0.030 | -0.034 |
| Eur¥ | 0.038 | 0.037 | 0.043 | $0.137^{*}$ | -0.032 | 0.047 | 0.007 |
| World | 0.055 | -0.031 | 0.047 | -0.001 | -0.012 | -0.037 | -0.047 |

**Table 2: (Cntd.)**

**Panel e: Cross-correlations of $r_{it}^2$: World and Asset j**

| Lag | U.S. | Fr. | Ger. | Nl. | U.K. | EurFr | EurNl | Eur£ | Eur$ | Eur¥ |
|---|---|---|---|---|---|---|---|---|---|---|
| -6 | .036 | -.073 | .002 | .022 | .010 | -.038 | -.010 | .017 | .025 | -.028 |
| -5 | -.027 | .037 | .028 | .039 | .059 | -.046 | -.042 | -.028 | -.069 | -.075 |
| -4 | -.015 | .218* | .184* | -.000 | .078 | -.012 | -.036 | -.028 | -.051 | -.085 |
| -3 | .034 | .050 | .039 | -.027 | .003 | -.009 | -.012 | .036 | .019 | -.063 |
| -2 | .007 | -.030 | -.018 | -.015 | .035 | -.006 | -.006 | .032 | .023 | .107 |
| -1 | .144+ | -.002 | .234* | .102 | .020 | .019 | -.014 | .148+ | .146+ | -.031 |
| 0 | .888* | .588* | .672* | .789* | .551* | .031 | -.011 | .185* | .239* | .068 |
| 1 | .045 | .073 | .062 | .073 | .016 | .039 | -.027 | -.040 | -.011 | -.070 |
| 2 | -.032 | -.055 | -.048 | -.040 | -.035 | .061 | -.003 | -.040 | -.049 | -.035 |
| 3 | .059 | -.001 | .059 | .013 | .009 | -.004 | -.056 | -.033 | -.040 | -.036 |
| 4 | .006 | .140+ | .001 | .027 | -.032 | .011 | -.041 | -.054 | -.041 | .016 |
| 5 | -.059 | -.032 | .052 | -.034 | -.008 | .012 | -.011 | -.050 | -.057 | -.000 |
| 6 | .003 | -.024 | -.014 | -.031 | -.023 | .028 | -.005 | -.050 | -.032 | .032 |

Number of significant cross-correlations of order (-2,-1,1,2): 23 out of 264.

$^+$ and $^*$ denote statistical significance at the 5% and 1% levels, respectively.

**Table 3: Summary Statistics of the Information Variables**

The information set includes the world dividend yield in excess of the one-month EuroDM rate (XDPR), the change in the one-month Eurodollar deposit rate (ΔEuro$), the U.S. default premium (USDP), and the difference between the local currency one month euro deposits real return and the real return on the Deutsche mark one month euro deposit (FrRRD, NlRRD, £RRD, $RRD, ¥RRD). The world dividend yield is the DM denominated dividend yield on the MSCI world index. The U.S. default premium is the yield difference between Moody's Baa and Aaa rated bonds. The real return on one month Eurodeposits is equal to the difference between the quoted nominal deposit rate and the previous month change in consumer price index. Inflation rates are obtained from the IFS database. The sample covers the period January 1974 through April 1997 (280 observations).

| | Mean | Median | Std. Dv. | Min. | Max. |
|---|---|---|---|---|---|
| XDPR | -0.245 | -0.205 | 0.217 | -1.017 | 0.206 |
| ΔEuro$ | -0.002 | -0.005 | 0.112 | -0.544 | 0.553 |
| USDP | 1.177 | 1.010 | 0.473 | 0.560 | 2.690 |
| FrRRD | 0.115 | 0.118 | 0.407 | -1.098 | 2.324 |
| NlRRD | 0.015 | 0.041 | 0.495 | -1.477 | 2.051 |
| £RRD | 0.026 | 0.120 | 0.631 | -2.995 | 2.642 |
| $RRD | -0.016 | -0.025 | 0.372 | -1.089 | 0.975 |
| ¥RRD | -0.077 | -0.046 | 0.656 | -3.362 | 1.481 |

| | Autocorrelations | | | | | | |
|---|---|---|---|---|---|---|---|
| Lag | 1 | 2 | 3 | 4 | 5 | 6 | 12 |
| XDPR | 0.901 | 0.869 | 0.868 | 0.825 | 0.797 | 0.772 | 0.578 |
| ΔEuro$ | -0.232 | -0.078 | 0.200 | -0.316 | 0.048 | 0.001 | 0.090 |
| USDP | 0.958 | 0.902 | 0.859 | 0.829 | 0.797 | 0.750 | 0.539 |
| FrRRD | 0.310 | 0.139 | 0.068 | -0.018 | 0.028 | 0.055 | 0.080 |
| NlRRD | 0.232 | -0.060 | -0.281 | -0.152 | 0.112 | 0.282 | 0.567 |
| £RRD | 0.256 | 0.027 | -0.004 | 0.036 | 0.132 | 0.236 | 0.474 |
| $RRD | 0.384 | 0.254 | 0.182 | 0.060 | 0.164 | 0.106 | 0.327 |
| ¥RRD | 0.128 | -0.155 | -0.101 | -0.109 | 0.130 | 0.219 | 0.437 |

| | Correlations | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | XDPR | ΔEuro$ | USDP | FrRRD | NlRRD | £RRD | $RRD | ¥RRD |
| ΔEuro$ | 0.183 | 1 | | | | | | |
| USDP | -0.020 | -0.127 | 1 | | | | | |
| FrRRD | -0.048 | -0.118 | 0.074 | 1 | | | | |
| NlRRD | 0.002 | 0.015 | -0.021 | 0.438 | 1 | | | |
| £RRD | -0.001 | 0.003 | -0.007 | 0.388 | 0.362 | 1 | | |
| $RRD | 0.164 | 0.033 | 0.340 | 0.481 | 0.401 | 0.218 | 1 | |
| ¥RRD | 0.126 | -0.027 | 0.179 | 0.350 | 0.437 | 0.349 | 0.348 | 1 |

**Table 4: Quasi-Maximum Likelihood Estimates of the Conditional International CAPM with Time-Varying Prices of Risk.**

Estimates are based on monthly Deutsche mark denominated continuously compounded returns from January 1974 through April 1997. Data for the country equity indices and the world portfolio are from MSCI. One-month Eurocurrency deposit rates are from DRI Inc and the B.I.S. Each mean equation relates the asset excess return $r_{it}$ to its world covariance risk $cov_{t-1}(r_{it}, r_{mt})$ and its currency risk $cov_{t-1}(r_{it}, r_{5+c,t})$. The prices of risk are functions of a number of instruments, $z_{t-1}$, included in the investors' information set. The instruments include a constant, the world index dividend yield in excess of the one-month Euromark rate (XDPR), the change in the one month Eurodollar rate (ΔEuro$), and the U.S. default premium (USDP) as well as the difference between the 1 month real rates for the local currency Euro deposits and the DM Eurodeposits (Loc RRD).

$$r_{it} = \delta_{m,t-1} cov_{t-1}(r_{it}, r_{mt}) + \sum_{c=1}^{5} \delta_{c,t-1} cov_{t-1}(r_{it}, r_{5+c,t}) + \varepsilon_{it}$$

where $\delta_{m,t-1} = \exp(\kappa'_m z_{t-1})$, $\delta_{c,t-1} = \kappa'_c z_{t-1}$ and $\varepsilon_t|\Im_{t-1} \sim N(0, H_t)$. The conditional covariance matrix $H_t$ is parameterized as follows

$$H_t = H_0 * (\iota\iota' - \mathbf{aa}' - \mathbf{bb}') + aa' * \varepsilon_{t-1}\varepsilon'_{t-1} + bb' * H_{t-1}$$

where * denotes the Hadamard matrix product, **a** and **b** are $11\times 1$ vectors of constants and $\iota$ is an $11\times 1$ unit vector. QML standard errors are reported in parentheses.

**Panel a: Parameter Estimates**

| | Const | | XDPR | | ΔEuro$ | | USDP | |
|---|---|---|---|---|---|---|---|---|
| $\kappa_m$ | -4.74 | (1.26) | 2.75 | (2.23) | -3.40 | (1.43) | 1.29 | (.756) |
| | **Const** | | **ΔEuro$** | | **USDP** | | **Loc RRD** | |
| $\kappa_{FFr}$ | .163 | (.220) | .484 | (.497) | -.078 | (.203) | .019 | (.245) |
| $\kappa_{Nl}$ | .443 | (.307) | -.631 | (.959) | -.324 | (.229) | .394 | (.188) |
| $\kappa_{£}$ | .123 | (.076) | .330 | (.206) | -.098 | (.061) | -.017 | (.036) |
| $\kappa_{¥}$ | -.109 | (.062) | .210 | (.167) | .066 | (.052) | .050 | (.056) |
| $\kappa_{\$}$ | -.068 | (.072) | -.014 | (.102) | .057 | (.061) | .069 | (.032) |

| | Fr. | Ger. | Nl. | U.K. | U.S. | EurFr | EurNl | Eur£ | Eur$ | Eur¥ | Wrld |
|---|---|---|---|---|---|---|---|---|---|---|---|
| $a_i$ | .104 | .287 | .169 | .252 | .200 | .377 | .208 | .112 | .233 | .226 | .151 |
| | (.029) | (.061) | (.036) | (.025) | (.024) | (.075) | (.024) | (.039) | (.044) | (.047) | (.019) |
| $b_i$ | .989 | .300 | .939 | .945 | .921 | .867 | .976 | .991 | .702 | .822 | .975 |
| | (.009) | (.220) | (.020) | (.014) | (.026) | (.066) | (.005) | (.015) | (.084) | (.056) | (.004) |

**Table 4: (Cntd.)**

**Panel b: Specification Tests**

| Null Hypothesis | $\chi^2$ | df | p-value |
|---|---|---|---|
| Is the price of market risk constant? <br> $H_0 : \kappa_{m,k} = 0 \quad \forall k > 1$ | 18.812 | 3 | 0.000 |
| Are the prices of currency risk equal to zero? <br> $H_0 : \kappa_{c,k} = 0 \quad \forall c, k$ | 62.742 | 20 | 0.000 |
| Are the prices of currency risk constant? <br> $H_0 : \kappa_{c,k} = 0 \quad \forall c, k > 1$ | 50.178 | 15 | 0.000 |
| Are the prices of currency risk of EMU countries equal to zero? <br> $H_0 : \kappa_{c,k} = 0 \quad \forall k, c = 1, 2$ | 15.150 | 8 | 0.056 |
| Are the prices of currency risk of non–EMU countries equal to zero? <br> $H_0 : \kappa_{c,k} = 0 \quad \forall k, c = 3, 4, 5$ | 24.013 | 12 | 0.020 |

**Panel c: Summary Statistics and Diagnostics for the Residuals**

| | Fr. | Ger. | Nl | U.K. | U.S. | EurFr | EurNl | Eur£ | Eur$ | Eur¥ | Wrld |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Avg. ExRet | 0.36 | 0.41 | 0.75 | 0.52 | 0.37 | 0.14 | 0.03 | 0.13 | 0.00 | 0.23 | 0.15 |
| Avg. PrErr. | -0.23 | 0.15 | 0.37 | -0.18 | -0.03 | 0.04 | 0.02 | 0.05 | 0.05 | 0.05 | -0.11 |
| RMSE | 6.41 | 5.11 | 4.75 | 7.12 | 5.51 | 1.23 | 0.53 | 2.64 | 3.37 | 2.98 | 4.50 |
| $R^2_{m}$ [a] | 0.59 | 0.47 | 2.37 | 1.63 | 2.64 | 0.13 | -0.69 | -0.92 | -0.04 | 0.88 | 3.74 |
| $R^2_{m-c}$ [b] | 0.30 | 0.45 | 2.54 | 0.53 | 2.79 | 2.17 | 4.24 | 2.49 | 2.31 | 2.81 | 4.43 |
| Kurt. [c] | 1.77* | 3.46* | 4.34* | 3.89* | 4.30* | 4.32* | 1.84* | 1.77* | 0.93* | 0.22 | 4.43* |
| B-J [d] | 40.7* | 157* | 226* | 185* | 241* | 300* | 42.3* | 38.7* | 10.3* | 4.15 | 256* |
| $Q_{12}(z)$ [e] | 0.57 | 0.36 | 0.20 | 0.74 | 0.80 | 0.28 | 0.42 | 0.19 | 0.52 | 0.41 | 0.40 |
| $Q_{12}(z^2)$ [e] | 0.15 | 0.02 | 0.94 | 0.84 | 0.99 | 0.80 | 0.28 | 0.91 | 0.88 | 0.64 | 0.99 |
| EN-LM [f] | 0.73 | 0.51 | 0.83 | 0.62 | 0.21 | 0.05 | 0.08 | 0.43 | 0.46 | 0.23 | 0.75 |
| Likelihood Function: | | | | | -6964.184 | | | | | | |

[a] Pseudo-$R^2$ when market risk is the only pricing factor; [b] pseudo-$R^2$ when both market and currency risk are pricing factors; [c] equal to zero for the normal distribution; [d] Bera-Jarque test statistic for normality; [e] p–values for Ljung-Box test statistic of order 12; [f] p–values for Engle-Ng test on the predictability of conditional second moments using the instruments.

+ and * denote statistical significance at the 5% and 1% levels, respectively.

## Table 5: Decomposition and Structural Changes of the Total Premia for Equity markets.

The table contains the overall means and standard errors of the risk premia estimated from the model with time varying risk as well as the parameter estimates from the regressions of these estimated premia on a constant and a dummy variable for the post June 1990 period ($D_t = 1$, if t > June 1990). The total risk premium (TP) is measured as the sum of the market risk premium (MP) and the aggregate currency premium (ACP). The currency premium is the sum of the premium associated with the currencies to be included in the EMU (ECP), i.e., French franc and Dutch guilder, and the premium associated with the currencies not included in the EMU (NECP), i.e., the British pound, the U.S. dollar and the Japanese yen. The premia for asset $i$ are measured by

$$\mathrm{MP}_{it} = \delta_{m,t-1} cov_{t-1}(r_{it}, r_{mt}) \text{ and } \mathrm{ACP}_{it} = \sum_{c=1}^{5} \delta_{c,t-1} cov_{t-1}(r_{it}, r_{5+c,t})$$

$$\mathrm{ECP}_{it} = \sum_{c=1}^{2} \delta_{c,t-1} cov_{t-1}(r_{it}, r_{5+c,t}) \text{ and } \mathrm{NECP}_{it} = \sum_{c=3}^{5} \delta_{c,t-1} cov_{t-1}(r_{it}, r_{5+c,t})$$

Standard errors are computed using the Newey-West heteroskedasticity and autocorrelation robust procedure. All estimates are reported in percent per year.

| | U.S. Equity | | | | | |
|---|---|---|---|---|---|---|
| | Overall | | $RP_t = b_0 + b_1 D_{(t>6/90)} + v_t$ | | | |
| | Avg. | s.e. | $b_0$ | s.e. | $b_1$ | s.e. |
| TP | 4.85 | 1.38 | 8.66 | 1.47 | -13.00 | 1.64 |
| MP | 8.17 | 1.02 | 10.53 | 1.22 | -8.05 | 1.25 |
| ACP | -3.32 | 0.52 | -1.87 | 0.52 | -4.95 | 0.78 |
| ECP | 1.26 | 0.23 | 1.18 | 0.31 | 0.28 | 0.35 |
| NECP | -4.58 | 0.63 | -3.05 | 0.70 | -5.23 | 0.90 |
| | French Equity | | | | | |
| | Overall | | $RP_t = b_0 + b_1 D_{(t>6/90)} + v_t$ | | | |
| | Avg. | s.e. | $b_0$ | s.e. | $b_1$ | s.e. |
| TP | 7.18 | 0.78 | 9.26 | 0.85 | -7.11 | 0.95 |
| MP | 6.27 | 0.79 | 7.99 | 0.96 | -5.87 | 0.98 |
| ACP | 0.91 | 0.25 | 1.28 | 0.31 | -1.24 | 0.43 |
| ECP | 2.11 | 0.28 | 1.91 | 0.39 | 0.70 | 0.43 |
| NECP | -1.20 | 0.23 | -0.63 | 0.25 | -1.94 | 0.37 |

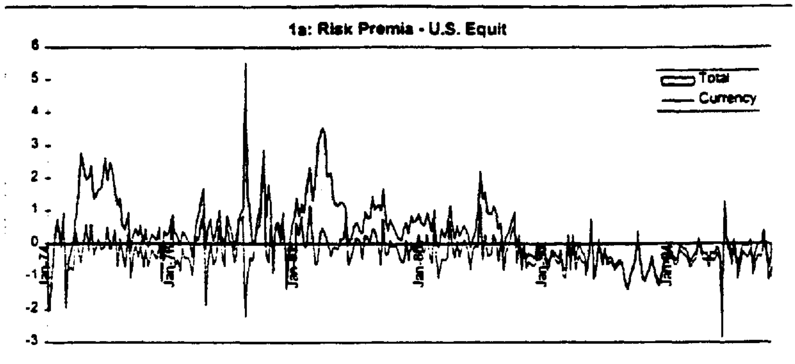
**Table 5: continued**

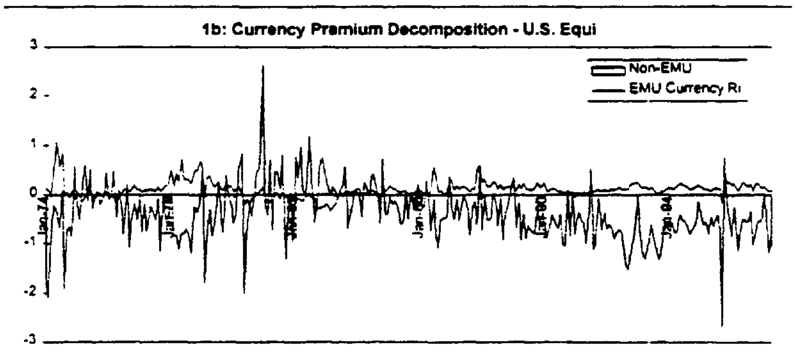
| | Overall | | $RP_t = b_0 + b_1 D_{(t>6/90)} + v_t$ | | | |
|---|---|---|---|---|---|---|
| | Avg. | s.e. | $b_0$ | s.e. | $b_1$ | s.e. |
| **German Equity** | | | | | | |
| TP | 3.07 | 0.59 | 4.48 | 0.68 | -4.82 | 0.75 |
| MP | 4.05 | 0.50 | 5.16 | 0.60 | -3.79 | 0.62 |
| ACP | -0.97 | 0.14 | -0.67 | 0.15 | -1.03 | 0.25 |
| ECP | -0.38 | 0.09 | -0.28 | 0.12 | -0.37 | 0.14 |
| NECP | -0.59 | 0.08 | -0.40 | 0.07 | -0.66 | 0.19 |
| **Dutch Equity** | | | | | | |
| TP | 4.62 | 0.79 | 6.66 | 0.88 | -6.96 | 0.98 |
| MP | 5.90 | 0.75 | 7.58 | 0.90 | -5.73 | 0.92 |
| ACP | -1.28 | 0.19 | -0.92 | 0.21 | -1.23 | 0.36 |
| ECP | 0.42 | 0.13 | 0.31 | 0.17 | 0.38 | 0.20 |
| NECP | -1.70 | 0.20 | -1.23 | 0.20 | -1.61 | 0.34 |
| **U.K. Equity** | | | | | | |
| TP | 8.41 | 0.95 | 10.75 | 1.05 | -8.02 | 1.28 |
| MP | 8.67 | 1.22 | 11.26 | 1.51 | -8.84 | 1.53 |
| ACP | -0.27 | 0.84 | -0.51 | 1.16 | 0.82 | 1.34 |
| ECP | 1.86 | 0.57 | 1.64 | 0.79 | 0.73 | 0.83 |
| NECP | -2.12 | 0.42 | -2.15 | 0.55 | 0.09 | 0.77 |
| **World Index** | | | | | | |
| TP | 5.26 | 1.13 | 8.31 | 1.23 | -10.42 | 1.38 |
| MP | 7.40 | 0.92 | 9.43 | 1.11 | -6.95 | 1.14 |
| ACP | -2.14 | 0.40 | -1.12 | 0.40 | -3.47 | 0.63 |
| ECP | 1.09 | 0.20 | 1.01 | 0.28 | 0.27 | 0.31 |
| NECP | -3.23 | 0.47 | -2.13 | 0.52 | -3.75 | 0.70 |

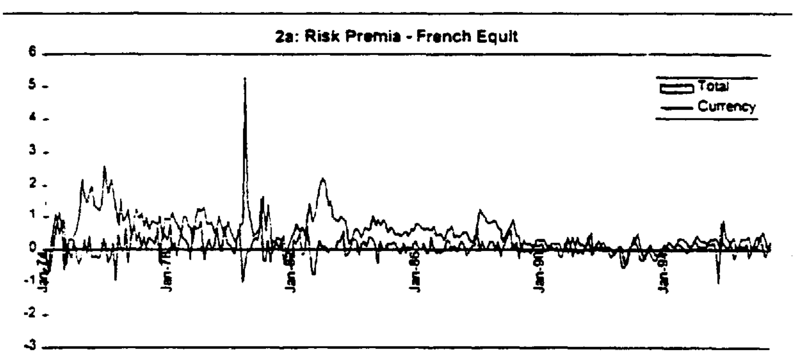
## Table 6: Summary Statistics and Structural Changes of the Prices of Risk

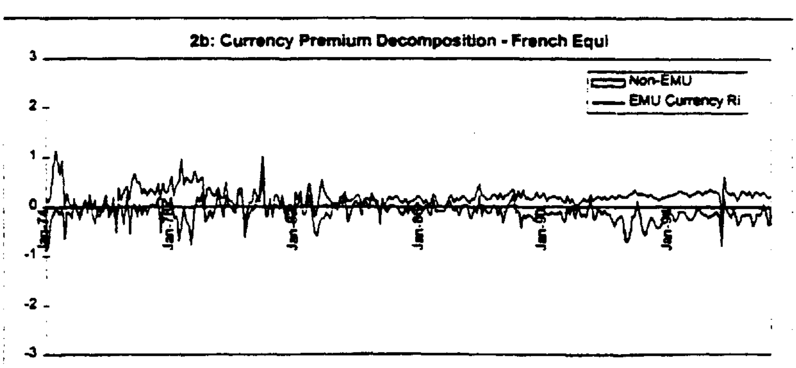
The table contains the overall means and standard errors of the prices of risk estimated from the model with time varying risk as well as the parameter estimates from the regressions of these estimated prices on a constant and a dummy variable for the post June 1990 period ($D_t = 1$, if t > June 1990). The price of market risk, $\delta_m$, is estimated as an exponential function of a constant, the world index dividend yield in excess of the one-month Euromark rate, the change in one month Eurodollar rate and the U.S. default premium. The prices of currency risk, ($\delta_c$, c=1,...,5:) are estimated as a linear function of the change in one month Eurodollar rate, the U.S. default premium and the difference between the 1 month real rates for the local currency eurodeposits and the DM eurodeposit. Standard errors are computed using the Newey-West heteroskedasticity and autocorrelation robust procedure.

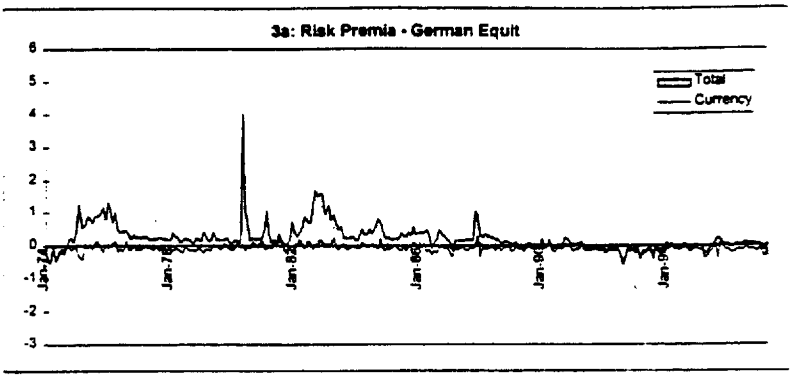
| | Overall | | $\delta_t = b_0 + b_1 D_{(t>6/90)} + v_t$ | | | |
|---|---|---|---|---|---|---|
| Prices of | Avg. | s.e. | $b_0$ | s.e. | $b_1$ | s.e. |
| Market Risk | 3.13 | 0.40 | 4.00 | 0.49 | -2.98 | 0.50 |
| French Franc Risk | 7.22 | 0.61 | 5.94 | 0.73 | 4.37 | 0.90 |
| Dutch Guilder Risk | 6.88 | 2.50 | 1.57 | 2.99 | 18.15 | 3.55 |
| British Pound Risk | 0.71 | 0.70 | -0.79 | 0.83 | 5.13 | 1.04 |
| U.S. Dollar Risk | -3.28 | 0.53 | -1.95 | 0.59 | -4.56 | 0.68 |
| Japanes Yen Risk | -0.68 | 0.52 | 0.30 | 0.64 | -3.35 | 0.78 |

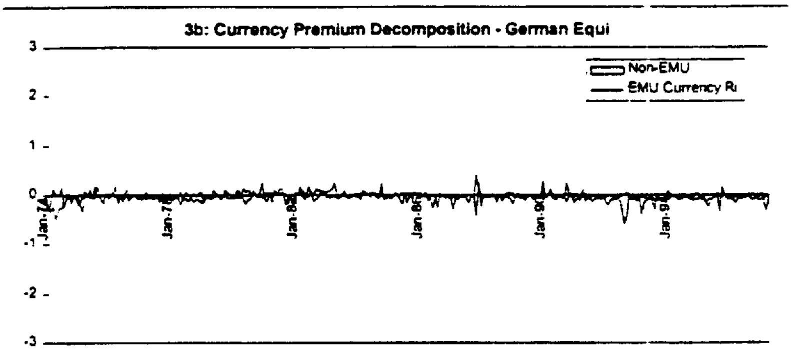

1a: Risk Premia - U.S. Equit
Total
Currency
Jan-74
Jan-78
Jan-82
Jan-86
Jan-90
Jan-94

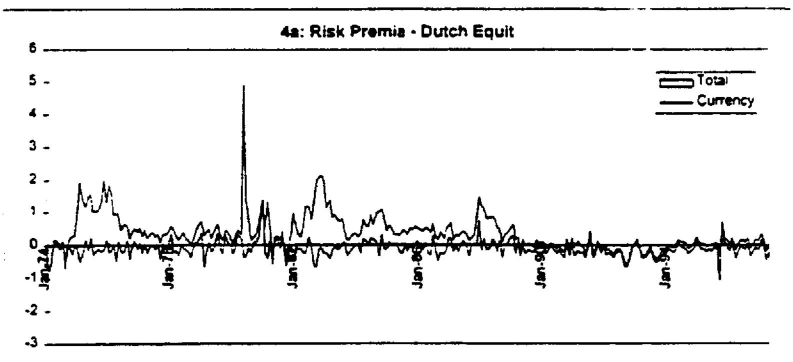

1b: Currency Premium Decomposition - U.S. Equi
Non-EMU
EMU Currency Ri
Jan-74
Jan-78
Jan-82
Jan-86
Jan-90
Jan-94

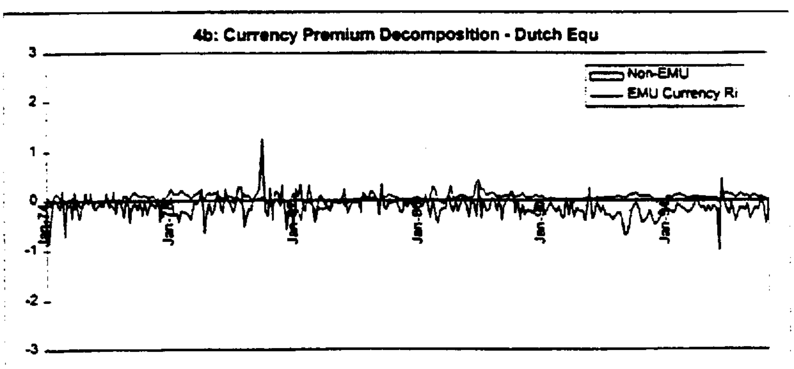

2a: Risk Premia - French Equit
Total
Currency
Jan-74
Jan-78
Jan-82
Jan-86
Jan-90
Jan-94


2b: Currency Premium Decomposition - French Equi
Non-EMU
EMU Currency Ri
Jan-74
Jan-78
Jan-82
Jan-86
Jan-90
Jan-94

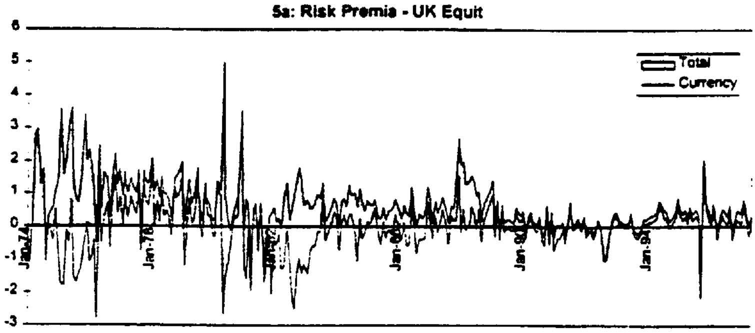

3a: Risk Premia - German Equit
Total
Currency
6
5
4
3
2
1
0
-1
-2
-3
Jan-74
Jan-78
Jan-82
Jan-86
Jan-90
Jan-94


3b: Currency Premium Decomposition - German Equi
Non-EMU
EMU Currency Ri
3
2
1
0
-1
-2
-3

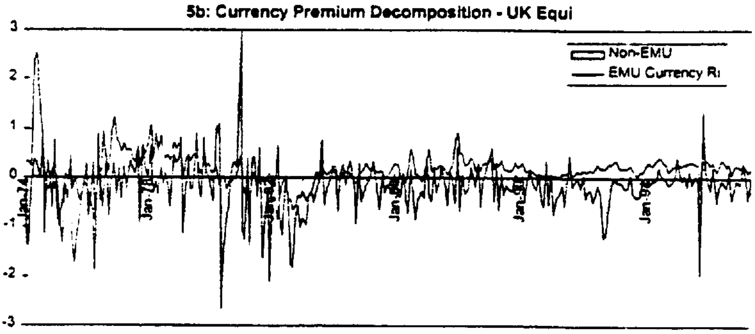

4a: Risk Premia - Dutch Equit
Total
Currency
6
5
4
3
2
1
0
-1
-2
-3


4b: Currency Premium Decomposition - Dutch Equ
Non-EMU
EMU Currency Ri
3
2
1
0
-1
-2
-3

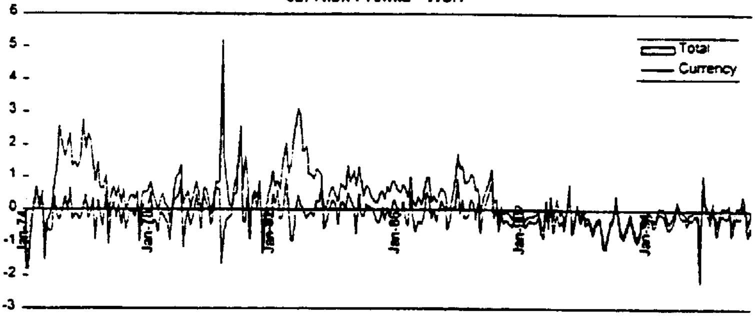
5a: Risk Premia - UK Equit




5b: Currency Premium Decomposition - UK Equi




6a: Risk Premia - Worl




6b: Currency Premium Decomposition - Worl

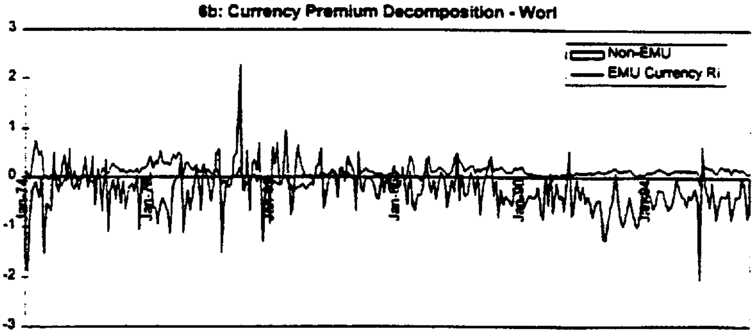


Fig.7a: Average Aggregate Currency Premia
with 2Std.Dev. Bounds

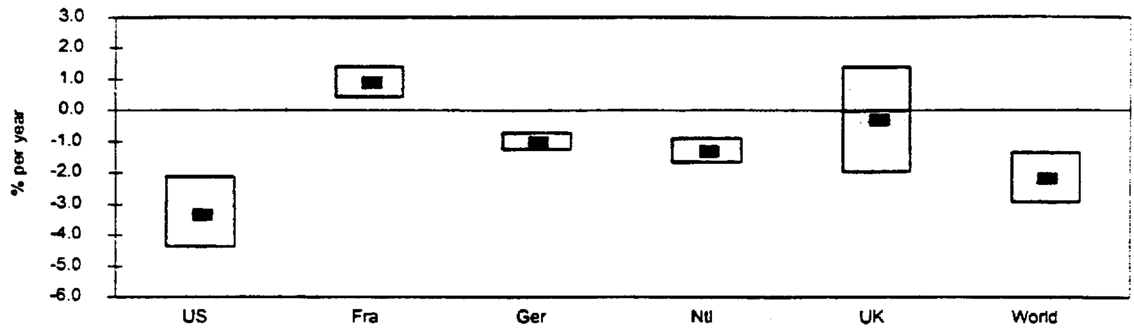



Fig.7b: Average EMU Currency Premia
with 2Std.Dev. Bounds

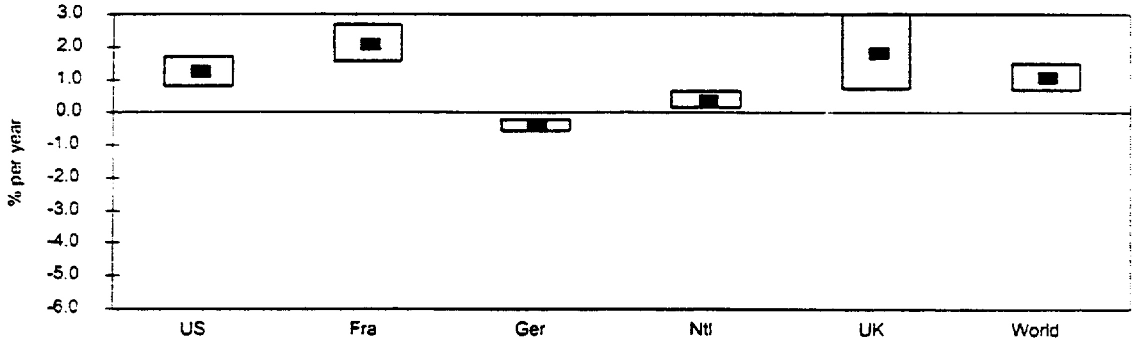



Fig.7c: Average Non-EMU Currency Premia
with 2Std.Dev. Bounds

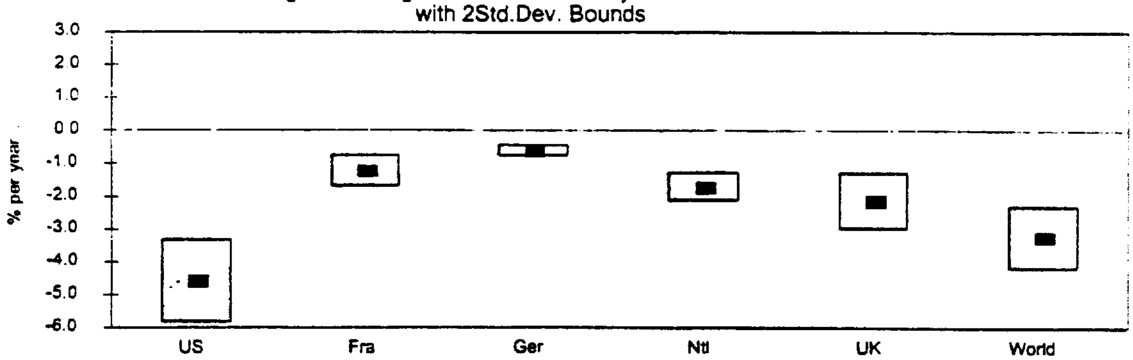


Fig. 8a: Structural Changes in Aggregate Currency Premia

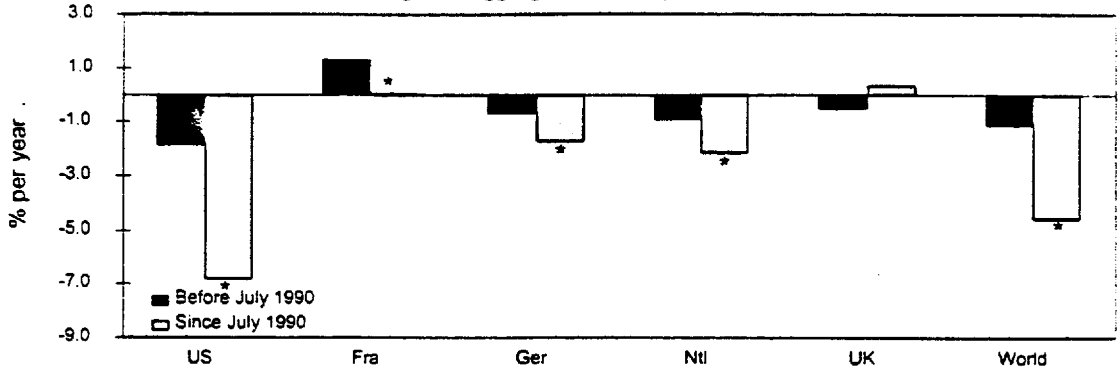



Fig. 8b: Structural Changes in EMU Currency Premia

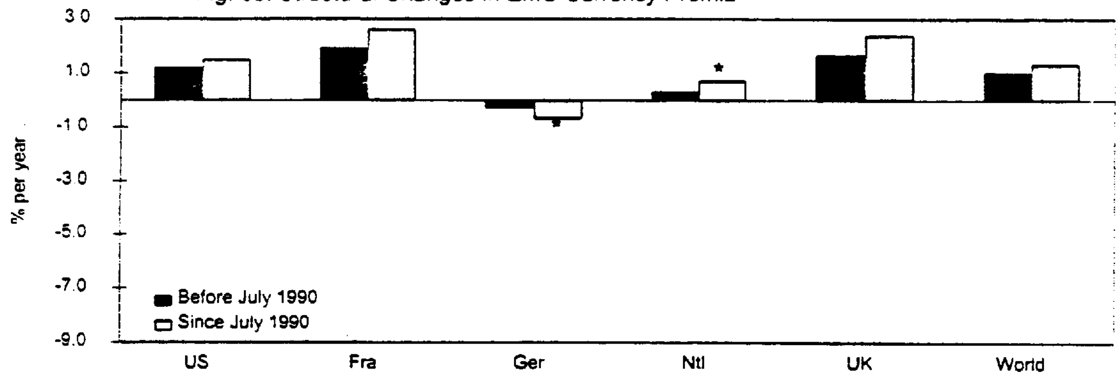



Fig. 8c: Structural Changes in Non-EMU Currency Premia