GRETA

WORKING PAPER n.01.02

Marzo 2001

The European Single Currency and the volatility of European Stock Markets

M. Billio[a,b]
L. Pelizzon[b,c]
D. Sartore[a,b]

a. University Ca' Foscari, Venice.
b. GRETA, Venice.
c. University of Padua.

Abstract

This paper analyses whether the convergence of European economies and the introduction of the euro has produced some effects on the world equity index and on European Stock Markets. Using multivariate switching regime models we test this issue for world equity index, stable European economies as Germany and France and historically unstable stock markets like Italy and Spain. Our results suggests that the euro introduction is empirically irrelevant for world market portfolio volatility. Instead, it generates a change in the parameter distribution of German and French idiosyncratic risk, in particular transition probabilities indicate an increase of the frequency of visiting the high volatility regime. On the contrary, as theory suggests, the euro introduction has indeed increased the frequency of visiting the low volatility regime for Spanish and Italian stock market idiosyncratic risk. Moreover, we do not observe any change in the correlation between France and Germany instead we do observe in general an increase of Spanish and Italian correlation with Germany.

1 Introduction

An interesting experiments of countries and capital market integration has taken place in Europe during the last twenty years. A tangible result of this process is represented by the European Monetary Union (EMU) and the euro. The euro has been introduced at the end of a long convergence process beginning in 1979 with the creation of the European Monetary System (EMS), and later on the removal of capital controls. The 1991 Treaty on European Union (Maastricht Treaty) set 1 January 1999 as the starting date for the final stage in the creation of the European Monetary Union. After this date the convergence process has accelerated dramatically in the few years leading to the introduction of the euro.

Most advocates of EMU describe the introduction of the Euro not as a major currency reform, but rather as a currency change over which will simplify international transaction 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 currency are intuitively appealing, a more through analysis of the consequences of the convergence process associated with the introduction of the Euro on European stock markets may be useful to better appreciate the relevance of the Euro for the European stock market as a whole and also to investors. Surprisingly, very limited empirical evidence is available on these issues.

The main objective of this study is to analyze the implications of EMU on equity volatility of both instable and stable countries and on the links between each others and with the rest of the world.

In more details this means that we would like to analyze the following questions: have convergence of European economies and EMU been associated with: (i) a lower idiosyncratic volatility of stock returns (mainly in the much instable countries such as Spain and Italy), (ii) a convergence of European stock return, and (iii) a change in the stochastic volatility process of stock returns?

Moreover, do we observe any change in the relation with the rest of the world stock markets? In particular, has EMU been associated with: (i) a lower idiosyncratic volatility of the European community with respect to the world market index volatility, (ii) a different link with the rest of the world, and (iii) a change in the stochastic volatility process of the market over all? Economic theory predicts that stock returns should reflect the systematic risk of the asset and expectations of future dividends, interest rates and risk premia. Therefore variance of stock returns should depend on variance and covariances of such fundamentals. It follows that both first and second moments of returns should be affected by the convergence process and the introduction of the euro (as observed by Beltratti and Morana (2000)) to the extent that these phenomena affect fundamentals and expectation thereof.

The implications of EMU on variance and covariances of European capital market excess returns could be studied with standard (linear) econometric methods. Nevertheless, it is a well-established fact that financial volatility is a non-constant stochastic process with a non-negligible degree of persistence. To understand the implications of EMU on time varying financial volatility more knowledge of the processes that drive volatility is required.

With this research we want to establish implications of EMU for time-varying volatility and intra-market dependence of national European stock markets. Here only a few studies have been conducted. Engle and Susmel (1993) and King et al. (1994), Hasler (1995), and Rouwenhorst (1998) estimate multivariate models with common factors.

An often noted observation is that there appear to be regime shifts in the variance-covariance matrix of different national stock markets[1]. During periods of high volatility there appears to be a tendency of higher international dependence. This observation calls for an attempt to apply Hamilton's regime switching models to a multivariate dataset of stock market returns. Recent estimates of switching regime models of stock returns appear in Ramchand and Susmel (1998) and Hamilton and Lin (1996).

Using such a model we can allow shifts in the stochastic volatility model driving the stock markets. For this reason in our work we use a Switching Regime Beta Model since it is inconclusive to analyze the impact of the EMU on European stock market volatility ignoring (as some other authors do as Beltratti and Morana (2000)) that such market is linked to the rest of the world and many other phenomena happened during Euro introduction. It is in fact insufficient to compare the different increase in volatility during the EMU introduction and conclude that the European stock volatility has increase less than the world portfolio!

We assume that the world stock market is driven by a stochastic process with two states, a low volatility and a high volatility state. National stock markets are affected by the world stochastic process and by a domestic idiosyncratic process. Also the volatility of the latter may shift between two levels.

In particular we analyze if the Euro has generated any change in the

[1] Among the many authors documenting this include Longin and Solnik (1998, 1995) Das and Uppal (1996), De Santis and Gerard (1997), King, Sentana and Wadhwani (1994) and Erb, Harvey and Viskanta (1994).

distribution of the world market and if the introduction of the euro has change the stochastic process of the idiosyncratic factor risk of the leading country: Germany.

Furthermore, with this work we shed some light on the volatility distribution of another stable country: France. Next, we test if the euro has allowed a transition of the Italian and Spanish markets towards a volatility regime similar to the one historically prevailing in Germany or if it has only change the frequency of visiting their previous high volatility regime.

Financial markets anticipate real economies due to the forward-looking nature of investors who may have set prices even before the end of 1998 with an eye towards the future introduction of the euro. It is conceivable thus that in 1998 there was already an anticipation EMU implications on the stochastic process of equity excess returns. For this reason, we test for the change in the distribution parameters at the beginning of 1998. To anticipate the main empirical results, the structure of the estimated volatility distribution suggests that the euro introduction had a limited impact on the world market portfolio. Instead, it generates a change in the parameter distribution of German and French idiosyncratic risk, in particular transition probabilities indicate an increase of the frequency of visiting the high volatility regime. On the contrary, as theory suggests, the euro introduction has indeed increased the frequency of visiting the low volatility regime for Spanish and Italian stock market idiosyncratic risk. Moreover, we do not observe any change in the correlation between France and Germany instead we do observe in general an increase of Spanish and Italian correlation with Germany and, an increase of such correlation during periods of high volatility and low volatility in both the systematic and idiosyncratic Markov chains for France and Spain, the opposite for Italy.

The outline of the paper is as follows. We start by presenting the econometric methodology in Section 2. In Section 3 we discuss theoretical models connecting stock returns and fundamentals on systematic and idiosyncratic risk factors and presents in details the economic meaning of our analysis. In Section 4 we describe the data and present our empirical results. In Section 5 we extend the analysis on causality tests. Section 6 concludes.

2 Econometric methodology

The risk profile of a firm or of the economy as a whole does not remain constant over time. A variety of systematic and unsystematic events may change the business and financial risk of firms significantly. It is argued here that this might derive from the presence of discontinuous shifts in return volatility.

The change in regime should not be regarded as predictable but as a random event. The effect of these risk shifts should be taken into account when the aim of the study is to analyze the stochastic process of equity market volatility and links between markets.

For this purpose, the dynamics of the volatility process of the major European stock markets are analyzed using a Markov switching approach.

Switching regime models is a methodology which has encountered great success in macroeconomics applications. In the path-breaking works by Quandt (1958), as well as Goldfeld and Quandt (1973, 1975) it was used to describe markets in disequilibrium. Hamilton (1989, 1994) has brought about a Renaissance of this methodology by modelling business cycles. In Engel and Hamilton (1990), the switching approach is successfully applied to exchange rates. Firstly, applications to finance have been scarce, noteworthy exceptions being Pagan and Schwert (1990), Turner, Startz and Nelson (1989), as well as van Norden and Schaller (1993), Rockinger (1994) and Hamilton and Susmel (1996). Now there is high interest for this type of models: see for example Billio and Pelizzon (1997), Ang and Bekaert (1999), Campbell and Li (1999), Khabie-Zeitoun, Salkin and Christofides (1999), Jeanne and Masson (1998), Beltratti and Morana (2000), Capiello (2000), Billio and Pelizzon (2000).

Switching regime models have been applied to stock market returns, assuming that returns are characterized by a mixture of distributions. This gives rise to a fat-tailed distribution, a feature of the return data which has been extensively documented since the early work by Mandelbrot (1963).

The advantage of using a Markov chain as opposed to a Bernoulli specification for the random discontinuous shift is that the former allows to conditional information to be used in the forecasting process. This allows us to: (i) fit and explain the time series, (ii) capture the well known cluster effect, under which high volatility is usually followed by high volatility (in presence of persistent regimes), (iii) generate better forecasts compared to the mixture of distributions model, since switching regime models generate a time conditional forecast distribution rather than an unconditional forecasted distribution.

2.1 Simple Switching Regime Models

Usually in the literature stock market returns or excess returns are modelized with a Simple Switching Regime Model (SSRM), which can be written as:

$$R_t = \mu(s_t) + \Sigma(s_t)\varepsilon_t \tag{1}$$

where $R_t = \ln(P_t/P_{t-1}) - r_t$ is the vector of excess returns of market indexes of dimension N, $\varepsilon_t \sim IIN(0, I)$, P_t is the stock price or the index price and r_t is the interest rate, s_t is a Markov chain with k states and transition probability matrix P. In particular if $k = 2$, we have:

$$R_t = \begin{cases} \mu_0 + \Sigma_0 \varepsilon_t if s_t = 0 \\ \mu_1 + \Sigma_1 \varepsilon_t if s_t = 1 \end{cases}$$

and the transition matrix P is:

$$P = \begin{bmatrix} p & 1-p \\ 1-q & q \end{bmatrix} \tag{2}$$

where the parameters p and q are probabilities that volatility remains in the same regime. In the model the variance and mean of returns change only as a result of periodic, discrete events.

With this model the state is the same for all the stock markets and then the mean and the variance of the vector process R_t change according to the state variable s_t. At the opposite it is possible to assume that there are country specific states and that the movements across states are independent. Then each country stock market excess return is described by a univariate SSRM.

We are interested in the link between stock markets and then we need to consider more general switching regime models which allow to better describe and understand these relations.

2.2 Switching Regime Beta Models

The SSRM does not provide an explicit link between the stock excess return of one country and the stock excess return of a leading country (or of a sovranational market). Following Billio and Pelizzon (2000), we consider the Switching Regime Beta Model (SRBM), which is a sort of one factor model where the excess return of a country i is characterized by the regime switching of the leading market index and the regime switching of the specific risk of the country. The SRBM can be written as:

$$\begin{cases} R_{mt} &= \mu_m(s_{mt}) + \sigma_m(s_{mt})\varepsilon_t, & \varepsilon_t \sim IIN(0,1) \\ R_{it} &= \mu_i(s_{it}) + \beta_i(s_{mt}, s_{it})R_{mt} + \sigma_i(s_{it})\varepsilon_{it}, & \varepsilon_{it} \sim IIN(0,1) \end{cases} \tag{3}$$

where s_{mt} and s_{it} are two independent Markov chains and ε_{it} and ε_t are independently distributed.

In such a framework the conditional mean of the single market is given by the parameter $\mu_i(s_{it})$ that is specific to the asset plus the factor loading $(\beta_i(s_t, s_{i,t}))$ on the conditional mean of the factor. The factor loading compensates for the risk of the single market which depends on the factor: higher covariances demand higher risk premium. The variance is the sum of variance of the leading market weighted by the factor loading and the variance of the idiosyncratic risk.

The SRBM considers a single asset only, but can be generalized for a vector of excess return taking into account the correlation between different markets.

2.3 Multivariate Switching Regime Model

The generalized version of the SRBM, considering N markets, that we call the Multivariate Switching Regime Model (MSRM), can be written as:

$$\begin{cases} R_{mt} &= \mu_m(s_{mt}) + \sigma_m(s_{mt})\varepsilon_t, & \varepsilon_t \sim IIN(0,1) \\ R_{1t} &= \mu_1(s_{1t}) + \beta_1(s_{mt}, s_{1t})R_{mt} + \sigma_1(s_{1t})\varepsilon_{1t}, & \varepsilon_{1t} \sim IIN(0,1) \\ R_{2t} &= \mu_2(s_{2t}) + \beta_2(s_{mt}, s_{2t})R_{mt} + \sigma_2(s_{2t})\varepsilon_{2t} & \varepsilon_{2t} \sim IIN(0,1) \\ \vdots & & \\ R_{Nt} &= \mu_N(s_{Nt}) + \beta_N(s_{mt}, s_{Nt})R_{mt} + \sigma_N(s_{Nt})\varepsilon_{Nt}, & \varepsilon_{Nt} \sim IIN(0,1) \end{cases} \tag{4}$$

where s_{mt} and s_{jt}, $j = 1, ..., N$ are independent Markov chains, ε_t and ε_{jt}, $j = 1, ..., N$, are independently distributed.

Using this approach we are able to take into account the correlation between different assets. In fact, if we consider $k = 2$, two stock markets, and, for example, $s_{mt} = s_{1t} = 0$ and $s_{2t} = 1$, the variance-covariance matrix between the two markets is:

$$\Sigma(0,0,1) = \begin{bmatrix} \beta_1^2(0,0)\sigma_m^2(0) + \sigma_1^2(0) & \beta_1(0,0)\beta_2(0,1)\sigma_m^2(0) \\ \beta_2(0,1)\beta_1(0,0)\sigma_m^2(0) & \beta_2^2(0,1)\sigma_m^2(0) + \sigma_2^2(1) \end{bmatrix} \tag{5}$$

then the correlation between different assets is given by β's parameters and the leading market variance.

In this model the covariance between market 1 and market 2 depends on the extent to which each market is linked, through the factor loading β to the leading market index.

3 Economic Analysis, Regime switching models and tests

Factor Models are equation that break down the returns of securities into two components. A factor model specifies that the excess return of each risky investment is determined by: a relatively small number of common factors, which are proxies for those events in the economy that affects a large number of different investments and a risk component that is unique to the investment. The simplest possible factor model is a one-factor model which is a factor model with only one factor. It is often convenient to think of this one factor as the excess world market return and to refer to the model as the market model.

With the conditional version of this model based on switching regimes in volatility we would like to analyze the implications of EMU on European Stock market volatilities and correlations. Our purpose is only positive, we do not attempt to analyze the implications of EMU on the world equity price. Nevertheless, models of asset pricing guide the specification of the econometric models and provide useful insights for the analysis and tests that should be useful to perform in order to explain the results we obtain.

One of the most widely used asset pricing models in finance is the CAPM originally derived by Sharpe (1964) and Linter (1965). In a two period framework, the model predicts that the expected return on any traded asset, in excess of a risk-free return, is proportional to the systematic risk of the asset, as measured by its covariance with a market-wide portfolio return.

CAPM has been extended in order to take into account the price of exchange rate risk. The International Capital Asset Pricing Model (ICAPM) predicts that, in equilibrium, the expected return of any asset is equal to the return on the risk free asset, determined 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 asset 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.

Which are the implication of such model on European stock volatility after EMU? The ICAPM points to the existence of two fundamental channels of transmission of the change in the currency on asset returns that is (a) the number of exchange rate risk premia and (b) the sensitivity of the excess return to the market risk premium as measured by the standard beta coefficient. In theory, the reduction of the number of exchange rates reduces the number of risk factors. Empirical evidence by De Santis Gerard and

Hillion (1999) shows that even if currency fluctuation induce a systematic source of risk returns, the EMU component is small relative to the non-EMU component. Currency risk is priced and the EMU currency risk commands a positive but small risk premium. Currency risk and its impact on returns vary over times as a function of changes in economic conditions and the institutional environment. In particular, the risk exposure of international equity markets to the EMU currency has declined since 1990. What does these finding imply for the transition to a single currency? First, to the extent that exposure to EMU currency risk is systematic, asset return is likely to decrease, both for European and non-European equity markets. Secondly, 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.

The beta is the ratio between the covariance between the European stock return and the market portfolio. The latter does not seem to be affected by the European convergence process, at least not in a very important way given the weight of the European stock markets on the world stock portfolio, currently lower than 30%. The covariance can be thought of as the product of the correlation coefficients and the standard deviation of the two returns. If the correlation coefficient is constant then a decrease in variance associated with elimination of exchange risk may reduce beta. A reduction of the beta, given a stability of the market risk premium amounts to a reduction of both the risk premium and its variance.

The Switching regimes models presented in the previous section offer a number of testable implications concerning the EMU impact on the risk premia volatility. First, with the SSRM we could analyze if we do observe any difference in the stochastic process of the world-wide market portfolio before and after the EMU. We are conscious that this analysis will provide only some insights about this issue since we are unable to analyze the world-wide portfolio process maintaining the rest of the world ceteris paribus. We cannot ignore the financial crisis that we did observe during the EMU introduction (Asian Crisis, Russian crisis, "Hi-tech revolution").

Second, SRBM could be a useful tool to analyze the implication of EMU on the link between the European Stock Markets and the rest of the world. In particular we analyze if there is any evidence of change in the link (beta) between the European driven countries: Germany and the world portfolio.

Clearly an analysis of any ICAPM (and even the impact of EMU on

European volatility) is inconclusive if the analysis is performed using an unconditional approach. As pointed out by many authors (Dumas and Solnik (1995), De Santis and Gerard (1998)), this type of analysis can be very misleading if the conditional distribution of asset returns changes over time. Nevertheless, if a model need to be conditional, has to be intertemporal too, since investors anticipate future variation of factors that characterize returns and hedge them over their life time. Indeed, recent research in international financial markets has made it a priority to use intertemporal models. These comes in two classes. The first class contains the so called Merton Itertemporal CAPM.

Merton (1973) shows that, in an intertemporal model, economic agents need to hedge against changes in the investment opportunity set. This implies that the expected return on any asset is a function of the covariances between its return and the return on a number of hedging portfolios. The second class contains so-called "consumption CAPM)" as in Breeden (1979), Lucas (1978, 1982); these are Euler condition based on one investor's consumption stream; they are valid equally in the domestic or international context.

One of the evolution of the second class models is the asset pricing models proposed by Campbell and Shiller (1988), Campbell (1991), Campbell and Ammer (1993), Ammer and Mei (1996). This branch of economic theory also predicts that stock prices should reflect expectation of future dividends, interest rates and excess stock return. Therefore, the variance of stock returns should depend on variances and covariances of such fundamentals. It follows that both first and second moments of return should be affected by the convergence process and the introduction of the Euro to the extent that these phenomena affect fundamentals and expectations and so systematic and idiosyncratic risks. The impact of volatility risk premia on the European stock volatility has been already presented above. Nevertheless, even the effects of EMU on dividends and interest rates may affect the idiosyncratic risk deeply.

The Euro introduction may affect the volatility of the European market over all and could also affect the volatility of the idiosyncratic (countries) risk factor. We may expect that the impact on European stock market volatility could be relatively different between countries with strong macroeconomic fundamentals (e.g. Germany) and countries with weak macroeconomic fundamentals (e.g. Italy) mainly because the Euro is expected to be a close substitute for the currency of the strong country, e.g. the Deutche Mark. Introduction of the Euro per se may or may not imply changes in the second moments of the distribution of the historically stable countries (Germany or France) that is countries with strong macroeconomic fundamentals (see De Grawe (1997) for the ex-ante macroeconomic implications of the introduction of the Euro); nevertheless, it may positively affect strongly macroeconomic equilibrium of unstable countries through several channels.

Concerning the former effect we analyze the implications of Euro on the idiosyncratic risk of the GEM using the SRBM taking into account the dynamic process of the world. The aim of this analysis is to study whether we observe any change in the stochastic process of the idiosyncratic GEM (German equity market) volatility. In particular we test if EMU has created a new economic regime for Germany or if instead has only increased the frequency of visiting one regime with respect to the other (a change in transition probabilities).

Regards the latter we may expect a double effect. First, the adoption of a single currency is likely to have a significant impact on European equity markets and in particular on their correlation. For example it is often argue that the convergence of economic structures and policies, the existence of a unique currency and identical interest rates will increase correlations between the European stock markets. What's about the link between the GEM and the other countries.

The implication of the increase of correlation is a potential increase of the beta (the ratio between the covariance of the unstable stock market and the GEM over the variance of the GEM). We expect to observe this phenomena even for the unstable (e.g. Italy and Spain) and the stable countries (e.g. France). As we stress above covariance increases with the monetary union, the later may increase initially. This implies that the beta could remain stable, or increase, depends on which of the two effects dominates. We study this phenomena with a Multivariate-SRBM and tests if betas have been changed with the EMU process.

Regards the second effect, the introduction of the Euro should be associated with a modification of volatility of macroeconomic fundamentals of the historically unstable European economies like Spain and Italy. In fact the modification of stock market volatility for these countries is likely to be in the direction of decrease, due to the convergence of the stochastic process of fundamentals to that of the more stable European countries.

A first channel is due to the substitution of a weak currency with a strong currency. This may impact competitiveness of exporters and may induce restructuring of firms which need to keep their costs in line with those of foreign non European competitors. A second channel is due to fixing the level of the nominal exchange rate with respect to other European countries. This may impact exporters in terms of their competitiveness with their European partners. A third relevant channel is due to the decrease in the level of the nominal interest rate connected to the switch to a strong currency and the introduction of an independent central bank. A decrease in interest rate is associated with a decrease in the burden of the public debt and a reduction (in general) of interest rate volatility. A fourth channel is due to the existence of a monetary policy which is tuned to the needs of the Euro area as a whole and not to the needs of specific countries.

Which are the possible effects of these macroeconomic changes on the second moment of stock return, that, as evidenced above, depends on volatility and covariances between expectation on dividends, interest rates and risk premia.

The elimination of the exchange rates certainly cancels the risk of investment in foreign (European) market and so reduce the uncertainty related to foreign costs or earnings.

A second direct effect of the introduction of the Euro is the unification of the European monetary policies and so interest rates. Interest rates volatility is likely to be reduced to the extent that the stochastic process generating European interest rates has converged to the stable German process. What's about the covariance between interest rate and stock risk premia. There is no presumption that the covariance between interest rates and stock risk premia will change even though a possible scenario is that in which the country risk of Italy, Belgium and Spain becomes more sensitive to the level of the interest rate. This could be due to the large effects that changes in the interest rate would have on public deficits in high debt countries.

Concerning the variance of shocks to dividends, it is at this moment unclear whether the convergence process associated with the Euro will decrease or increase the variance of dividends. A reduction in the variance may be due to stabilization of the economy. This may however be offset by some instability connected with the adjustment to a fixed exchange rate, especially in the long run. Presumably the variance of the business cycle for some European countries might decrease with the reduction of the Euro to the extent that monetary and fiscal policies are subtracted from the national authority and are handed in to a well-behaved authority with a reputation for good management in terms of inflation and public deficits. On the other hand the stabilization of monetary policy means that the fine tuning will be imperfect in some areas due to imperfect correlation of international business cycles and this might increase the variance of local business cycles. This effect potentially affects unstable but even stable countries. We analyze jointly the implication of dividends, interest rates on the domestic risk factor. We leave the analysis of the separate effects as a topic for future research to be conducted with different analytical tools.

Implications on idiosyncratic risk of EMU on France, Italy and Spain is performed with the Multivariate-SRM. We analyse if we observe a structural break on the variance states and in particular if EMU has created a new economic regime (similar for all the different European countries) or if the stabilization of fundamental brought about by the introduction of the

Euro may have increased the frequency of visiting low volatility regimes for traditionally unstable European stock markets. In order to disentangle this issue we perform a series of tests.

4 Data and empirical results

We use weekly returns on stock indexes for four European countries (the Germany, France, Italy and Spain) plus a value-weighted world index. All the indexes are obtained from Morgan Stanley Capital International (MSCI) and the sampling period covers 687 observations over the period 1 January 1988-28 February 2001. To determine the equity excess return we use Eurocurrency rates offered in the interbank market in London for one week deposits in Deutche Mark, French Francs, Italian Lira, Spanish Pesetas. The summary statistics are reported in Table 1.

The Switching regime models described in Section 2 offers a number of testable implications presented in Section 3 which are of primary interest in our study.

First we can determine whether world-wide market risk premia volatility did change after the EMU. As we point out in the introduction, test for a reduction in the unconditional variance of stock return after the date of the introduction of the euro by means of a dummy variable is insufficient (as already stressed among others by Beltratti and Morana (2000) due to the forward-looking nature of investors who may have set prices even before the end of 1998 with an eye towards the future introduction of the Euro. In fact, financial markets anticipate real economies, so that it is conceivable that in 1998 there was already an anticipation EMU implications on the stochastic process of equity excess returns.

We use the SSRM with the aim to analyze whether we find any difference in the stochastic process of the world-wide market portfolio before and after the EMU. First we estimate the model with all the available sample and make inference of being in one of the two volatility regime for each date of the sample using the Hamilton's filter and smoothed algorithm (Hamilton (1994)). Figure 1 shows the resulting series. From Figure 1 we observe that the probability that the world index is in the high volatility regime is extremely high in the last part of the sample. This outcome is generated mainly by the high instability of the financial markets in the last years starting from the Asian crisis till the High-tech revolution and the last Japanese crisis of March 2001. Because of these events we are unable to disentangle if EMU has produced any minimal effect on the world index volatility distribution. Nevertheless this result is important since the elevate instability of the world index during the last years for sure also affects European markets; in order to analyze EMU implications for European markets we need to identify properly the potential increase of volatility generated by world wide conditions. Since later on we would like to test if we observe any structural change in the European volatility markets after the EMU, we need to be sure that at the world wide level we do not observe a structural break generated by other financial phenomena totally orthogonal to the EMU.

In order to assess the stability of the obtained results and to evaluate the change in the stock market volatility after the introduction of Euro, we analyze the behavior of the world index by allowing all parameters to change and perform the corresponding Likelihood Ratio test. Table 2 - panel (a) - provides the test results. The LR test statistics accept the hypothesis of no change in the parameter of the distribution of excess return of the world index.

As we stress above, from 1997 many events affects the world financial markets. Our finding suggests that the new-economy, the explosion of the new (hi-tech market) and all the different financial crisis do not generate a structural change in the world financial markets.

Having provided the empirical irrelevance of EMU on world market volatility it is useful to analyze the implications of EMU on (i) the link between world market portfolio and the European leading market: the GEM and (ii) the idiosyncratic volatility of such leading market.

For a more educated assessment of this issue we requires an explicit measure of the stability of the results obtained. In order to evaluate the change in the stock market volatility and correlation with the world market index after the introduction of Euro, we compare the SRBM estimated in all the sample with the estimated results of several models where we allow a change in: (i) all the parameters; (ii) only betas; (iii) only the transition probabilities, and perform the corresponding Likelihood Ratio tests.

Figure 2 and 3 show the filtered probabilities of being respectively on the low volatility regime for the world index and the high volatility regime for the idiosyncratic German risk. For the world index the graph indicates that the probability estimated with the SSRM are almost the same as that estimated with the SBRM, again we observe an increase in the persistence of the high volatility regime in the last part of the sample. On the other hand, for Germany, the idiosyncratic risk, that may represent the implication of EMU on the volatility of such market indicates that EMU may have increased the volatility of the GEM.

Table 2 panel (b) contains the LR test statistics and the level of significance to evaluate the different hypothesis. The statistics reject at the 1% level the hypothesis of no change in the parameters. Nevertheless, the statistical analysis accepts the hypothesis of the stability of the beta between and after the EMU. This means that neither the link between GEM and the world index has been affected by the EMU introduction.

We also find, as previous authors point out, a general increase of correlation during periods of high volatility (beta are higher when the world market is in the high volatility regime).

Even more interesting for our purposes is the result that the main change that we observe in the stochastic process of the GEM is the change of the transition probabilities. This means that the euro introduction have increased the frequency of visiting the high volatility regime for the traditionally stable Germany. In order to study the robustness of this result we estimate also a SBRM with three regime for the world chain, in such a way to be sure that the higher frequency of visiting the high volatility regime by the idiosyncratic German factor risk is not related to a poor estimation of the risk of the world index. The result are almost the same as with the two volatility regimes.

The previous outcome suggest that the hypothesis that the euro is a close substitute for the currency of the leading country (Germany) has to be rejected. Our empirical finding open the issue if the Euro has indeed modified the stochastic processes of domestic fundamentals of the leading country. We leave to further research the issue whether the Euro is or not a good substitute of the DM strong currency.

Having established the relation between Germany and the rest of the world and the insights about the changes on its fundamentals, it is worthy to analyze the implications of EMU on (i) the links between GEM and the other national equity markets and (ii) the idiosyncratic risk factor.

Statistics in table 2 panels b,c,d show that as for Germany we do observe a change in the distribution parameter of excess returns, in all the cases in fact the null hypothesis is rejected at the 1% level. Moreover, we do not observe any change about the link between GEM and French equity market. Betas are almost the same in the two subsamples. Again we observe a high correlation when the leading market is in the high volatility regime.

On the contrary, Spain and in particular Italy present a change about the link with the leading country. The test statistic indicate that Spain reject at 1% probability level the null hypothesis and Italy reject at the 5% level. On average we observe, as expected, an increase of betas. However, we found that betas are higher when systematic and idiosyncratic risk are both in the high or the low volatility regime for France and Spain, instead for Italy when they are the opposite. For this reason in Section 5 we extend the analysis on causality test in order to deeply analyze this empirical evidence.

Regards the second effect, that is if the introduction of the Euro should be associated with a modification of the volatility of macroeconomic fundamentals, figures 3,4,5 show that indeed after the period following the introduction of the Euro Italy and Spain have been characterized by a low volatility regime. Nevertheless, for Spain and Italy we accept the hypothesis that transition probability are still the same, the main change is observed for the betas. Following the discussion in the economic analysis, our result demonstrates that the main reason of this is connected with stabilization of fundamentals and not with the elimination of the exchange risk per se.

Concerning France, the result are similar to Germany. The change in the distribution has been generated by a change in the transition probability with an increase in the likelihood of visiting the high volatility regime.

For completeness we report also in figure 6 the filtered probability of the GEM chain and we could observe that it is similar to the world chain probability.

5 EMU and European stock market correlations: an extension of the analysis

5.1 Correlation between states

In the SRBM we assume that the Markov chain of the leading market is independent of the Markov chain describing the specific risk of the country, as is usual assumed in a factor model. However, this only one possible way to describe the relation between the Markov chains. In the spirit of Hamilton and Lin (1996) and Susmel (1998), three possible cases arise from the combination of s_{mt} and s_{it}.

1. Independent states.

   This is the hypothesis considered in describing the SRBM. In this case the combination of s_{mt} and s_{it} produces a new latent variable, S_t, specified as follows (for the simpler case $k = 2$ for both Markov chains)

$$\begin{array}{lll} S_t = 1 & if s_{mt} = 0 & and s_{it} = 0, \\ S_t = 2 & if s_{mt} = 0 & and s_{it} = 1, \\ S_t = 3 & if s_{mt} = 1 & and s_{it} = 0, \\ S_t = 4 & if s_{mt} = 1 & and s_{it} = 1 \end{array} \tag{6}$$

the resulting transition probabilities are obtained by multiplying the probabilities that drive s_{mt} and s_{it}. Accordingly, the transition probability matrix $\mathbf{P}$ will be:

$$\mathbf{P} = P_m \otimes P_i \tag{7}$$

where $\otimes$ indicates the Kronecker product and P_m and P_i are the transition matrices respectively of s_{mt} and s_{it}.

2. Common states.

   Shifts in the leading market index and in the specific risk of the country are determined by the same factors, thus the two latent variables s_{mt} and s_{it} are in fact the same, namely $S_t = s_{mt} = s_{it}$ and the

   transition probability matrix is simply (2) for $k = 2$.

3. Related states.

   The forces that govern the leading market index and the specific risk of the country are the same, but are not in phase. Two sub-cases need to be considered: the leading market index shifts before the specific risk and then the former leads the latter, so $s_{it} = s_{mt-1}$; causality is reversed, namely $s_{mt} = s_{it-1}$. For example, if $s_{it} = s_{mt-1}$ the state variable S_t, generated by the combination of s_{mt} and s_{it}, is defined in the following way:

$$\begin{array}{lll} S_t = 1 & if s_{mt} = 0 & and s_{mt-1} = 0, \\ S_t = 2 & if s_{mt} = 0 & and s_{mt-1} = 1, \\ S_t = 3 & if s_{mt} = 1 & and s_{mt-1} = 0, \\ S_t = 4 & if s_{mt} = 1 & and s_{mt-1} = 1 \end{array} \tag{8}$$

   and the associated transition probability matrix is

$$\mathbf{P} = \begin{bmatrix} p_m & 1-p_m & 0 & 0 \\ 0 & 0 & 1-q_m & q_m \\ p_m & 1-p_m & 0 & 0 \\ 0 & 0 & 1-q_m & q_m \end{bmatrix} \tag{9}$$

4. General specification.

   This specification does not make any *a priori* assumptions about the latent variables. The transition probabilities are give by:

$$p_{ij} = P(S_t = i/S_{t-1} = j)$$

while the associated matrix will be

$$\mathbf{P} = \begin{bmatrix} p_{11} & p_{12} & p_{13} & p_{14} \\ p_{21} & p_{22} & p_{23} & p_{24} \\ p_{31} & p_{32} & p_{33} & p_{34} \\ p_{41} & p_{42} & p_{43} & p_{44} \end{bmatrix} \tag{10}$$

where $p_{i1} + p_{i2} + p_{i3} + p_{i4} = 1$, $i = 1, ..., 4$.

As general specification, it nests the first and third ones as special cases. Since the Markov transition probability matrix given by this specification has a different dimension than the one associated with the second one, is more difficult to identify the latter within the general specification.

The common state case is not of interest because we would like to understand the causality between the leading market and the single country market. With $k = 2$, the independent case asks for 4 parameters, while the general specification asks for 12 parameters. Now we propose to describe several correlated cases with a number of parameters comprised between 4 and 12. In particular, in the general specification we can decompose the transition probabilities as follows

$$\begin{aligned} P(S_t/S_{t-1}) &= P(s_{mt}, s_{it}/s_{mt-1}, s_{it-1}) \\ &= P(s_{mt}/s_{it}, s_{mt-1}, s_{it-1})P(s_{it}/s_{mt-1}, s_{it-1}) \end{aligned} \tag{11}$$

and then suppose that, for example, s_{mt} causes s_{it} in the Granger sense without imposing common states

$$\begin{aligned} P(S_t/S_{t-1}) &= P(s_{mt}, s_{it}/s_{mt-1}, s_{it-1}) \\ &= P(s_{mt}/s_{it}, s_{mt-1}, s_{it-1})P(s_{it}/s_{it-1}) \end{aligned} \tag{12}$$

or by imposing another restriction

$$P(S_t/S_{t-1}) = P(s_{mt}/s_{it}, s_{mt-1})P(s_{it}/s_{it-1}) \tag{13}$$

This type of decomposition allows to describe the previous specifications besides other interesting cases.

5.2 Empirical results

To be done

6 Conclusion

In this paper we have analyzed the variances and covariances of four major European markets and their links with the world equity market. The aim of the paper is to evaluate the changes in the volatility distribution brought about the introduction of the euro. Theory suggests that stock excess return are affected by the systematic risk of the asset, as measured by its covariance with a market-wide portfolio return, and a risk component that it is unique to the market. From our review of the economic asset pricing theory we could conclude that the introduction of the euro may have affected the world index volatility (because of the reduction of currency risk factors), and the macroeconomic convergence process associated with the EMU should increase the idiosyncratic risk of the stable countries (e.g. Germany and France) and decrease the idiosyncratic component of variance of the traditionally unstable European stock markets like Italy and Spain.

For this purpose we have estimated and compared statistically several models. First we have analyzed if the EMU has in some way affected the distribution of the World index. Our tests suggests that we are unable to observe any change in the parameters. Nevertheless, we do observe from filtered probability that during EMU the world excess return has been characterized by a high volatility regime mainly because the recent crisis in the financial markets (clearly unrelated with the EMU). This means that if theoretically the euro may generate a reduction of the world index volatility, empirically we demonstrate that this effect is not so significant.

Second we study the link with the GEM and the world index and the idiosyncratic risk of GEM. In this case we found a change in the parameter distribution. Nevertheless, the link with the world index does not evidence any significant change instead transition probabilities has been changed. In fact, we observe an increase of the frequency of visiting the high volatility regime by the idiosyncratic risk GEM chain. This result highlight two potential explanations. First it may confirm the theoretical implication that euro could be not a proper substitute of DM. Second, that the high tech revolution has affected the European Market more intensely than the world index. We leave to further research the analysis of this topic. We found almost the same behavior for France. Instead, Italy and Spain show a general increase in the betas and even a change in the transition probability. In particular, we found that the correlation has been increased in general and that the probability of visiting the low volatility regime for the Italian idiosyncratic chain has increased.

These results have various implications. From the point of view of stock market efficiency, European stock markets have indeed reacted in the way predicted by fundamentals in terms of volatilities and correlation, in particular for Italy. From the point of view of European stock market as a whole, the euro seems to have brought a net benefit in terms of reduced volatility due to the discipline that economically strong European countries like Germany have been able to impose to economically weaker countries like Spain and Italy. Nevertheless, the euro, the high tech revolution and the fragility of the European equity market seems has increased the idiosyncratic volatility of the historically stable markets.

The results seems to be relevant also for investors. On the one hand the successful modeling of volatility as a multiregime Markov process is another confirmation that the standard practice of estimating variance-covariance matrices on the basis of historical data without considering time-varying volatility is inappropriate. On the other hand, the sensitivity of stock market volatility to general macroeconomic events suggests that macroeconomic variable are important risk factors for stock prices. Moreover, we do observe an increase of the link between European capital markets. Nevertheless, it may therefore premature to declare the death of country diversification within Europe to support the introduction of sector diversification. From our analysis in fact we do observe only in some state of the world an increase of the correlation in some others regime we do observe a reduction of correlation. Implications for portfolio diversification has to be taken into account by investors.

References

Ammer J. and J. Mei (1996), Measuring international economic linkages with stock market data, Journal of Finance, 60, 1743-1763.

Ang A. and G. Bekaert (1999), International Asset Allocation with Time varying Correlation, mimeo, Stanford University.

Beltratti and Morana (2000), The effects of the introduction of the Euro on the volatility of European stock markets, Working Paper Paolo Baffi Centre for Monetary and Financial Economics, Milan.

Billio M. and L. Pelizzon (1997), Pricing options with switching volatility, Money, Finance, Banking and Insurance, ed. C. Hipp, Verlang and Nota di Lavoro n. 97.07, D.S.E. Università Ca' Foscari, Venice.

Billio M. and L. Pelizzon (2000), Value-at-Risk: a multivariate switching regime approach, Journal of Empirical Finance, 7, 531-554.

Breeden D. T. (1979), An intertemporal asset pricing model with stochastic consumption and investment opportunities, Journal of Financial Economics, 7, 265-296.

Campbell J.Y. (1991), A variance decomposition for stock returns, Economic Journal, 101, 157-179.

Campbell J. Y. and R.J. Shiller (1998), The dividend price ratio and expectations of future dividends and discount factors, Review of Financial Studies, 1, 195-227.

Campbell J.Y. and J. Ammer (1993), What moves the stock and bond markets? A variance decomposition for long-term asset returns, Journal of Finance, 48, 3-37.

Capiello L. (2000), A conditional multi-asset intertemporal CAPM with switching prices of risk, The Graduate Institute of International Studies, University of Geneva.

De Grawe P. (1997), The Economics of Monetary Integration, Oxford University press.

De Santis G. and B. Gerard (1997), International asset pricing and portfolio diversification with time-varying risk, Journal of Finance, 52, 1881-1912.

De Santis G. and B. Gerard (1998), How big is the premium for currency risk? Journal of Financial Economics, 49.

De Santis G., B. Gerard and P. Hillion (1999), The European Single Currency and World Equity Markets, in J. Dermine and P. Hillion (eds), European Capital Markets with a Single Currency, Oxford University Press.

Dumas B. and B. Solnik (1995), The world price of foreign exchange risk, Journal of Finance, 50, 445-479.

Engel, C. and J.D. Hamilton (1990), Long Swings in the Dollar: are they in the data and do markets know it?, American Economic Review, 80, 689-713.

Engle R. and R. Susmel (1993), Common Volatility in International Equity Markets, Journal of Business and Economic Statistics 11, 2.

Goldfeld, S.M. and R.E. Quandt (1973), A Markov model for switching regressions, Journal of Econometrics 1, 3-15.

Goldfeld, S.M. and R.E. Quandt (1975), Estimation in a disequilibrium model and the value of information, Journal of Econometrics 3.

Hamilton J.D. and G. Lin (1996), Stock market volatility and the business cycle, Journal of Applied Econometrics, 11, 573-593.

Hamilton J.D. and G. Lin (1996), Stock market volatility and the business cycle, Journal of Applied Econometrics, 11, 573-593.

Hamilton, J.D. (1989), A new approach to the Economic Analysis of nonstationary time series and the business cycle, Econometrica 57, 357-384.

Hamilton, J.D. (1994), Time series analysis (Princeton University Press).

Hamilton, J.D. and R. Susmel (1994), Autoregressive Conditional Heteroskedasticity and Changes in Regime, Journal of Econometrics 64, 307-33.

Hasler J. (1995), Regime Shifts and Volatility Spillovers on International Stock Markets, mimeo, Stockholm.

Jeanne, O. and P. Masson (1999), Currency crises, sunspots and Markov switching regimes, Proceedings FFM99 London.

Khabie-Zeitoun, D., G. Salkin and N. Cristofides (1999), Factor GARCH, regime switching and term structure models, Proceedings FFM99 London.

King M., E. Sentana and S. Wadhwani (1994), Volatility and Links Between National Stock Markets, Econometrica 62, 4.

Linter 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, 13-37.

Longin F. and B. Solnik (1995), Is the correlation in international equity returns constant: 1970-1990? Journal of International Money and Finance, 14, 3-26.

Longin F. and B. Solnik (2000), Extreme correlation of International Equity Markets, Journal of Finance, forthcoming.

Lucas R.E. (1978), Asset prices in an exchange economy, Econometrica, 46, 1429-1445.

Lucas R. E. (1982), Interest rates and currency prices in a two country world, Journal of Monetary Economics, 10, 335-360.

Mandelbrot, B. (1963), The variation of certain speculative prices, Journal of Business 36.

Merton R.C. (1973), An intertemporal capital asset pricing model, Econometrica, 41, 867-888.

Pagan, A.R. and G.W. Schwert (1990), Alternative models for conditional stock volatility, Journal of Econometrics 45.

Quandt R.E. (1958), The estimation of the parameters of a linear regression system obeying two separate regimes, Journal of the American Statistical Association, 53/284, 873-880.

Ramchand L. and R. Susmel (1998), Volatility and Cross Correlation Across Major Stock markets, mimeo, Journal of Empirical Finance, 5, 397-416.

Rockinger, M. (1994), Regime switching: evidence for the French stock market, Mimeo HEC.

Rouwenhorst G. (1998), European Equity Markets and EMU: are the difference between countries slowly disappearing, mimeo, Yale School of Management.

Sharpe W. (1964), Capital asset prices: a theory of market eauilibrium under conditios of risk, Journal of Finance, 29, 365-378.

Susmel R. (1998), Switching volatilities in international equity markets, Department of Finance, University of Houston.

Susmel R. (1998), Switching volatilities in international equity markets, Department of Finance, University of Houston.

Turner, C.M., R. Startz and C.R. Nelson (1989), A Markov Model of Heteroschedasticity, risk and learning in the stock market, Journal of Financial Economics, 25, 3-22.

van Norden, S. and H. Schaller (1993), Regime Switching in Stock Market returns, Mimeo Bank of Canada and Carleton University.

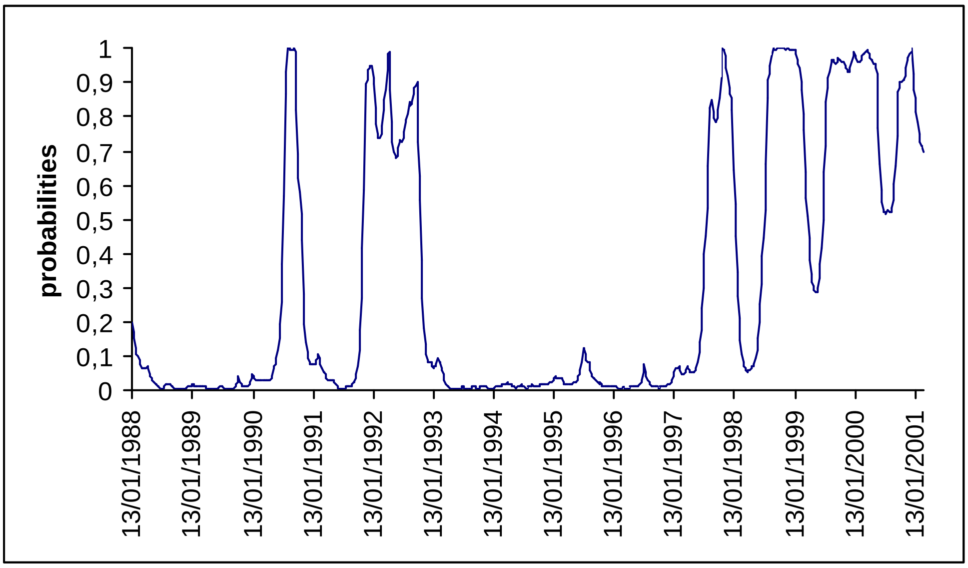

Figure 1 – SSRM: smoothed probabilities of high volatility regime for the world index.

	World	Germany	France	Italy	Spain
Mean	0,000752	0,001321	0,001307	0,000176	0,000356
Standard deviation	0,021863	0,026473	0,025769	0,030646	0,027946
Asimmetry	-0,53876	-0,37392	-0,24252	-0,02243	-0,49063

Table 1 - Summary statistics

Panels		Number of constraints	LR statistic	p value
A	**World (univariate)**			
	all parameters	5	7,8274	0,1660
B	**Germany w/World**			
	all parameters	14	33,2935	**0,0026**
	Betas	4	4,1718	0,3833
	transition probabilities	4	13,3238	**0,0098**
C	**France w/Germany**			
	all parameters	14	30,0374	**0,0075**
	Betas	4	5,5082	0,2390
	transition probabilities	4	8,4030	0,0779
D	**Italy w/Germany**			
	all parameters	14	36,1805	**0,0010**
	Betas	4	9,8018	***0,0439***
	transition probabilities	4	14,7970	**0,0051**
e	**Spain w/Germany**			
	all parameters	14	43,1269	**0,0001**
	Betas	4	22,2282	**0,0002**
	transition probabilities	4	27,3826	**0,0000**

Table 2 – Test statistics

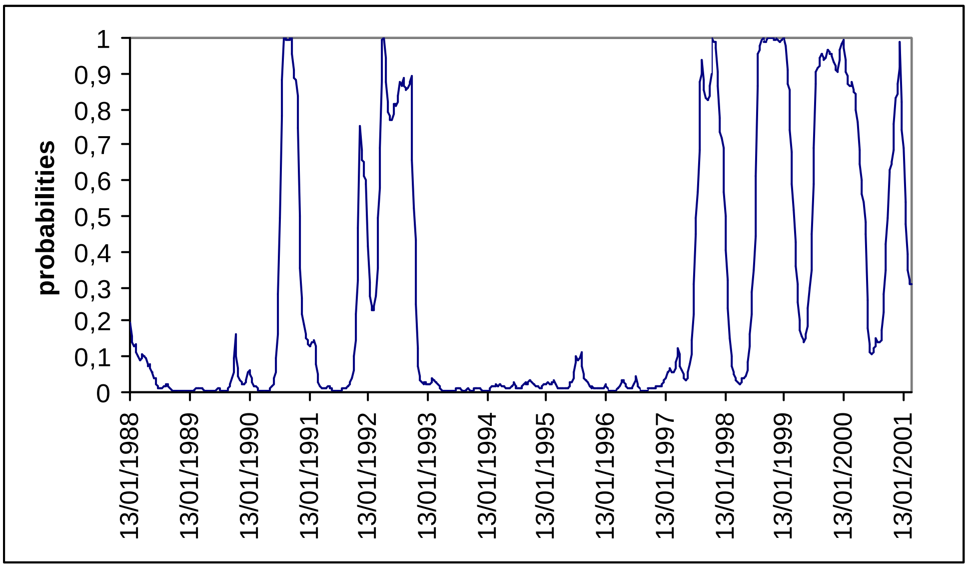

Figure 2 – SBRM: smoothed probabilities of high volatility regime for the world index chain when extimated together with Germany.

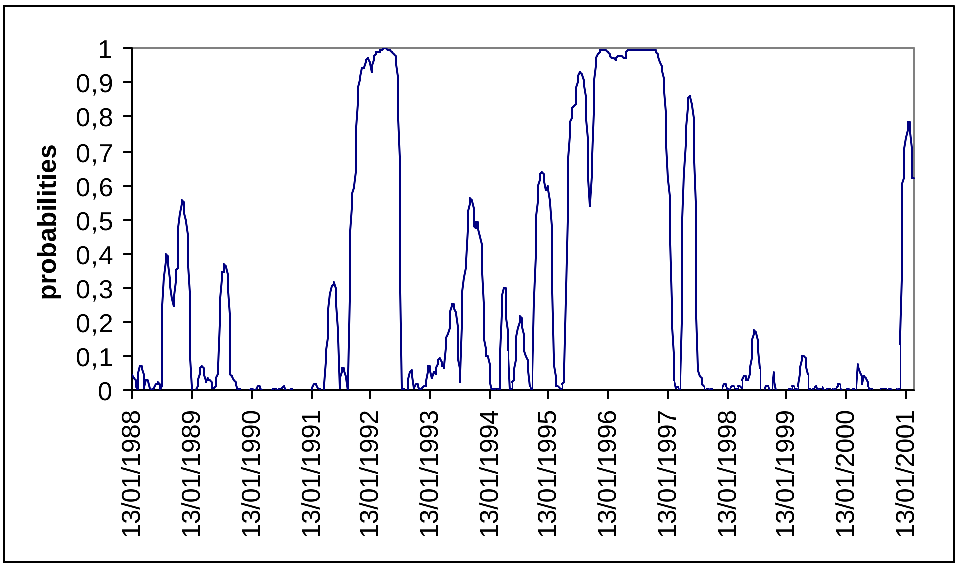

Figure 3 – SBRM: smoothed probabilities of low volatility regime for the German idiosyncratic risk chain.

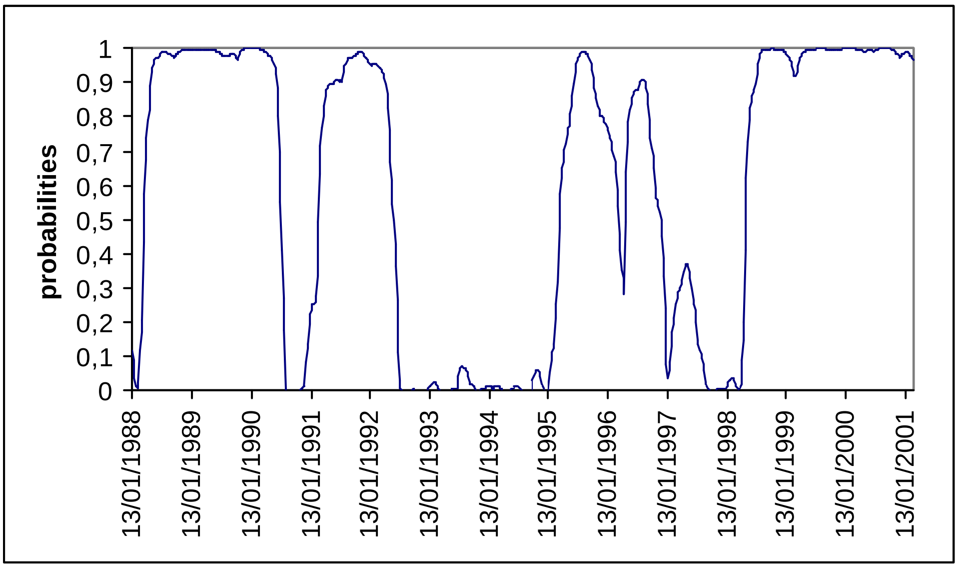

Figure 4 – SBRM: smoothed probabilities of low volatility regime for the Italian idiosyncratic risk chain.

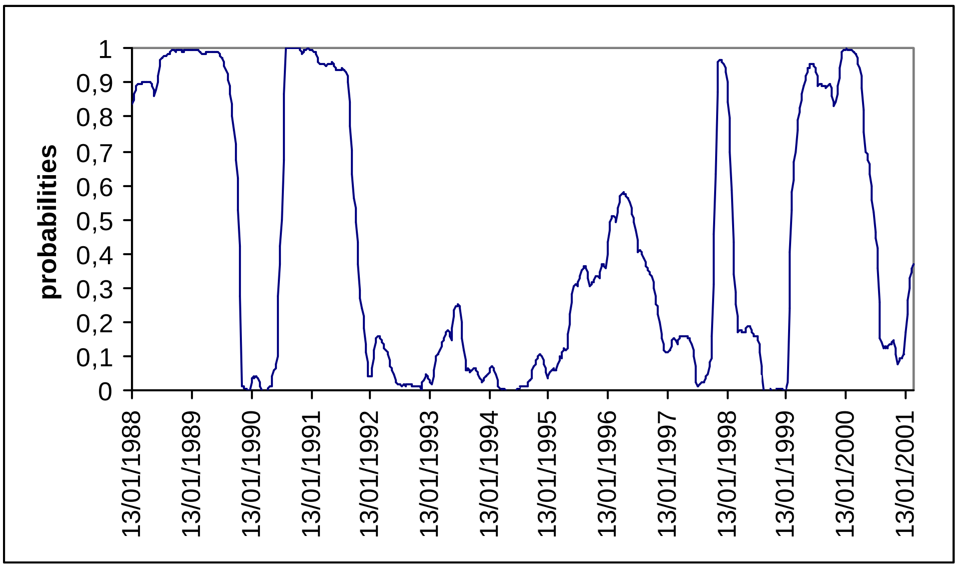

Figure 5 – SBRM: smoothed probabilities of low volatility regime for the Spanish idiosyncratic risk chain.

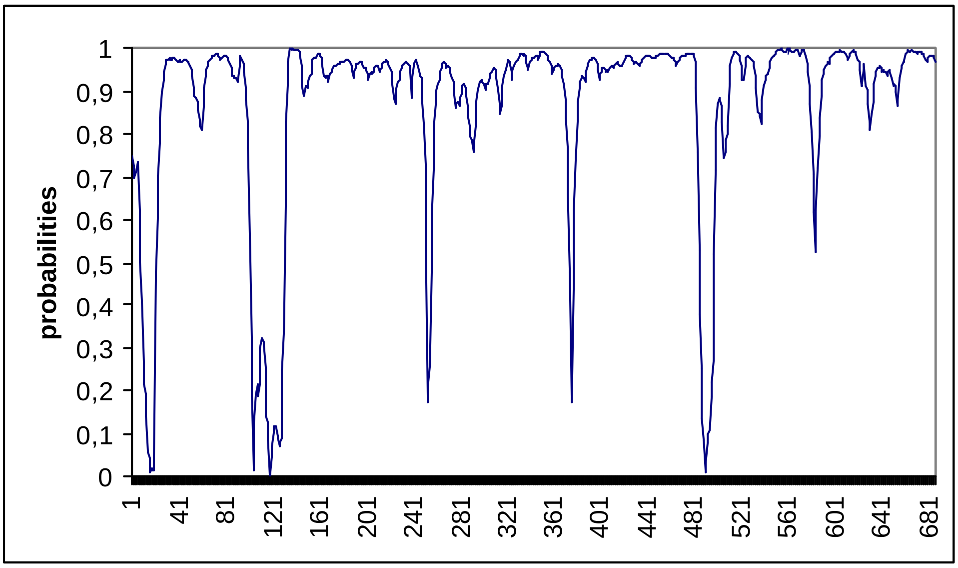

Figure 6 – SBRM: smoothed probabilities of low volatility regime for the French idiosyncratic risk chain.

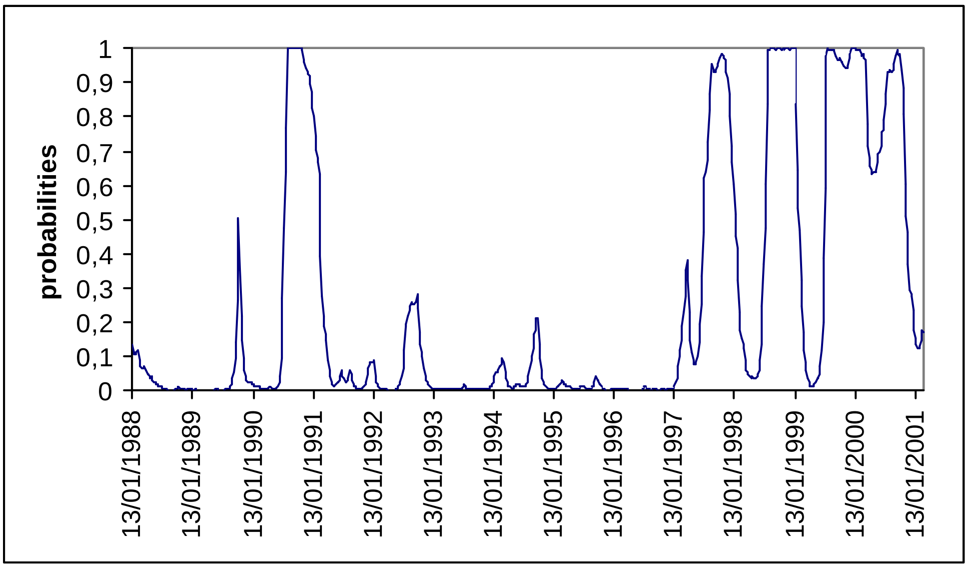

Figure 7 – SBRM: smoothed probabilities of low volatility regime for the German chain when estimated together with Italy, Spain and France.