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ABSTRACT

EMU and European Stock Market Integration*

The paper examines whether or not the convergence process of European economies towards Economic and Monetary Union (EMU) has led to increased integration of European stock markets. We estimate a conditional asset pricing model, which allows for a time-varying degree of integration that measures the importance of EU-wide risk relative to country-specific risk. The model accounts for intra-European currency risk, time-varying quantities of risk and time-varying prices of risk. The results indicate that the degree of integration is closely related to forward interest differentials *vis-à-vis* Germany, i.e. to the probability of a country joining EMU. Integration increases substantially over time, especially since 1995, when these differentials began shrinking, and by mid-1998, six months before the official date for EMU launch, stock markets in EMU member states seem to be almost fully integrated. The average saving in the cost of capital from integration in Europe over the period 1992–8 is estimated at around 2%.

JEL Classification: G12, G15
Keywords: CAPM, integration of stock markets, EMU, cost of capital

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NON-TECHNICAL SUMMARY

The central question in this paper is whether or not the intense efforts of European countries in the 1990s to establish the European Monetary Union (EMU) also led to a gradual integration of national stock markets. Integration of bond and money markets is a well known implication of EMU. Bond yields converged among the EMU–11 countries as early as 1997 due to the explicit interest rate criterion in the Maastricht Treaty. Similarly, after 1 January 1999, the common monetary policy in the EMU zone has resulted in equal money market rates. Convergence in national stock markets is less transparent, however, because it is not as easily measurable. National stock markets are completely integrated if investors face only common EU-wide risk factors and price them identically. Markets are partially integrated if, in addition to common EU-wide factors, investors face country-specific factors and price them both.

The issue of European stock market integration is of considerable importance to both investors and corporate managers. As stock markets become more integrated and move increasingly together, the diversification benefits of investing in many countries may well be reduced, given that intra-European exchange rate risk is also eliminated. The focus of diversification may well shift from a country level to the industry level across European markets. As a result, investors may have to switch portfolio compositions in order to achieve efficient portfolios.

For corporate managers, an important implication of increasing integration is its impact on the firm’s cost of capital. Moving toward a more integrated stock market would likely result in a reduction in the cost of capital, as less weight is being placed on domestic risk factors and more weight on EU-wide factors. A lower cost of capital should lead to more positive net present value projects being undertaken and a consequent rise in national wealth.

There are a number of reasons why one might expect increased European stock market integration in the 1990s. First, convergence of interest rates and inflation rates towards German levels leads to convergence in risk-free real rates across EMU member states. Second, real convergence of European economies, which is boosted not only from the common monetary policy but from the constraints on fiscal policy as well, leads to convergence in expected future cash flows, resulting in a more homogeneous valuation of equities, hence, an increased cross-country correlation in real cash flows and volatilities. Third, the elimination of intra-EMU exchange rate risk leads to more homogeneous reward to risk ratios across European stock markets.

Intuition also suggests that for a given country, stock market integration is expected to be higher, the higher its probability of joining EMU. Stock market integration is also expected to be higher, the closer the calendar date is to January 1999, the time of EMU launch, as a higher amount of future cash flows are influenced by the advent of EMU.

We estimate a conditional asset pricing model of European stock markets with a time varying degree of integration, modelled as the weight that is applied to EU-wide risk factors as opposed to country-specific risk factors. A major innovation in our model is the incorporation of an explicit link between the probability of a country joining EMU and the degree of a country's stock market integration. The degree of integration of each national stock market with a value-weighted global European market index is modelled as a function of the country's forward interest rate differential *vis-à-vis* Germany, the benchmark country in our analysis. This differential incorporates markets' perception of the probability that the country will join EMU. Although forward interest rate differentials have been widely used by a number of financial institutions and market practitioners to calculate the probability of individual countries joining EMU, the paper represents, to our knowledge, the first attempt in the literature to link a time-varying measure of integration in stock markets with forward spreads in bond markets.

The model accounts for intra-European currency risk, time-varying quantities of risk and time-varying prices of risk. The quantities of risk are modelled through a multivariate generalized autoregressive conditional heteroscedastic (GARCH) in mean model. The prices of risk are conditioned on local and EU-wide information variables. The model provides a robust description of the time-variability in risk and expected return because additional information variables do not add explanatory power. Furthermore, the model is not sensitive to alternative specifications, such as the functional form of the price of market risk or other measures of the interest rate differential, free of worldwide comovements in interest rates, which can also be used to capture the probability of a country joining EMU. The model outperforms significantly a model that assumes full integration throughout the 1990s in terms of pricing errors and goodness of fit measures, suggesting that a partial integration model provides a better specification of European risk premia. Hence, a partial integration model ought to be used when calculating expected return and risk for decision-making by investment and corporate managers.

We discovered that in the 1990s, the probability that an EU country would join EMU significantly influenced the degree of integration of its local market with the EU-wide market index. First, simple correlations of local market returns with the EU-wide market return are negatively associated over time with forward interest rate differentials *vis-à-vis* Germany. Second, the model's more precise and theoretically accurate measures of integration, which reflect the importance of EU-wide risk factors relative to country-specific risk factors in the pricing of stocks, also show an economically and statistically significant negative association with the size of the forward interest rate differential *vis-à-vis* Germany. Moreover, when these interest rate differentials shrink in 1997 and 1998, the markets converge towards full integration, that is, expected returns are increasingly determined by EU-wide market risk and less by local risk.

We illustrate the importance of the level and variation in the degree of integration on calculating expected returns by decomposing expected returns into the contribution made by local risk premia and the contribution made by EU risk premia. Splitting the sample into two periods, we find that in the 1991–5 sub-period, on average, the percentage of total expected returns due to local risk is 77% across the EU–12 countries. With respect to the EU risk factors, the currency risk premium is negative in all countries. In contrast to this early sub-period, the sub-period 1996–8 is one in which the contribution of local risk falls substantially to an average of 34%. In addition, the currency risk premium is positive in all cases but one and contributes on average 23% of total expected returns. Overall, these variations in expected returns illustrate the importance of variations in integration over time and also the importance of capturing the variation in the prices and quantities of risk.

Finally, the paper evaluates the impact of integration on the equity cost of capital. The average cumulative saving in the cost of capital from integration in European stock markets over the period 1992–8 is estimated at around 2% for the EU–12 countries on a value-weighted basis. Most of this saving originates from the reduction in country-specific risk as integration of European stock markets increases over time. This result in its own right should be important to policy-makers who are considering the benefits of joining EMU and to corporate managers who make real investment decisions.

1 Introduction

The central question in this paper is whether or not the intense efforts of the European countries in the 1990s to establish the European Monetary Union (EMU) also led to gradual stock market integration. The process of economic and monetary integration in Europe can be traced back to the Treaty of Rome in March 1957, which established the European Economic Community, later renamed the European Union (EU). Economic integration first began with the adoption of a common agricultural policy and the gradual abolition of tariffs. It followed with the establishment of the European Monetary System in 1979, which aimed at reducing the fluctuation of intra-European exchange rates and at safeguarding price stability. Subsequently, in February 1986, the Single European Act imposed a deadline, the end of 1992, for the complete abolition of all obstacles to free cross-border movement of labor, capital and goods and services. At the same time, the regulatory structure of the financial markets was harmonized with the First and Second Banking Directive and a set of other legislative and institutional measures.[1] Finally, in February 1992, the signing up of the Maastricht Treaty, which became effective in November 1993, opened up the possibility for a monetary union among those EU countries that would satisfy certain convergence criteria on inflation, interest rates, the public finances and exchange rates.

In May 1998, the finance ministers of the fifteen EU countries decided that eleven countries satisfied the convergence criteria and, hence, they would form the first core of the monetary union on January 1, 1999. In 1999, a common monetary policy is effective across EMU and euro, the common currency, has been introduced in scriptural form. Later on, in 2002, euro will also circulate in fiduciary form and become legal tender. The eleven countries are also supposed to abide by the Stability and Growth Pact, which imposes penalties for countries that run annual budget deficits beyond 3% of GDP.

Monetary integration has wide ranging implications for European capital markets. Money market and bond market integration is one such implication. After January 1, 1999, all new government bonds and bills are denominated in euro and there is one central bank carrying out a common monetary policy. Hence, money market rates are equalized across the 11 national markets in Europe. Similarly, all EU-11 government bonds are carrying identical market

[1] For a recent survey on the regulatory and legislative aspects of European stock market integration, see Licht (1998).

risk, with credit risk being the only characteristic that differentiates them. The latter is expected to be small. Hence, bond market yields are also similar. In fact, because financial markets are forward looking and because by 1997 they were convinced that, with very high probability, 11 of the 15 EU countries would join EMU, bond market integration had taken place among those 11 countries as early as 1997. Since 1993, a country's long-term interest rate spread with the corresponding interest rates of Germany, the anchor country, served as an indicator of the probability that the country would eventually manage to join EMU.

Stock market integration is another possible implication of EMU, an item we explore in this paper. Stock market integration is, however, less transparent than bond market integration because it is not as easily measurable. Asset markets are integrated if they carry the same required rate of return for the same amount of risk. Both the required rate of return and the riskiness of stocks are harder to assess than is the case for bonds. Yet, the issue of European stock market integration is crucial because it has important implications for the cost of capital and portfolio management issues in a unified Europe.

There are a number of reasons why one might expect increased European stock market integration throughout the 1990s. First, convergence of interest rates and inflation rates towards German levels leads to convergence of real risk-free rates across EMU member states. Second, real convergence of European economies leads to convergence of expected real cash flows across markets, leading to a more homogeneous valuation of equities. Real convergence is expected to be boosted not only from the common monetary policy but also from similar long-run fiscal policy, which, according to the Maastricht criteria and the Stability and Growth Pact, aims at keeping each government's budget approximately in balance. Therefore, monetary and fiscal policies are expected to lead to increased synchronization in business cycles across the European economies, resulting in higher cross-country correlations in real cash flows and volatilities. Third, exchange rates between EMU member states have been irrevocably fixed on January 1, 1999, making way for the euro. This, in turn, should eliminate intra-European currency risk, and, to the extent that currency risk is priced, reduce the overall exchange rate exposure of European consumers. Since exchange rate fluctuations are mainly driven by national economic policies, the elimination of currency risk within EMU is expected to lead to more homogenous reward to risk ratios across European stock markets.

The issue of European stock market integration is of considerable importance to both investors and corporate managers. As stock markets become more integrated and move increasingly together, the diversification benefits of investing in many countries may well be reduced, given that intra-European exchange rate risk will also be eliminated. It may well be the case that the focus of diversification shifts from a country level to an industry level across European markets. As a result, investors may have to switch portfolio compositions in order to achieve efficient portfolios.

For corporate managers, an important implication of increasing integration is its impact on the firm's cost of capital. While, ex ante, it is not necessarily clear what the impact of increasing integration will be on the cost of capital, intuition suggests that this may fall. Moving towards a more integrated stock market will lead to more weight being placed on EU risk factors. This event, together with the fact that covariances with EU risk factors are likely to be lower than variances of individual markets, coupled with the elimination of currency risk in the member states, suggests that a firm's cost of capital is likely to fall. A lower cost of capital should lead to more positive net present value projects being undertaken and a consequent rise in national wealth.

One way to assess whether increased economic and monetary integration leads to higher integration of European stock markets is to examine whether or not the influence of country-specific risk factors on required stock returns decreases in favor of EU-wide factors. For this reason we estimate a conditional asset pricing model of European stock markets, which incorporates an explicit time-varying degree of integration. The time-varying degree of integration measures the importance of EU-wide relative to country-specific risk factors. For simplicity, we treat Europe as the universe of investment opportunities available to a European investor and, consequently, measure integration of each individual stock market relative to a value-weighted European market index which consists of the EMU-11 countries and the UK.

A major innovation in our model is the incorporation of an explicit link between the probability of a country joining EMU and the degree of a country's stock market integration. The probability of joining EMU is modeled as a function of a country's expected interest rate differential vis-á-vis Germany for the year when EMU was expected to begin. Although forward interest rate differentials have been widely used by a number of financial institutions and market practitioners to calculate the probability of individual countries joining EMU,[2] this paper represents, to our knowledge, the first attempt in the literature to link a time-varying measure of integration in stock markets with forward spreads in bond markets.

Some other attractive features of our model are the following: First, the model accounts for intra-European currency risk, thus, allowing to assess the effect of the elimination of currency risk on required returns. Second, it allows for both time-varying quantities of risk and time-varying prices of risk. The latter are conditioned on EU-wide and country-specific information variables. Overall, the model allows us to recover a conditional measure of integration of European stock markets and to quantify the relevance of local and global risk as well as currency risk in determining expected returns over time.

A first piece of preliminary evidence that forward interest rate differentials vis-á-vis Germany are related to the degree of integration of European stock markets comes from simple graphical analysis. Figure 1 displays on the left scale a 52-week rolling estimate of the average cross-correlation coefficient between local stock returns and the EU-12 market return, where the latter is computed as the value-weighted return of the eleven EMU countries[3] plus the UK. The figure also displays on the right scale the average forward interest rate differential of the seven countries for which data on interest rate swaps are available over a longer sample.[4] The average cross-correlation between local returns and EU-12 returns increases significantly over the sample from less than 0.5 in 1991 to around 0.75 in the first half of 1998. Over the same period, the average forward differential fluctuates in the opposite direction and decreases from more than 170 basis points to less than 20 basis points. The sample correlation coefficient between the average forward interest rate differential and the average cross-correlation of local returns and EU-12 returns is -0.88, suggesting a strong negative association between the series.[5] Figure 1 also demonstrates that the large swings of the

[2] See, for example, JP Morgan: "The EMU Calculator", October 1996, and "EMU Calculator Handbook", January 1997; Paribas: "EMU Countdown", February 1997; Credito Italiano: "Economic Trends in Italy", IV 1996; Goldman Sachs: "European Bond Spreads and the Probability of EMU", May 1996; Favero et.al. (1997).

[3] Austria, Belgium, Finland, France, Germany, Ireland, Italy, Luxembourg, Netherlands, Portugal and Spain.

[4] Belgium-Luxembourg, France, Germany, Italy, Netherlands, Spain and the UK.

[5] One could argue that the increasing correlation of the national stock markets with the EU-wide portfolio during the 1990s is originating from accidental, increasingly more symmetric, shocks hitting the EU economies. Such a hypothesis, however, cannot accomodate

forward interest differential during the period of the EMS crisis in 1992-1993 are inversely related to significant changes in the unconditional correlation between local stock returns and the EU-12 market return.[6]

The results of the model are similar to the above picture. They indicate that integration of European stock markets increased substantially throughout the 1990s and that this increase was related to the probability of the countries joining EMU. During this period, expected European stock market returns were determined increasingly by EU-wide market risk and less by local risk. In particular, the percentage of total expected returns due to EU-wide risk increased from an average of less than 25% during the subperiod 1991-1995 to an average of more than 65% in the subperiod 1996-1998. Interestingly, six months before the official date for EMU launch, stock markets in EMU member states seem to be fully integrated.

The rest of the paper is as follows: Section 2 presents a brief review of the literature on stock market integration, our asset pricing model and its econometric implementation. Section 3 presents the data and some preliminary empirical results on European stock market integration. Section 4 contains the main empirical results along with a battery of specification tests. Section 5 discusses the implications for the cost of capital. Section 6 summarizes the principal findings and concludes.

2 Model and Econometric Specification

2.1 Overview

We define integration of European stock markets both in terms of the type of risk factor investors are exposed to and in terms of their reward to risk relationship. Stock markets are assumed to be completely integrated if investors face only common EU-wide risk factors and price them identically. Markets are assumed to be partially integrated if, in addition to common EU-wide factors, investors face country-specific factors and price them both. Markets are assumed to be completely segmented when investors face and price only country-specific factors.

the negative association of this correlation with the forward interest differentials.

[6] The correlation between the average forward interest rate differential and the average cross-correlation of local returns and EU-12 returns over the period 1992-1993 is -0.91 (with an asymptotic standard error of 0.10), which is not significantly different from the average correlation of the series during the rest of the sample.

In the framework of the Capital Asset Pricing Model (CAPM) of Sharpe (1964), Lintner (1965), and Mossin (1966), stock market integration imposes restrictions on the pricing of national assets by ruling out a relationship with purely national risk factors. In completely integrated markets the only priced risk should be related to systematic risk relative to the EU market. Hence, expected returns should move in relation to the conditional covariance between the local market and the EU market. A wide class of studies in international asset pricing that assume complete integration of national markets includes the studies of a world CAPM (Harvey (1991), De Santis and Gerard (1997)), a world CAPM with currency risk (Solnik (1974), Adler and Dumas (1983), Stulz (1981b), Dumas and Solnik (1995), De Santis and Gerard (1998)), consumption-based asset pricing models (Wheatley (1988)), multiple risk factor models (Ferson and Harvey (1994, 1997)) and international latent factor models (Campbell and Hamao (1992), Bekaert and Hodrick (1992)).

In completely segmented markets, on the other hand, only domestic risk should affect expected returns. With a single risk factor as a proxy, complete segmentation implies that expected returns are affected solely by the conditional variance of the local market (Merton (1980)). Consequently, the reward to risk ratio may differ across national markets because the sources of risk are different in each market. Furthermore, in segmented markets the cost of capital and the corresponding present value of an investment will generally depend on the particular market where the investment project is financed. A wide class of early studies on asset pricing relative to a national benchmark, mostly using US data, is based on the assumption of complete market segmentation.

In a third class of more recent studies, markets are assumed to be partially integrated with a degree of integration that can change over time according to a regime switching model (Bekaert and Harvey (1995)), or according to a logistic function of a vector of predetermined information variables (Bekaert and Harvey (1997)). This approach has the appealing feature of nesting both polar cases of complete integration and complete segmentation within the same framework. The degree of integration is applied as a time-varying weight on both the conditional covariance with the benchmark index (global risk) and the conditional variance of the local market (local risk). An increase in the degree of integration implies that the importance of global risk in explaining expected returns increases at the cost of local risk.

Finally, there is an extensive literature that examines the effects of barriers to international investments. These studies include, among many others, Stehle (1977), Stulz (1981a), Errunza and Losq (1985), Jorion and Schwartz (1986), Hietala (1989), Stulz and Wasserfallen (1995), Domowitz, Glen, and Madhavan (1997), and Bailey, Chung, and Kang (1998).

2.2 The Model

The model takes as its starting place the conditional CAPM of Sharpe (1964), Lintner (1965) and Mossin (1966) under the assumptions of either complete market integration or complete market segmentation. Under complete integration,[7]

$$E_{t-1}\left[r_{i,t}\right] = \lambda_{EU,t-1} cov_{t-1}\left[r_{i,t}, r_{EU,t}\right] \tag{1}$$

where $r_{i,t}$ is the excess return on the local stock market index, $r_{EU,t}$ is the excess return on the EU stock market index, $\lambda_{EU,t-1}$ is the conditional price of EU market risk, cov_{t-1} is the conditional covariance operator and E_{t-1} is the conditional expectations operator, given information up to time $t-1$.We assume that the universe of investment opportunities is the EU market, excluding the rest of the world from the analysis. This assumption should not affect our empirical estimates, since the core of the analysis focuses on the pricing of national stocks vis-á-vis the EU market. Nevertheless, after estimating the model, we test to check if the residuals are, indeed, orthogonal to world-wide, non-EU, information variables.

Even under full market integration, however, the Sharpe-Lintner model is not an adequate description of expected excess returns in a period of flexible exchange rates. Because purchasing power parity is at best a long-run phenomenon (see for example Grilli and Kaminsky (1991), Wu (1996) and Papell (1997), among others), international investors are exposed to exchange rate risk. Theoretical models which incorporate currency risk are Solnik (1974), Stulz (1981b), Adler and Dumas (1983) and Anderson and Danthine (1983) and empirical tests of conditional versions of this model are Dumas and Solnik (1995), De Santis and Gerard (1998) and De Santis et.al. (1997). Generalizing the Sharpe-Lintner-Mossin model to include currency risk yields:

$$E_{t-1}\left[r_{i,t}\right] = \lambda_{EU,t-1} cov_{t-1}\left[r_{i,t}, r_{EU,t}\right] + \lambda_{C,t-1} cov_{t-1}\left[r_{i,t}, r_{c,t}\right] \tag{2}$$

[7]To move from the unconditional version of the CAPM to a conditional version (see Merton (1973)) requires, for example, the assumption of logarithmic preferences.

where $r_{c,t}$ is the excess return on the currency and $\lambda_{C,t-1}$ is the price of currency risk. Theoretically, λ_C and r_c are vectors of currency risk prices and currency returns respectively, but for simplicity, in the empirical analysis we utilize a single basket of currencies.[8]

At the opposite extreme of complete segmentation the expected excess return on the local stock market index follows Merton (1980):

$$E_{t-1}\left[r_{i,t}\right] = \lambda_{i,t-1} var_{t-1}\left[r_{i,t}\right] \tag{3}$$

where $\lambda_{i,t-1}$ is the conditional local price of risk and var_{t-1} is the conditional variance operator given information up to time $t-1$. However, neither model (2) nor model (3) is an adequate description of European stock market premia in the 1980s and 1990s, because the markets were likely to be only partially integrated. Moreover, the level of integration is likely to have changed over time as various regulatory restrictions were lifted, investors began to increasingly diversify beyond national borders and EMU was approaching. In the 1990s, in particular, we expect to observe an increasing degree of integration, driven by the rising prospect of joining EMU. As the time of EMU launch was approaching, a larger component of the present value of future cash flows was being affected by the prospect of EMU, hence an increasingly closer association ought to have materialized between the pricing of stocks across European countries. Assuming that markets were partially integrated and the degree of integration varies over time, the conditional mean excess return on the ith stock market index, $i = 1, ..., N$, can be written as:

$$\begin{aligned} E_{t-1}\left[r_{i,t}\right] &= \phi_{i,t-1}\left(\lambda_{EU,t-1} cov_{t-1}\left[r_{i,t}, r_{EU,t}\right] + \lambda_{C,t-1} cov_{t-1}\left[r_{i,t}, r_{c,t}\right]\right) \\ &\quad + (1-\phi_{i,t-1})\lambda_{i,t-1} var_{t-1}\left[r_{i,t}\right] \end{aligned} \tag{4}$$

where $\phi_{i,t-1}$ measures the conditional level of integration of market i based on information up to time $t-1$ ($0 \leq \phi_i \leq 1$). Equation (4) may be viewed as an imperfect approximation of expected returns in partially integrated markets where both global and local risk factors are priced. The parameter $\phi_{i,t-1}$ determines the contribution of global relative to local risk in required

[8] In theory, $r_{c,t}$ includes the differential inflation as well. This component is excluded in the empirical analysis because it is very small in the weekly horizon, which we utilize in the estimation. Dumas and Solnik (1995) and other authors make a similar assumption at a monthly horizon.

returns. Alternatively, in the context of a regime switching model, $\phi_{i,t-1}$ could be interpreted as the conditional probability that market i is fully integrated (Bekaert and Harvey (1995)).

Equation (4) encompasses a wide range of asset pricing models. Clearly, when $\phi = 1$ the model is equivalent to the international CAPM with currency risk and full integration (Dumas and Solnik (1995)). When $\phi = 1$ and $\lambda_C = 0$ the model reduces to the conditional CAPM of Sharpe (1964) and Lintner (1965). When $\phi = 0$ the model collapses to the national CAPM (Merton (1980)). Finally, with $\lambda_C = 0$, $0 \leq \phi \leq 1$ the model collapses to the Bekaert and Harvey (1995) model with partial integration and no currency risk.

We model the conditional level of integration as a function of the forward interest rate differential as follows:

$$\phi_{i,t-1} = g_{0,i} + \exp\left(g_{1,i} \left|s_{i,t-1}\right|\right) \tag{5}$$

where $s_{i,t-1}$ is the forward interest rate differential between country i and Germany, the benchmark country, $g_{0,i}$, $g_{1,i}$ are country-specific parameters and exp(.) denotes exponentiation.

Note that the level of the forward interest rate differential between two countries is a function of the expected change in the exchange rate between two *future* points in time. After January 1, 1999 the exchange rates of the EMU countries are irrevocably fixed and no changes can take place. It should be stressed that EMU is a stronger legal arrangement than a simple regime of fixed exchange rates, like, say, the old Bretton Woods system, because it is backed by a common monetary policy and the abandonment of national monetary policies. This shift of economic power away from local authorities implies the relative absence of peso-type problems in the pricing of forward exchange rates and, through Open Interest Rate Parity, the forward interest rate differentials, which typically plague the econometric analysis during periods of fixed exchange rates. Consequently, if market participants expect that, say, France and Germany will be in EMU in 1999, then the forward interest rate differential between France and Germany, which connects two future points in time — both dates occurring after January 1, 1999 — ought to be zero. Conversely, if market participants expect that country i will not be in EMU in 1999, then the forward interest rate differential between country i and Germany can be different from zero. Thus, market expectations of economic and monetary integration are incorporated into forward interest rate differentials. We use this information to obtain a measure of the conditional integration in the stock market.

In equation (5), when the forward interest rate differential, $s_{i,t-1}$, is zero, $\exp\left(g_{1,i}\left|s_{i,t-1}\right|\right)$ becomes unity. When $s_{i,t-1}$ deviates from zero and $g_{1,i}<0$, then $0<\exp\left(g_{1,i}\left|s_{i,t-1}\right|\right)<1$. The larger the deviation of $s_{i,t-1}$ from zero, whether it is positive or negative, the closer $\exp\left(g_{1,i}\left|s_{i,t-1}\right|\right)$ is to zero and the further away from unity. The constant term $g_{0,i}$ in equation (5) acts as an intercept correction on the level of integration. For example, spreads may be zero by chance but markets may not be fully integrated (due to say capital market or ownership restrictions). In this case, $-1<g_{0,i}<0$. When equation (5) is estimated, $g_{1,i}$ is negative and $g_{0,i}$ is very close to zero, thus the level of integration $\phi_{i,t-1}$ ends up being bounded between zero and unity.

A final note on the special dual role that currency risk plays in the model. There is a difference between the actual currency risk faced by an investor over the investment horizon of, say, one week, and the long-run currency risk, which is priced in the stock market. The model's exchange rate risk factor $cov_{t-1}\left[r_{i,t},r_{c,t}\right]$ captures the risk from actual exchange rate variation over the week. This factor does not capture the market's evolving probabilities that as of January 1, 1999, the exchange rates of the EMU countries will be irrevocably fixed. This latter anticipation has an indirect effect on the degree of integration and ought to be incorporated into stock prices. In the model, it is captured by the time-varying weights $\phi_{i,t-1}$ that are attached to the EU-wide risk factors.

2.3 Estimation

The previous sub-section set out the mean return equation for each country i. Before estimation, it is also necessary to establish a model for the EU market return, the currency return, as well as a model of the second moments of all the returns. The model to be estimated is described below by equations (6)-(12):

$$r_{EU,t}=\lambda_{EU,t-1}var_{t-1}[r_{EU,t}]+\lambda_{C,t-1}cov_{t-1}[r_{EU,t},r_{C,t}]+\varepsilon_{EU,t} \tag{6}$$

$$r_{C,t}=\lambda_{EU,t-1}cov_{t-1}\left[r_{EU,t},r_{C,t}\right]+\lambda_{C,t-1}var_{t-1}\left[r_{C,t}\right]+\varepsilon_{C,t} \tag{7}$$

$$\begin{aligned} r_{i,t} \;=\; & \phi_{i,t-1}\left(\lambda_{EU,t-1}cov_{t-1}\left[r_{i,t},r_{EU,t}\right]+\lambda_{C,t-1}cov_{t-1}\left[r_{i,t},r_{C,t}\right]\right) \\ & +(1-\phi_{i,t-1})\lambda_{i,t-1}var_{t-1}\left[r_{i,t}\right]+\varepsilon_{i,t} \end{aligned} \tag{8}$$

where $r_{EU,t}$ is the excess return on the EU index, $r_{C,t}$ is the excess currency return, $r_{i,t}$ is the excess stock return of market i, $\lambda_{EU,t-1}$ is the EU-wide price of market risk, $\lambda_{C,t-1}$ is the price of currency risk, $\lambda_{i,t-1}$ is the local price of risk, $\boldsymbol{\varepsilon}_t = [\varepsilon_{EU,t}, \varepsilon_{C,t}, \varepsilon_{i,t}] \mid \mathbf{X}_{t-1} \sim N(0, \mathbf{H}_t)$, is the vector of unexpected excess returns, given the set of information $\mathbf{X}$ available at time $t-1$, $\mathbf{H}_t$ is the conditional variance-covariance matrix of excess returns, and the parameter $\phi_{i,t-1}$ is determined by Equation (5). If markets are completely integrated the last term in (8) disappears and (6) is then obtained by aggregation. We let the conditional variance-covariance matrix of excess returns $\mathbf{H}_t$ follow a GARCH(1,1) process (see Baba et.al. (1989)):

$$\mathbf{H}_t = \mathbf{C}'\mathbf{C} + \mathbf{A}'\boldsymbol{\varepsilon}_{t-1}\boldsymbol{\varepsilon}'_{t-1}\mathbf{A} + \mathbf{B}'\mathbf{H}_{t-1}\mathbf{B} \tag{9}$$

where for N assests $\mathbf{C}$ is a $(N+2 \times N+2)$ symmetric matrix and $\mathbf{A}$ and $\mathbf{B}$ are $(N+2 \times N+2)$ matrices of constant coefficients. It is common to place restrictions on $\mathbf{H}_t$ in order to ease computations. Following Bollerslev, Engle and Wooldridge (1988) and De Santis and Gerard (1997, 1998) for example, we assume that the variances depend only on lagged squared errors and lagged conditional variance, and the covariances depend upon cross-products of lagged errors and lagged conditional covariances. That is, we impose the assumption that $\mathbf{A}$ and $\mathbf{B}$ are diagonal matrices.[9]

The final step in completing the model is to specify a process for the evolution of the conditional prices of risk. There is now extensive evidence that prices of risk vary over time (see, for example, Campbell (1987), Harvey (1989, 1991), Bekaert and Harvey (1995) and De Santis and Gerard (1997, 1998)). Consequently, we let:

$$\lambda_{EU,t-1} = \exp\left(\boldsymbol{\delta}'_{EU}\mathbf{X}^{EU}_{t-1}\right) \tag{10}$$

$$\lambda_{C,t-1} = \left(\boldsymbol{\delta}'_{C}\mathbf{X}^{EU}_{t-1}\right) \tag{11}$$

$$\lambda_{i,t-1} = \exp\left(\boldsymbol{\gamma}'_{i}\mathbf{X}^{L}_{i,t-1}\right) \tag{12}$$

where $\mathbf{X}^{EU}$ represents EU-wide information variables, $\mathbf{X}^{L}$ represents local information variables specific to country i and $\boldsymbol{\delta}'_{EU}$, $\boldsymbol{\delta}'_{C}$ and $\boldsymbol{\gamma}'_{i}$ are vectors of

[9] De Santis and Gerard (1997) find strong support for this parameterisation of matrices $\mathbf{A}$ and $\mathbf{B}$.

coefficients. The functional form of $\lambda_{EU,t-1}$, $\lambda_{C,t-1}$ and $\lambda_{i,t-1}$ is dictated by the implications of the theoretical model. Under risk aversion, the prices of risk $\lambda_{EU,t-1}$ and $\lambda_{i,t-1}$ must be always positive (see Merton (1980) and Adler and Dumas (1983)). In order to ensure that this restriction is satisfied, we assume that $\lambda_{EU,t-1}$ and $\lambda_{i,t-1}$ are exponential functions of the instruments.[10] However, the theory does not impose any restrictions on the sign of the price of currency risk, since market participants may be willing to attach a negative price to currency deposits if their expected return in excess of the risk-free rate is negative. Therefore, a linear specification is chosen for $\lambda_{C,t-1}$.

The parameters of interest are estimated first using the SIMPLEX algorithm based on starting values obtained from OLS and NLLS and then by maximum likelihood (ML) assuming conditional normally distributed errors. The log-likelihood function is:

$$\ln L(\mathbf{\Theta}) = -\frac{T(N+2)}{2}\ln 2\pi - \frac{1}{2}\sum_{t=1}^{T}\ln|\mathbf{H}_t(\mathbf{\Theta})| - \frac{1}{2}\sum_{t=1}^{T}\boldsymbol{\varepsilon}_t(\mathbf{\Theta})'\mathbf{H}_t(\mathbf{\Theta})^{-1}\boldsymbol{\varepsilon}_t(\mathbf{\Theta}) \quad (13)$$

where $\mathbf{\Theta}$ is a vector of parameters to be estimated. In order to avoid problems due to non-normality in excess returns we provide Quasi-ML (QML) estimates, as proposed by Bollerslev and Wooldridge (1992), which are robust to departures from normality. We obtain QML estimates of $\mathbf{\Theta}$ by using the BFGS algorithm and compute the robust variance-covariance matrix of the estimated parameters from the last BFGS iteration.

Given the highly nonlinear structure of the model and the large number of parameters involved in estimation (due largely to the inclusion of the local instruments in the local return equations) we estimate the model for each country in two steps. First we estimate a bivariate model of the EU market returns and currency returns — equations (6) and (7). This provides estimates of the price of EU market risk, the price of currency risk, the conditional variances and the covariance of the EU market excess return and the excess currency return. In order to maintain the assumption that this price of risk is equal across countries, we then impose these estimates on a set of N bivariate equations, one for each country along with the EU index and the excess currency return. This strategy necessarily leads to some loss of efficiency. However, a simultaneous estimation of the full model is not

[10] Given the sensitivity of results in Gerard and De Santis (1997) to this assumption, in the empirical section we relax it in order to check the robustness of our model. However, we find that our results are independent of the assumption.

practically feasible, given that — with 11 national markets, five local and five global instruments — a total of 149 parameters would need to be estimated simultaneously.[11]

3 Data and Preliminary Analysis

3.1 Returns

There are eleven countries which have signed up for EMU: Austria, Belgium, Finland, France, Germany, Ireland, Italy, Luxembourg, Netherlands, Portugal and Spain. We use weekly, Deutschmark-denominated, total (i.e. dividend adjusted) continuously compounded stock returns based on Friday closing prices on these eleven countries. In addition, we also include the United Kingdom, which has yet to decide when and if it will enter EMU, because of its large market capitalization. Returns on the EU-12 benchmark index are weekly, Deutschmark-denominated, total returns based on a capitalization-weighted equity price index of the EMU-11 countries plus the UK. The data source is Datastream International, which provides indices for all EMU member states, the UK and for the aggregate EMU-11 market. We compile the EU-12 benchmark index as a market weighted price index of the EMU-11 index and the UK index. In a similar manner, we also compile a capitalization-weighted dividend yield series of the EU-12 index. Belgium-Luxembourg are aggregated into one single market. The sample begins in January 1991 and ends in June 1998 (390 weekly observations).[12]

Total market indices compiled by Datastream International are preferred to the widely-used Morgan Stanley Capital International (MSCI) indices since they are defined as value-weighted broad indices of national stock markets, covering also medium- and small-capitalization companies. As such, they are more likely to proxy the whole equity market as opposed to indices based on high-capitalization companies. This difference is likely to be important when addressing issues such as stock market integration and segmentation, since small-capitalization stocks may behave differently than large

[11] The alternative, more parsimonious, methodology for estimating the conditional variance-covariance matrix suggested by Ding and Engle (1994) and De Santis and Gerard (1997) would only reduce the number of parameters to be estimated to 124.

[12] The beginning of the sample is constrained by the availability of data on interest rate swaps, which are used in the construction of forward interest rate differentials.

capitalization stocks.[13] Additionally, Datastream indices are expected to be more homogeneous across markets than local price indices, hence making empirical results more comparable.

The weekly excess currency return is calculated as the continuously compounded difference in the Eurocurrency interest rates between a given country and Germany, adjusted for the rate of depreciation vis-á-vis the Deutschmark.[14] Hence, currency risk is measured by the ex post deviation from uncovered interest parity vis-á-vis the Deutschmark. Eurocurrency interest rates are London Friday closing rates and Deutschmark exchange rates are Frankfurt stock exchange fixings from Datastream. Also, the yields employed come from the relatively more liquid one-month euro-deposit market. The use of euro-deposits with maturity of one month instead of one week — the latter are not easily available — does not create any problems if the term structure of interest rates of country i in the horizon between one week and one month is the same as that of Germany.

The currency risk can be broken down into a separate component for each currency, as in Dumas and Solnik (1995) and De Santis and Gerard (1998), or can be approximated by a single aggregate variable as in Jorion (1991) and Ferson and Harvey (1994). Simplicity plus the lack of euro-deposit interest rates for some of the European currencies, leads us to prefer the latter approach.[15] An aggregate measure of currency risk is calculated as the trade-weighted excess currency return vis-á-vis the Deutschmark of the six most actively traded European currencies, the British pound, the French franc, the Italian lira, the Belgian franc, the Dutch guilder, and the Spanish

[13] Large firms are likely to be more effected by EU factors given that they are more likely to be engaged in international operations than small firms. Consequently, their stock prices may be more sensitive to EU factors than small firms' stock prices are. As a result, using indices that omit small firms may bias the results towards finding integrated markets.

[14] The weekly excess return for each individual currency is computed as: $r_{c,i,t} \equiv \ln(e_{i,t}) - \ln(e_{i,t-1}) + [(1 + R_{i,t-1})^{1/52} - (1 + R_{GE,t-1})^{1/52}]$, where $e_{i,t}$ is the exchange rate (Deutschmark per unit of currency i) and R_i, R_{GE} are the annualized one-month eurocurrency interest rates of currency i and the Deutschmark, respectively.

[15] The choice of whether to include individual currencies or to aggregate currency risk is, nevertheless, a difficult one. When using individual currencies only a very small subset of relevant currencies is typically chosen due to difficulties in estimating large non-linear systems. Consequently, the omission of some currencies results in biases. On the other hand, when aggregating the currencies, some important dynamics of currency returns may be cancelled out, also imparting bias. It is not possible to know the extent of the biases in each case.

peseta. The weights used to construct the aggregate measure of currency risk are the 1994 export shares of each country in total intra-EC-trade, adjusted such that they add up to unity.[16]

Table I presents information regarding the market capitalizations of the various countries (in end-of-period US dollars), the weightings relative to the EU-12 market index and the weightings relative to the world market index. Of the EMU-11 countries, Germany and France have the largest market capitalization and contribute nearly 34% of the total EU-12 index. With the exception of Luxembourg, Austria is the smallest market in the EU-12. The UK market is the largest European stock market with a market capitalization of nearly one third of the total EU-12 market. Together the EMU-11 and the UK contribute nearly one third of total world stock market capitalization (EMU-11: 22%, UK: 10.5%) and consequently are important investment areas for international investors. The US market contributes 52% to the total world market.

Table II provides summary statistics on the Deutschmark-denominated excess returns of the individual countries and the EU-12 value-weighted index. The excess returns are sampled weekly, are not annualized, and are calculated in excess of the one-month euro-DM interest rate. The latter is adjusted to reflect the return over a week. In Panel A, we report the mean excess return, the standard deviation, measures of skewness and excess kurtosis and the Bera-Jarque test statistic for normality. There is considerable cross-sectional variation in the mean excess returns. For example, Finland records a mean of 0.309% per week whilst Austria records a mean of -0.033% per week. The excess currency return happens to have a mean of exactly zero and a standard deviation of about one fifth of the standard deviation of the EU-12 excess return, which indicates that, over the sample period, intra-European currency risk has been relatively small. In terms of mean-variance analysis, the EU-12 index clearly dominates a few local market indices, suggesting that investors can profit from diversification across these countries. The measures of skewness and excess kurtosis and the resulting test for normality indicate that normality of the returns is rejected in most cases. Excess kurtosis is particularly high in currency returns due to periodic realignments

[16]The trade-weighted aggregate excess currency return is computed as: $r_{c,t} \equiv (0.06r_{c,BL,t} + 0.106r_{c,FR,t} + 0.061r_{c,IT,t} + 0.057r_{c,NL,t} + 0.038r_{c,SP,t} + 0.077r_{c,UK,t})/0.399$, where 0.399 is the sum of the six individual country export shares in total intra-EC trade. The source for trade weights is "European Economy", European Commission, DG II, No. 64, 1997, Table 45, column EUR12.

of ECU central rates.

Panel B of Table II reports autocorrelation coefficients of the excess returns and squared excess returns, and contemporaneous correlations of the individual countries with the excess EU-12 returns and the excess currency return. A number of autocorrelation coefficients for the past returns and past squared returns are significantly different from zero. This suggests that lagged local market returns may be useful as instruments in predicting returns and that a conditional heteroskedastic model of the excess return variance might be useful. Panel B also presents the contemporaneous correlation coefficient between each local market and the EU-12 index. The correlation between local markets and the EU-12 index vary form 0.858 in the UK and 0.236 in Belgium-Luxembourg with an average of 0.60. With the exception of Austria and Belgium-Luxembourg, all markets have a significant, positive correlation with the aggregate excess currency return, ranging from 0.176 for Germany to 0.495 for Italy.

3.2 Instruments

The literature on stock return predictability is now extensive.[17] Predictability is related to time variation in expected returns. Expected returns are assumed to time vary with business conditions and, therefore, variables that are thought to be related to business conditions are sought as instruments to predict expected returns. We choose a set of instruments that has been shown to be useful in predicting returns (see references in footnote 17). For the EU market we chose a constant, the first lag of the EU-12 index dividend yield in excess of the one-month, annualized, euro-DM deposit rate (DYIR), the first lag of the change in the term structure (ΔTS), the first lag of the change in the one-month ECU deposit rate (ΔSIR), and the first lag of the default spread (DS).[18] The local instruments are a constant, the first lag of the local market index dividend yield in excess of the local market one-month deposit rate, the first lag of the change in the local short term interest rate,

[17] See, for example, Campbell (1987), Harvey (1991), Ferson and Harvey (1993, 1994), Bekaert and Harvey (1995), Hardouvelis et.al. (1996) and De Santis and Gerard (1997).

[18] ΔTS is defined as the change in the spread between the yield on ECU bonds with ten years to maturity and the one-month ECU deposit rate. DS is defined as the spread between a weighted average of the corporate bond yields in France, Germany, Italy, Netherlands, Spain and the UK (weights based on stock market capitalizations) and the yield on the ten-year ECU bond. Corporate bond yields are from *"The Economist"*.

the first lag of the change in the local market term structure, and the first lag of the local market excess return.[19,20] All data are taken from Datastream International.

Table III reports results from regressing the excess returns of the 11 local markets on both sets of instruments using a robust variance covariance matrix (see White (1980)). We report Wald tests and their associated probability values for the exclusion of the EMU instruments, the exclusion of the local instruments and the exclusion of both sets of instruments. In most cases it is not possible to exclude both sets of instruments. For most markets there appears to be predictive power from the set of EMU instruments, the only major exceptions being Italy at the 16% significance level and Austria at the 10% significance level. In the majority of cases local instruments have predictive power independent of the EMU instruments. In most cases the corrected R^2 is relatively high for weekly data, ranging from 3% to more than 7%.

3.3 Forward Interest Rate Differentials

For each of the EU-12 countries, we report summary statistics of forward interest rate differentials. The differentials are calculated from swap rates between fixed and floating rate government bonds as follows: define $w_{i,\tau,t}$ as the swap rate at time t in country i for an interest rate contract in which the interest payments of a variable rate government bond with τ years to maturity are exchanged against the interest payments of a fixed rate government bond with the same years to maturity and the same notional principal on which the interest payments are based. Let $f^n_{i,T,t}$ denote the n-year forward rate T years from now for country i. From the swap rates we can calculate

[19] The local term structure is defined as the spread between the yield on ten-year benchmark government bonds and the one-month euro-deposit rate of the local currency.

[20] The instrument set is slightly different for Ireland, where no short term interest rate is available. Here, we replace the change in the short term rate with the change in the long term rate and omit the term structure instrument. Consequently, the χ^2 statistic reported for Ireland relating to the exclusion of local information variable from the return regression has one degree of freedom less than in other local markets. For all the local markets, we include the first lag of the local excess return as an instrument since in a number of markets we find evidence of autocorrelation in local market excess returns.

the forward rates as:

$$f^n_{i,T,t} = \left[\frac{(1 + w_{i,T+n,t})^{T+n}}{(1 + w_{i,T,t})^T} \right]^{\frac{1}{n}} - 1$$

We set $n = 8$ and $T = 2$ and hence calculate for each market the eight year forward rate in two years' time. Subsequently, we calculate spreads for each market vis-á-vis Germany, the anchor-country, as: $s_{i,t} = f^8_{i,2,t} - f^8_{GE,2,t}$. For Germany itself, we construct the spread between the German forward rate and the ECU forward rate. These forward interest rate differentials provide a measure of convergence towards EMU, which is independent of the stock market. They have been widely used by market participants in order to assess the probability of individual countries to participate in EMU.[21]

Interest rate swap yields are weekly (Friday) quotes collected from Datastream International. Datastream quotes the all-in cost of the fixed-side of the swap contract for maturities from one year to ten years. The swap rate represents the interest rate paid by the fixed-rate party for receiving the variable interest rate. For most of the countries the sample covers the period 29:6:91 to 26:6:98 except for Portugal and Austria (6:1:95 to 26:6:98), Finland (18:10:96 to 26:6:98) and Ireland (2:8:96 to 26:6:98). In calculating interest rate swap yields, we adjust for market conventions in national swap markets. Coupon payments are usually made annually, but in Ireland and the UK they are made semi-annually. We annualize interest rate swap yields in these countries accordingly in order to derive comparable returns with Germany. Also, in Belgium, Ireland and the UK we convert swap yields to a 360 day year instead of 365, which is the market convention in these three countries.

Table IV presents summary statistics on the forward interest rate differentials including the mean, standard deviation and maximum and minimum values. The mean values of these differentials are quite revealing: the core EMU countries of Austria, France, Belgium-Luxembourg and the Netherlands have small mean differentials, whereas the countries which have been struggling to fulfil the Maastricht criteria for EMU participation (Italy, Portugal, Spain) have larger mean differentials. This is also revealed in the standard deviations and minimum and maximum values. Germany has a negative mean differential with the ECU rate, reinforcing our choice of Germany as the country to measure the remaining EMU countries against.

[21] See references in footnote 2.

Ideally, we would like to measure convergence towards EMU with expected, say one-year, interest rate differentials vis-á-vis Germany for January 1, 1999, the date of EMU launch. However, the earliest available interest rate swap data, which are needed to construct such a measure, start in 1995 and, thus, we would loose approximately 180 observations from the empirical analysis, about half of our sample. Our measure of $s_{i,t}$ as the eight year interest differential expected in two years' time is an unbiased measure of the expected interest rate differential for 1999 if the slope of the term structure between two years from t and 1999 for country i is the same as the equivalent slope for Germany. In order to measure this bias, we calculated the forward interest differential for bonds with $10 - k$ years to maturity in k years' time: $s_{i,t}^{99} = f_{i,k,t}^{10-k} - f_{GE,k,t}^{10-k}$, where k is the number of years between date t and 1999. The differential steepness of the term-structure between two years from t and 1999 (bias) can be computed as the difference $s_{i,t} - s_{i,t}^{99}$. The average bias across all countries in our post-1995 sample is 4.3 basis points with a standard deviation of 8.3 basis points, compared to a mean of the differential $s_{i,t}$ of 88.7 basis points with a standard deviation of 66.6 basis points. Hence, the bias in our measure of the forward interest differential is very small compared to the information contained in forward differentials regarding convergence towards EMU.

A second reason for using $s_{i,t}$, at least in the first half of the sample, is that 1999 was not necessarily the expected EMU launch date from the start. According to the Maastricht Treaty, EMU could have started as early as 1997, or any time between 1997 and 1999, provided that the convergence criteria had been satisfied by at least half of the countries in EU. The year 1999 became the official launch date of EMU only in December 1995.

3.4 Some Preliminary Evidence on Integration

In order to motivate our empirical model, this section of the paper presents some preliminary evidence on whether the convergence process of European economies towards EMU and the rising probability of a country of joining EMU is accompanied by an increase in the unconditional correlation of the country's stock market and the EU portfolio. If our initial guess is right, then a decrease in forward interest rate differentials over time should be accompanied by an increase in correlation between national stock markets and the aggregate EU market index. Figure 1 in the introduction provided visual evidence consistent with this intuition. Here, we examine in more detail the statistical properties of such an association. We calculate a 52-week rolling estimate of the cross-correlation coefficient between each country's return and the EU-12 index return, $\rho_{i,t}$, using data for weeks t though $t+51$, and regress the estimated cross-correlation coefficient on the forward interest rate differentials and a constant:

$$\rho_{i,t} = a_0 + a_1|s_{i,t}| + v_{i,t} \tag{14}$$

where $|s_{i,t}|$ is the absolute value of the forward interest differential and $v_{i,t}$ is an autocorrelated error term. Since $\rho_{i,t}$ is a 52-week rolling estimate, the residual term, $v_{i,t}$, follows a moving average process of order 51 when the regression is estimated with weekly data. For this reason, the Newey-West (1987) correction for serial correlation of order 51 is used to calculate standard errors of the coefficient estimates. Table V reports the results from this regression for the seven markets in which interest rate swap data are available over a longer sample. The last row of the table reports estimation results for the equally weighted average correlation of all EU-7 markets. In all cases a_1 is negative and (with the exception of Spain) highly significant, suggesting that decreases in the forward interest differential are related to an increase in correlations of local stock markets with the EU-12 market index. In most cases the $\bar{R}^2$ from these regressions are high, ranging from 15% in Spain to 50% in Belgium-Luxembourg. The $\bar{R}^2$ in the regression of the average correlation of all EU-7 markets on the average interest rate differential is 78.8%, indicating that averaging across countries reduces the noise in the data. This simple evidence suggests that the forward interest rate differential vis-á-vis Germany may be useful in uncovering changes in the degree of integration among European stock markets.

4 Empirical Results

We use equations (5) to (12) to estimate the expected returns, risk and level of integration of the 11 local markets. Before we consider each market separately, the EU-12 market and currency expected return and variance must be estimated. We then impose these estimates on the bivariate mean equations and conditional variance-covariance matrix.

4.1 Price of EU-12 Market Risk and Price of Currency Risk

Panel A of Table VI reports results from estimating the price of EU-12 market risk and the price of currency risk associated with fluctuations of a trade-weighted basket of European currencies vis-á-vis the Deutschmark. The estimated model is:

$$r_{EU,t} = h_{EU,t}(\lambda_{EU,t-1}) + h_{EU,C,t}(\lambda_{C,t-1}) + \varepsilon_{EU,t}$$

$$r_{C,t} = h_{EU,C,t}(\lambda_{EU,t-1}) + h_{C,t}(\lambda_{C,t-1}) + \varepsilon_{C,t}$$

$$\lambda_{EU,t-1} = \exp(\boldsymbol{\delta}'_{EU}\mathbf{X}^{EU}_{t-1})$$

$$\lambda_{C,t-1} = (\boldsymbol{\delta}'_{C}\mathbf{X}^{EU}_{t-1})$$

$$h_{EU,t} = c_{0,EU} + c^2_{1,EU}\varepsilon^2_{EU,t-1} + c^2_{2,EU}h_{EU,t-1}$$

$$h_{C,t} = c_{0,C} + c^2_{1,C}\varepsilon^2_{C,t-1} + c^2_{2,C}h_{C,t-1}$$

$$h_{EU,C,t} = d + (c_{1,EU})(c_{1,C})\varepsilon_{EU,t-1}\varepsilon_{C,t-1} + (c_{2,EU})(c_{2,C})h_{EU,C,t-1}$$

where $r_{EU,t}$ is the excess return on the EU-12 stock index, $r_{C,t}$ is the excess return on a basket of European currencies, $h_{EU,t}$ is the conditional variance of the EU-12 return, $h_{C,t}$ is the conditional variance of the excess currency return, $h_{EU,C,t}$ is the conditional covariance between the excess returns of the EU-12 index and the currency basket, λ_{EU} is the price of EU-12 market risk, λ_C is the price of currency risk, $\mathbf{X}^{EU}_{t-1}$ is a vector of predetermined EU-12 instrumental variables, where the coefficient vector $\boldsymbol{\delta}$ is related to the instruments as follows: δ_0 multiplies the constant term, δ_1 the EU-12 dividend yield in excess of the one-month Euro-DM deposit rate, δ_2 the change in the spread between the long term yield on ECU government bonds and the one-month ECU rate, δ_3 the default spread defined as the value-weighted average of the yield on corporate bonds in the six biggest markets (UK, Germany, France, Italy, Netherlands and Spain) minus the ECU long bond yield, and δ_4 multiplies the change in the one-month ECU rate. $\varepsilon_{EU,t}$, and $\varepsilon_{C,t}$ are error terms. $c_{0,j}$, $c_{1,j}$ $c_{2,j}$ and d (j =EU and C) are coefficients to be estimated in the conditional variance and covariance equations.

All the coefficients in the conditional (co-)variance equations and most of the coefficients on the EU instruments are significantly different from zero at the 1% confidence level (Panel A, Table VI). This suggests time-variation in both prices and quantities of risk. Furthermore, the sum of the squared coefficients, $c_1^2 + c_2^2$, is less than unity for both excess stock and currency returns, indicating that condititional variances are stationary.

Panel B of Table VI reports a set of diagnostic tests of the model. We report the percentage pricing error and the pseudo R^2 as measures of the performance of the model. The pricing error for the EU-12 excess return equation is only 0.003% per week and the pseudo R^2 is 3.14%. For the excess currency return equation the pricing error is 0.002% and the R^2 is 6.96%. In columns 4-7 of Panel B we report specification tests on the standardized and squared standardized residuals of both equity return and currency risk models. We cannot reject the null hypothesis that the standardized residuals and the squared standardized residuals are serially uncorrelated. Furthermore, using the positive and negative size and sign bias tests of Engle and Ng (1993) that search for asymmetries in conditional variances, we cannot reject the null hypothesis that the symmetric GARCH model fits the data well.[22] However, normality is rejected for the excess currency return residuals, justifying the use of QML inferential procedures. The evidence against normality of the excess currency return residuals suggests that, although the GARCH parameterization is able to capture the dynamics of the conditional second moments of the data adequately, the use of a fat-tailed conditional distribution might improve the performance of the model. Finally, in Panel B we report two robust Wald tests of the null hypothesis that the price of risk is constant and zero respectively. Both null hypotheses are easily rejected for both the EU-12 excess return model and the excess currency return model. Overall, the model with a time-varying price of risk and time-varying quantities of risk appears to fit the data quite well.

Figure 2, Panel A, plots the estimated price of EU-12 market risk and Panel B plots the price of currency risk. The price of market risk varies significantly over time with two large peaks in early 1993 and one in mid 1996. The mean value is 5.068 with a standard deviation of 7.59. This type of variation is somewhat similar to previous studies, which extract time-varying prices of risk. In Panel B, the price of currency risk appears to have

[22] The joint Engle and Ng (1993) test for nonlinear ARCH effects is based on the regression: $e_{j,t} \equiv \varepsilon_{j,t}/h_{j,t} = a_0 + a_1 S_{t-1} + a_2 S_{t-1}\varepsilon_{j,t-1} + a_3(1 - S_{t-1})\varepsilon_{j,t-1} + \eta_t$, where S_{t-1} is a dummy variable that takes on the value one if $\varepsilon_{j,t-1} < 0$ and zero otherwise. The test statistic for the joint null $H_0 : a_1 = a_2 = a_3 = 0$ is the LM statistic TR^2, distributed as $\chi^2(3)$.

more pronounced swings and more extreme values than the price of market risk. The extreme negative values in 1992 track the ERM crisis with the dropping-out of the British pound and the Italian lira in September 1992, the speculative attacks against the French franc, the Spanish peseta and the Portuguese escudo during the first half of 1993 and the subsequent widening of the ERM bounds to $\pm 15\%$ around new central rates. The price of currency risk moves into positive territory in the latter part of the sample. The peak in 1996 reflects the substantial depreciation of the Deutschmark against the US dollar due to a widening interest differential in favour of the US since early 1994. This would seem to suggest that for Deutschmark denominated investments, the early part of the period is one where the Deutschmark is expected to appreciate relative to other currencies in the currency index and in the later part of the sample the Deutschmark is expected to depreciate. These expectations are also reflected in the sharp decrease in short-term interest differentials between European currencies and the Deutschmark after 1995. The mean value of the price of currency risk over the whole sample is -6.219.

4.2 Estimates of Time-Varying Integration

Panels A and B of Table VII report individual country estimates, after imposing the estimates of the price of EU-12 market risk, the price of currency risk and estimates of conditional variance of the EU-12 excess return and the currency basket excess return from the first stage:

$$r_{i,t} = \phi_{i,t-1}(h_{EU,i,t}(\widehat{\lambda}_{EU,t-1}) + h_{C,i,t}(\widehat{\lambda}_{C,t-1})) + (1-\phi_{i,t-1})(h_{i,t}(\lambda_{i,t-1})) + \varepsilon_{i,t}$$

$$\lambda_{i,t-1} = \exp(\boldsymbol{\gamma}_i' \mathbf{X}_{i,t-1}^L)$$

$$\phi_{i,t-1} = g_{0,i} + \exp\left(g_{1,i}\left|s_{i,t-1}\right|\right)$$

$$h_{i,t} = c_{0,i} + c_{1,i}^2 \varepsilon_{i,t-1}^2 + c_{2,i}^2 h_{i,t-1}$$

$$h_{EU,i} = d_{EU,i} + (\widehat{c}_{1,EU})(c_{1,i})\widehat{\varepsilon}_{EU,t-1}\varepsilon_{i,t-1} + (\widehat{c}_{2,EU})(c_{2,i})h_{EU,i,t-1}$$

$$h_{C,i} = d_{C,i} + (\widehat{c}_{1,C})(c_{1,i})\widehat{\varepsilon}_{C,t-1}\varepsilon_{i,t-1} + (\widehat{c}_{2,C})(c_{2,i})h_{C,i,t-1}$$

where $r_{i,t}$ is the excess return on the ith local stock market, $h_{EU,i,t}$ is the conditional covariance between excess returns on the ith local stock market and the excess return on the EU-12, $h_{C,i,t}$ is the conditional covariance between the excess returns on the *ith* local stock market and the currency basket excess return, and $h_{i,t}$ is the conditional variance of the *ith* local market excess return. $\widehat{x}$ denotes an estimate of x from the first step. $\widehat{\lambda}_{EU}$ is the price of EU-12 market risk, $\widehat{\lambda}_C$ is the price of currency risk, λ_i is the price of local risk. $\phi_{i,t}$ is the estimate of the level of integration, s_t is the forward rate spread, exp(.) denotes exponentiation and $\mathbf{X}^L_{i,t-1}$ is a vector of predetermined local instrumental variables, where the coefficient vector $\boldsymbol{\gamma}_i$ is related to the instruments as follows: $\gamma_{0,i}$ multiplies the constant term, $\gamma_{1,i}$ the local market dividend yield in excess of the local market one-month euro-deposit rate, $\gamma_{2,i}$ the change in the spread between the long term yield on local government bonds and the local one-month euro-deposit rate, $\gamma_{3,i}$ the change in the local one-month euro-deposit rate, and $\gamma_{4,i}$ multiplies the first lag of the local market excess return.[23] $\varepsilon_{i,t}$ is an error term, $c_{0,i}$, $c_{1,i}$ $c_{2,i}$ are coefficients to be estimated in the conditional variance equations and $d_{EU,i}$ and $d_{C,i}$ are the constants in the conditional covariance equations.

Panel A of Table VII reports estimates from the mean equations. Many of the local instruments are significant in predicting the local price of risk suggesting time variation in the local price of risk. The estimate of g_1 is negative, as expected, and significantly different from zero in all cases except Portugal, suggesting that the degree of integration with EU-12 increases as forward spreads approach zero. Panel B reports estimates from the conditional variance and covariance equations, which are all significantly different from zero, with the exception of Finland

Panel C of Table VII reports the same diagnostic tests as Panel B of Table VI. The pricing errors and pseudo R^2 for our weekly data are very reasonable when compared to the corresponding figures that use monthly data (see, for example De Santis and Gerard (1997, 1998) and Harvey (1991)). This evidence would seem to suggest that partial integration is important in providing a well specified European asset pricing model. In six out of eleven cases we reject the null hypothesis of normally distributed errors. We reject the null hypothesis of no serial correlation of the squared standardized residuals at the 5% level in only four cases, otherwise all local market squared standardized residuals are uncorrelated. The standardized residuals

[23]Note that, due to lack of data on short term interest rates, there is no term structure instrument or change in the short term interest rate for Ireland. Instead we use the dividend yield in excess of the long term yield on government bonds ($\gamma_{1,IR}$), the change in the long term government bond yield ($\gamma_{2,IR}$), and the first lag of excess returns ($\gamma_{3,IR}$) as instruments.

are serially correlated in Austria (note Austria has a relatively small sample) and the Netherlands at the 5% level of significance. In all the local markets we cannot reject the null hypothesis that the GARCH model fits the data well according to the Engle and Ng (1993) test reported in column 7. The final column of Panel C reports a robust Wald tests of the null hypothesis of constant prices of local risk The null hypothesis of a constant price of risk is rejected in every case except the Netherlands.

Figure 3 displays the estimated integration weight for each local market. There is a clear upward trend in the integration weight for every local market. All the weights approach unity at the end of the sample with the interesting exception of the UK which has not signed up to the single currency. Among the countries with a full sample, both the UK and the Netherlands begin with relatively high levels of integration. This is reasonable given the international nature of these two economies, which are both characterized by large multinational corporations and international financial markets. However, unlike the UK, the integration measure of the Netherlands does approach one at the end of the sample, reflecting the decision by the Netherlands to enter monetary union.

There are similar cross-country patterns in the integration weights. After the ERM crisis in September 1992 there was a general increase in the degree of integration as the Bundesbank began a policy of gradual monetary easing in autumn 1992 and ERM fluctuation bands were widened to $\pm 15\%$ in September 1993, allowing interest rate differentials vis-á-vis Germany to decline and increasing the likelihood of a future monetary union. The decrease in the degree of integration during the first half of 1994 coincides with the international bond market crisis in February 1994, triggered by step-wise increases in US short-term interest rates. Concerns about the ability of highly indebted governments to control budget deficits, led to substantial increases in long-term interest rate differentials among European countries. Growing uncertainty about the future of European monetary integration during this period has been reflected in a general increase in forward interest differentials vis-á-vis Germany and a corresponding decrease in stock market integration. In 1995, integration weights gradually rise again to peak at the end of the sample, which is consistent with the increasing expectations of joining monetary union, the convergence of monetary and fiscal policy and the fact that an increasingly larger amount of future cash flows are expected to occur during the EMU era. Overall, there has been a clear increase in the level of integration over the sample period.

4.3 Decomposing Expected Returns into Rewards for Different Risk Premia

In order to be able to assess the contribution of each source of risk to the total risk premium, in this sub-section we decompose the mean total expected returns from the partially integrated model into its constituent parts of local risk and EU risk. Subsequently, we further decompose the EU risk premium into the part due to market risk and the part due to currency risk. In Table VIII we perform this exercise in two sub-periods, 1991-1995 (Panel A) and 1996-1998 (Panel B). In both panels, column two reports the annualized total expected returns, column three reports the component of total expected returns due to local risk and column four reports the component of total expected returns due to EU risk. Finally, columns five and six decompose the component of expected returns due to EU risk (column four) into the contribution by market risk and currency risk respectively.

There are some interesting patterns in the composition of the expected returns series. In the period 1991-1995 reported in Panel A, the contribution of currency risk to expected returns is negative in all countries and in the cases of Spain and Italy the extent of this is enough to make the total EU expected return negative overall. In most cases local risk in this period contributes more than EU risk to total expected returns. On average, the percentage of total expected returns due to local risk is 77% across the EU-12 countries.

Examining the 1996-1998 period provides much different evidence. *First*, relative to the earlier period, the total expected return in this period is higher for all countries. Currency risk has now a positive impact on total expected returns in all countries but Finland. Apparently, investors required a premium in order to hold non-Deutschmark denominated assets during the first sub-period, whilst in the second sub-period they require a premium in order to hold Deutschmark denominated assets. This pattern roughly corresponds to the long swings of the Deutschmark: during the period 1991-1995 the Deutschmark appreciated by more than 30% in real terms relative to EU currencies, whereas during the period 1996-1998 the Deutschmark depreciated by around 15% against the same currencies. The average contribution of currency risk in total expected returns over the period 1996-1998 is 23% across all countries, suggesting that Deutschmark based investors were willing to give up 23% of total expected returns in order to eliminate intra-European currency risk. Hence, the elimination of intra-European currency risk will also reduce expected returns on European equities.

Second, the contribution of local risk to total expected returns is much smaller in the second sub-period, falling by more than 50% to an average of 34% across the EU-12 countries. This observation suggests that economic and monetary convergence in Europe contributed over time to a stronger integration of European stock markets in the sense that expected returns are determined increasingly by pan-European market risk and less by local risk.

4.4 Robustness of the Model: How well does it Capture the Time Variation in Risk and Expected Return?

In order to assess the robustness of the estimated model we provide a set of diagnostic tests. If the model has adequately captured the dynamic risk return relationship of the local market returns then the local markets' residuals should be orthogonal to both sets of instruments. To test this we regress the residuals from each model on the local instruments and then on the EU-12 instruments and perform Wald tests of the orthogonality conditions. In addition, it is possible that the EU-12 price of risk is related to other "global" instruments outside the EU-12 area. For example, tests of international asset pricing models (see, e.g. Harvey (1991), Bekaert and Harvey (1995), De Santis and Gerard (1997, 1998) use US based or global variables as instruments for prices of risk. If a set of global instruments has predictive power for the prices of risk over and above the EU-12 instruments, then our estimated prices of risk will be misspecified. Therefore, we consider the orthogonality of the residuals to a third set of variables based on global instruments: the world stock market dividend yield in excess of the one-month euro-dollar deposit rate, the change in the term spread, defined as the yield on ten-year US benchmark government bonds and the one-month euro-dollar deposit rate, the change in the default spread, defined as the yield on US AAA corporate bonds minus the US long bond yield, and the change in the one-month euro-dollar deposit rate.

Table IX reports the χ^2 tests along with their associated p-values. At the 5% level of significance only the residuals from the Netherlands and Portugal are not orthogonal to the local instruments. With respect to the EU-12 instruments, the residuals from Portugal are not orthogonal at the 5% level. Finally, with respect to the global instruments, the residuals for the Netherlands are not orthogonal at the 5% level whilst the residuals for Finland are not orthogonal at the 8% level. Using the above levels of significance, we can reject orthogonality only in 5 out of 37 cases. This evidence suggests that the empirical asset pricing model is well specified in terms of capturing the time variation in risk and expected return.

4.5 Sensitivity to Alternative Specifications of the Probability of Convergence and the Prices of Market and Local Risk

This section of the paper addresses two potential problems with the estimated model. First, it is possible that, rather than capturing the movement towards EMU, forward interest differentials simply proxy for some world wide convergence in interest rates based on the synchronization of business cycles and/or monetary policy across the world (interest rate coupling phenomenon). In this case, it is possible that our analysis captures nothing more than common worldwide (co-)movements in interest rates and has nothing to do with convergence towards EMU. We do not think this is a realistic possibility because worldwide interest rate couplings are usually followed by decouplings, i.e. they are not permanent. By contrast, the convergence in interest rates in Europe is perceived as permanent. It is the permanent nature of interest rate convergence that can have a major impact on discount factors and present values of cash flows. Yet, despite our reservation, to assess whether forward interest differentials contain information about EMU integration in addition to general world information, we compute an orthogonalized forward interest differential for each local market which is the residual term from a regression of the local market forward interest differential vis-á-vis Germany on the German forward interest differential vis-á-vis the US. The residual term from this regression should contain information related to EMU only. We then reestimate the model with the orthogonal forward interest differential.

Second, the model estimated above imposes the assumption that the price of market risk is positive. De Santis and Gerard (1997) show that their fully integrated model is rejected by the data due to this assumption. When the nonnegativity assumption of the price of market risk is relaxed, their model is no longer rejected. To assess whether the assumption of a positive price of risk matters, we simply omit the exponentiation of the prices of EU-12 market risk and local risk and reestimate the model.

Table X reports the means and standard deviations of the integration measure for the original model, the model with orthogonalized spreads and the model with unconstrained prices of market risk and local risk. In addition, we report the correlation coefficients between the original integration measure and the two new measures of integration. The different specifications have little impact on the means or standard deviations of the measures. Furthermore, the correlations between the integration weight from the original model and that from the model with the orthogonal spread are above 0.9 for the countries with a full sample (except the UK) and still reasonably high for those countries with a smaller sample. The correlation between the integration weight from the original model and the integration weight from the model with an unconstrained prices of risk are all extremely high and approach unity. We can thus conclude that our measure of integration is robust to both the interest rate coupling-decoupling phenomenon and the nonnegativity assumption of the prices of market risk and local risk.

4.6 A Fully Integrated Model: How Large are the Pricing Errors?

In this sub-section we consider the performance of the model relative to one that assumes the local markets are completely integrated into the EU-12. The purpose of this exercise is to illustrate the potential pitfalls of erroneously assuming market integration. In the new model we impose the estimated prices of EU-12 market risk and currency risk and the estimated EU-12 conditional variance on the local markets, whilst omitting the local price of risk.

Table XI shows the estimated equations and reports some statistics from this model for each local market. Columns two and three report the average pricing error and the pseudo R^2. Overall, the results are in line with our earlier finding that local instruments have predictive power for expected returns independent of the EMU instruments. In all countries except Italy the pricing error is smaller for the partially integrated model than for the fully integrated model and the R^2 from the fully integrated model is smaller than the corresponding figure for the partially integrated model for all countries but Italy and Spain. The means of the absolute pricing errors across all countries is 0.239% for the fully integrated model and 0.179% for the partially integrated model. Considering the seven countries with longer sample, the corresponding means are 0.129% and 0.075% respectively, i.e. nearly 50%

larger for the fully integrated model. With respect to the R^2, for the fully integrated model the mean for all EU-12 countries is 1.18% and for the seven countries with a large sample the mean is 1.67%. For the partially integrated model the corresponding figures are 2.78% and 2.97%.

Clearly, the partially integrated model captures significantly more variation in excess returns than a fully integrated model. The extent of these differences and the resultant impact they would have in any decision making scenario is illustrated in column four, which reports the annualized differences in expected returns between the model with partial integration and the model with full integration. These differences range from -0.521% per annum in Italy to over 9% per annum in Spain and the UK. The average absolute difference in the two expected returns series is a significant number of 4.18% per annum, indicating that wrongly assuming full integration of stock markets leads to a significant underestimation of the cost of capital. For countries which have been struggling to meet EMU entry criteria the differences in expected returns between the two models tend to be larger, supporting the notion that the cost of capital in less integrated markets is higher.

The final three columns of Table XI report orthogonality tests of the fully integrated models' errors with respect to the EU-12 instruments, the local instruments and the global instruments. Whilst earlier in Table VII we reported five rejections of orthogonality in the partially integrated model, using the same significance level for the fully integrated model we now reject fourteen times, six of these with respect to local instruments.

Overall, the effect of erroneously assuming full integration increases the pricing errors of the model and hence affects estimates of expected returns of the local markets. Furthermore, rejections of orthogonality increase substantially when moving from a partially integrated model to a fully integrated model. This evidence adds support to the notion of partial integration of European stock markets.

5 Implications for the Cost of Capital

The results of the last section have important implications for investment manager's assessment of risk and return, asset allocation decisions and for firm's calculation of the cost of capital. To illustrate this point further, we compute the saving in the cost of capital due to integration of European stock markets. Given the estimates for prices of risk, quantities of risk and the degree of integration, we can calculate the effect of integration on the cost of capital in each individual market from equation (4) by taking the partial derivative of expected returns with respect to the conditional degree of integration:

$$\frac{\vartheta E_{t-1}[r_{i,t}]}{\vartheta \phi_{i,t-1}} \Delta\phi_{i,t-1} = (h_{EU,i,t}\lambda_{EU,t-1} + h_{C,i,t}\lambda_{C,t-1} - h_{i,t}\lambda_{i,t-1})(\phi_{i,t-1} - \phi_{i,t-2}) \quad (15)$$

where $\Delta\phi_{i,t-1}$ is the change in ϕ_i between time $t-1$ and t conditional on information at time $t-2$ and $t-1$, respectively.

The total effect of integration on the cost of capital can be decomposed into three parts:

- the effect due to market risk: $h_{EU,i,t}\lambda_{EU,t-1}(\phi_{i,t-1} - \phi_{i,t-2})$,
- the effect due to currency risk: $h_{C,i,t}\lambda_{C,t-1}(\phi_{i,t-1} - \phi_{i,t-2})$, and
- the effect due to local risk: $-h_{i,t}\lambda_{i,t-1}(\phi_{i,t-1} - \phi_{i,t-2})$.

With increasing degree of integration, the cost of capital decreases due to a decrease in the local risk component and increases due to an increase in the market risk component. The effect of the currency risk component may be positive or negative, depending on the signs of $h_{C,i,t}$ and $\lambda_{C,t-1}$. The net effect on the cost of capital is the sum of the three components.

Table XII reports the average effect of integration on the cost of capital and its decomposition in percentage points. The individual country effects are cumulated over time in order to obtain an estimate of the total effect of integration on the cost of capital. The individual country effects are then averaged across countries using market capitalizations as weights. Row one of the table reports the market weighted average saving across seven countries with a full sample over the period 15:5:92 to 26:6:98 (EU-7). Row two reports the market weighted average saving across all twelve countries over the period 6:12:96 to 26:6:98 (EU-12). Column two reports the total average saving in percentage points. Columns 3-5 report the market, currency, and local risk components of the total average saving, respectively.

The average saving in the cost of capital in the EU-7 over the whole sample is approximately two percentage points. Most of this saving appears to be due to a decrease in local risk by 3.14 percentage points as a result of higher integration, which compensates for an increase in the market risk component (1 percentage point) and the currency risk component (0.24 percentage point). Note that the cumulative currency risk component is relatively small. This is due to two factors. First, the British pound, which continues to float freely against the EU-11 currencies, is part of the currency basket in our model. A large part of the covariation of stock prices with the currency basket is due to the variability of the British pound, which has not subsided and is not expected to subside any time soon. Second, the reduction in short-term cumulative currency risk is relatively small because during our sample period, the remaining European currencies continued to float against the Deutschmark. The Italian lira, for example, continued to gyrate against the Deutschmark even after April 1998, when it was decided that Italy would join EMU. This short-term currency risk ought not be confused with the future currency risk, which is expected to go to zero the moment the EU-11 countries fix their exchange rates irrevocably on January 1, 1999. As explained earlier, in the model, the influence of future currency risk is being captured by the time-varying parameter $\phi_{i,t-1}$ and not by the conditional covariance $h_{C,i,t}$.

The average saving in the cost of capital in the EU-12 over the period December 1996 to June 1998 is estimated at around 1.3 percentage points, indicating that most of the saving in cost of capital took place during the last two years of the sample, when interest rates in Europe converged rapidly towards German levels.

Figure 4 displays an estimate of the cumulative average saving in the cost of capital due to integration of European stock markets and its decomposition. Panel A displays estimates for the EU-7 countries, which are based on a long sample from May 1992 to June 1998. Panel B displays estimates for the EU-12 countries from December 1996 to June 1998. The cumulative saving in the cost of capital is the cross-country value-weighted average of the individual country cost savings, as they are illustrated in equation (15). As expected, the effect of integration on the cost of capital is relatively low during the first half of the sample, when markets were less integrated, and relatively high towards the end of the sample, particularly in 1997, the year when most of the convergence in bond yields took place. It should be noted that, according to the Maastricht Treaty, 1997 was the year during which the convergence criteria had to be satisfied for joining EMU in 1999.

6 Summary and Concluding Remarks

The paper examines whether or not the convergence process of European economies towards Economic and Monetary Union has led to increased integration of European stock markets. Intuition suggests that convergence of inflation and interest rates, the expectation of post-1999 common monetary policy and constrained fiscal policy should have led to a convergence in the discount rates that are used to discount future cash flows, hence, an integration in the pricing of stocks, as well as a convergence in the risk characteristics of these cash flows. For a given country, stock market integration is expected to be higher, the higher the probability of a country joining EMU and the closer the calendar date is to January 1999, the time of EMU launch, as a higher amount of future cash flows are influenced by the advent of EMU.

We estimate a conditional asset pricing model of European stock markets with a time-varying degree of integration, modeled as the weight that is applied to EU-wide risk factors as opposed to country-specific risk factors. A major innovation in our model is the incorporation of an explicit link between the probability of a country joining EMU and the degree of a country's stock market integration. The degree of integration of each national stock market with a value-weighted global European market index is modeled as a function of the country's forward interest rate differential vis-á-vis Germany, the benchmark country in our analysis. This differential incorporates markets' perception of the probability that the country will join EMU. Although forward interest rate differentials have been widely used by a number of financial institutions and market practitioners to calculate the probability of individual countries joining EMU, this paper represents, to our knowledge, the first attempt in the literature to link a time-varying measure of integration in stock markets with forward spreads in bond markets.

The model accounts for intra-European currency risk, time-varying quantities of risk and time-varying prices of risk. The quantities of risk are modeled through a multivariate GARCH-in-mean model. The prices of risk are conditioned on local and EU-wide information variables. The model provides a robust description of the time-variability in risk and expected return because additional information variables do not add explanatory power. Furthermore, the model is not sensitive to alternative specifications, such as the functional form of the price of market risk or other measures of the interest rate differential, free of worldwide comovements in interest rates, which can also be used to capture the probability of a country joining EMU. The model outperforms significantly a model that assumes full integration throughout the 1990s in terms of pricing errors and goodness of fit measures, suggesting that a partial integration model provides a better specification of European risk premia. Hence, a partial integration model ought to be used when calculating expected return and risk for decision making by investment and corporate managers.

We discovered that in the 1990s, the probability that an EU country would join EMU significantly influenced the degree of integration of its local market with the EU-wide market index. First, simple correlations of local market returns with the EU-wide market return are negatively associated over time with the forward interest rate differentials vis-á-vis Germany. Second, the model's more precise and theoretically accurate measures of integration, which reflect the importance of EU-wide risk factors relative to country-specific risk factors in the pricing of stocks, also show an economically and statistically significant negative association with the size of the forward interest rate differential vis-á-vis Germany. Moreover, when these interest rate differentials shrink in 1997 and 1998, the markets converge towards full integration, that is, expected returns are increasingly determined by EU-wide market risk and less by local risk.

We illustrate the importance of the level and variation in the degree of integration on calculating expected returns by decomposing expected returns into the contribution made by local risk premia and the contribution made by EU risk premia. Splitting the sample into two periods, we find that in the 1991-1995 subperiod, on average, the percentage of total expected returns due to local risk is 77% across the EU-12 countries. With respect to the EU risk factors, the currency risk premium is negative in all countries. In contrast to this early subperiod, the subperiod 1996-1998 is one in which the contribution of local risk falls substantially to an average of 34%. In addition, the currency risk premium is positive in all cases but one, and contributes on average 23% of total expected returns. Overall, these variations in expected returns illustrate the importance of variations in integration over time and also the importance in capturing the variation in the prices and quantities of risk.

Finally, the paper evaluates the impact of integration on the equity cost of capital. The average cumulative saving in the cost of capital from integration in European stock markets over the period 1992-1998 is estimated at around 2% for the EU-12 countries on a value-weighted basis. Most of this saving originates from the reduction in country-specific risk as integration of European stock markets increases over time. This result in its own right should be important to policy makers who are considering the benefits of joining EMU and to corporate managers who make real investment decisions.

References

Adler, Michael, and Bernard Dumas, 1983, International portfolio selection and corporation finance: A synthesis, *Journal of Finance* 46, 925-984.

Anderson, Ronald W., and Jean Pierre Danthine, 1983, Cross hedging, *Journal of Political Economy* 89, 1182-1196.

Baba, Yoshihisa, Robert F. Engle, Dennis F. Kraft, and Kenneth F. Kronner, 1989, Multivariate simultaneous generalized ARCH, Working Paper, University of California, San Diego, California.

Bailey, Warren, Chung, Y. Peter, and Jun-Koo Kang, 1998, Foreign ownership restrictions and equity price premiums: Some evidence on demand, sentiment, and information, Working Paper, Cornell University.

Bekaert, Geert, and Campbell R. Harvey, 1995, Time-varying world market integration, *Journal of Finance* 50, 403-444.

Bekaert, Geert, and Robert Hodrick, 1992, Characterizing predictable components in excess returns on equity and foreign exchange markets, *Journal of Finance* 47, 467-509.

Bekaert, Geert, and Campbell R. Harvey, 1997, Emerging equity market volatility, *Journal of Financial Economics* 43, 29-77.

Bollerslev, Tim, Robert F. Engle, and Jeffrey M. Wooldridge, 1988, A capital asst pricing model with time-varying covariances, *Journal of Political Economy* 96, 116-131.

Bollerslev, Tim, and Jeffrey M. Wooldridge, 1992, Quasi-maximum likelihood estimation and inference in dynamic models with time-varying covariances, *Econometric Reviews* 11, 143-172.

Campbell, John Y., 1987, Stock returns and the term structure, *Journal of Financial Economics* 18, 373-400.

Campbell, John Y., and Yasushi Hamao, 1992, Predictable stock returns in the United States and Japan: A study of long-term capital market integration, *Journal of Finance* 47, 43-69.

Chen, B., and K. Tran, 1994, Are we sure that the real exchange rate follows a random walk? A reexamination, International Economic Journal, 33-44.

De Santis, Giorgio and Bruno Gerard, 1997, International asset pricing and portfolio diversification with time-varying risk, *Journal of Finance* 52, 1881-1912.

De Santis, Giorgio, Bruno Gerard, and Pierre Hillion, 1997, The relevance of EMU currency risk in financial markets, *mimeo*, September 22, 1997.

De Santis, Giorgio and Bruno Gerard, 1998, How big is the premium for currency risk?, *Journal of Financial Economics* 49, 375-412.

Ding, Zhuanxin and Robert F. Engle, 1994, Large scale conditional covariance matrix modeling, estimation and testing, Working Paper, University of California at San Diego.

Domowitz, Ian, Glen, Jack, and Anath Madhavan, 1997, Market segmentation and stock prices: Evidence from an emerging market, *Journal of Finance*, 52, 1059-1086.

Dumas, Bernard, and Bruno Solnik, 1995, The world price of foreign exchange risk, *Journal of Finance* 50, 445-479.

Engle, Robert F., and Victor K. Ng, 1993, Measuring and testing the impact of news on volatility, *Journal of Finance* 48, 1749-1778.

Errunza, Vihang, and Ettienne Losq, 1985, International asset pricing under mild segmentation: Theory and test, *Journal of Finance*, 40, 105-124.

Favero, Carlo A., Francesco Giavazzi, Fabrizio Iacone, and Guido Tabellini, 1997, Extracting information from asset prices: The methodology of EMU calculators, CEPR Discussion Paper No. 1676, Centre for Economic Policy Research, London.

Ferson, Wayne E., and Campbell R. Harvey, 1993, The risk and predictability of international equity returns, *Review of Financial Studies* 6, 527-566.

Ferson, Wayne E., and Campbell R. Harvey, 1994, Sources of risk and expected returns in global equity markets, *Journal of Banking and Finance* 18, 775-803.

Ferson, Wayne E., and Campbell R. Harvey, 1997, The fundamental determinants of national equity market returns: A perspective on country risk in asset pricing, *Journal of Banking and Finance* 21, 1625-1665.

Grilli, Vittorio, and Graciela Kaminsky, 1991, Nominal exchange rate regime and the real exchange rate: Evidence from the United States and Great Britain, 1885-1986, *Journal of Monetary Economics* 27, 191-212.

Hardouvelis, Gikas A., Doncheol Kim, and Thierry Wizman, 1996, Intertemporal asset pricing models with and without consumption: An empirical evaluation, *Journal of Empirical Finance* 3, 267-301.

Harvey, Campbell R., 1989, Time-varying conditional covariances in tests of asset pricing models, *Journal of Financial Economics* 24, 289-317.

Harvey, Campbell R., 1991, The world price of covariance risk, *Journal of Finance* 46, 111-158.

Harvey, Campbell R., 1995, Predictable risk and returns in emerging markets, *The Review of Financial Studies* 3, 773-816.

Hietala, Pekka, 1989, Asset pricing in partially segmented markets: Evidence from the Finnish market, *Journal of Finance*, 44, 697-718.

Jorion, Philippe, 1991, The pricing of exchange rate risk in the stock market, *Journal of Financial and Quantitative Analysis* 26, 363-376.

Jorion, Philippe, and Eduardo Schwartz, 1986, Integration vs. segmentation in the Canadian stock market, *Journal of Finance*, 41, 603-614.

Licht, Amir N., 1998, Stock market integration in Europe, CAER II Discussion Paper No. 15, Harvard Institute for International Development, Cambridge, MA.

Lintner, John, 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.

Merton, Robert, C., 1973, An intertemporal capital asset pricing model, *Econometrica* 41, 867-888.

Merton, Robert, C., 1980, On estimating the expected return on the market: An exploratory investigation, *Journal of Financial Economics* 8, 323-361.

Mossin, Jan, 1966, Equilibrium in a capital asset market, *Econometrica*, 34, 768-783.

Newey, Whitney, and Kenneth D. West, 1987, A simple, positive-definite, heteroskedasticity and autocorrelation consistent covariance matrix, *Econometrica* 55, 703-708.

Papell, David, H., 1997, Searching for stationarity: Purchasing power parity under the current float, *Journal of International Economics* 43, 313-332.

Sharpe, William, 1964, Capital asset prices: A theory of market equilibrium under conditions of risk, *Journal of Finance* 19, 425-442.

Solnik, Bruno, 1974, An equilibrium model of the international capital market, *Journal of Economic Theory* 8, 500-524.

Stehle, Richard, 1977, An empirical test of the alternative hypotheses of national and international pricing of risky assets, *Journal of Finance*, 32, 493-502.

Stulz, Rene M., 1981a, On the effects of barriers to international investment, *Journal of Finance*, 36, 923-934.

Stulz, Rene M., 1981b, A model of international asset pricing, *Journal of Financial Economics* 9, 383-406.

Stulz, Rene M., and Walter Wasserfallen, 1995, Foreign equity investment restrictions and shareholder wealth maximization: Theory and evidence, *Review of Financial Studies*, 8, 1019-1058.

White, Halbert, 1980, A heteroskedasticity-consistent covariance matrix estimator and direct test for heteroskedasticity, *Econometrica* 48, 817-838.

Wu, Yangru, 1996, Are real exchange rates nonstationary? Evidence from a panel-data test, *Journal of Money, Credit, and Banking* 28, 54-63.

Table I
Description of Market Indices

This table reports the market capitalization in billion US dollars (in column 2) of the respective indices listed in column 1 as of the end of the sample period (26:06:98). Column 3 reports the percentage weights of the 11 EMU countries (Austria, Belgium, Finland, France, Germany, Ireland, Italy, Luxembourg, Netherlands, Portugal, Spain) relative to the EU-12 index, where the latter is defined as the capitalization weighted index of the EMU-11 countries and the UK index, expressed in US dollars. Column 4 reports the percentage weights of the countries and indices listed in column 1 relative to the world index. All data are Datastream total market indices and are collected from Datastream International.

Country	Market Cap.(US$ bn.)	% Weights in EU-12	% Weights in World
Austria	47.988	0.81	0.27
Belgium-Luxembourg	257.545	4.38	1.34
Finland	113.572	1.93	0.63
France	874.581	14.86	4.84
Germany	1106.530	18.80	6.13
Ireland	60.304	1.02	0.33
Italy	468.283	7.96	2.59
Netherlands	656.636	11.16	3.63
Portugal	78.780	1.34	0.44
Spain	334.716	5.68	1.85
U.K.	1887.011	32.06	10.45
EU-12	5886.011		32.58
US	9405.000		52.06
World	18065.000		

Table II
Summary Statistics: Excess Returns

In panel A, for each of the countries and a value-weighted index of the EU-12 listed in column 1, we report summary statistics of weekly excess stock returns. Weekly excess returns are not annualized and are measured as national returns in Deutschmark minus the one month euro-DM deposit rate (assumed risk free rate), which is transformed to reflect the return over a weekly horizon. In the last row we report summary statistics of excess currency returns, CUR, calculated as a trade-weighted eurodeposit return of six major European currencies vis a vis the Deutschmark (French franc, British pound, Italian lira, Dutch guilder, Spanish peseta and Belgian franc) in excess of the one-month euro-DM deposit rate, adjusted for the rate of depreciation against the Deutschemark. The data are weekly observations over the sample 05:01:91 - 26:06:98. Column 2 reports the weekly mean excess return in percentage points, column 3 reports the standard deviation and columns 3 and 4 report skewness and kurtosis. Column 5 reports the Berra-Jarque test for normality of excess returns and is distributed $\chi^2(2)$. Panel B reports autocorrelation coefficients of the first and second lag of excess returns and the contemporaneous correlation of the individual countries excess return with the excess return on the EU-12 index (ρ_{EU-12}) and the excess currency return (ρ_{CUR}). Figures in brackets denote probability values. ** indicates statistically significant at the 1% level, * indicates statistically significant at the 5% level and † indicates statistically significant at the 10% level.

Panel A: Summary Statistics

Country	Mean %	Std. Dev. %	Skewness	Kurtosis	Normality
Austria	-0.033	1.978	0.138	0.672	7.942 [0.02]
Belgium-Luxembourg	0.299	1.713	-0.218	0.806	12.630 [0.00]
Finland	0.309	3.422	-0.145	0.576	6.257 [0.04]
France	0.211	2.191	-0.033	0.235	0.899 [0.64]
Germany	0.193	1.837	-0.286	0.930	17.903 [0.00]
Ireland	0.308	2.057	0.146	0.360	3.227 [0.20]
Italy	0.136	3.412	-0.065	0.569	5.125 [0.07]
Netherlands	0.306	1.693	-0.501	3.388	187.313 [0.00]
Portugal	0.208	2.020	-0.046	1.026	15.920 [0.00]
Spain	0.208	2.377	-0.279	0.470	8.022 [0.02]
U.K.	0.220	2.048	0.006	0.482	3.495 [0.17]
EU-12	0.221	2.153	-0.137	0.251	2.073 [0.35]
CUR	0.000	0.446	-1.541	13.059	2701.077 [0.00]

Panel B: Autocorrelations and Correlations

Country i	Autocorr. of $r_{i,t}$		Autocorr. of $r_{i,t}^2$		ρ_{EU-12}	ρ_{CUR}
	Lag 1	Lag 2	Lag 1	Lag 2	Contemporaneous	Contemporaneous
Austria	0.119^{*}	0.132^{**}	0.108^{*}	0.139^{**}	0.507^{**}	0.014
Belgium-Lux.	0.209^{**}	0.140^{**}	$0.089^{\dagger}$	0.091^{*}	0.236^{**}	-0.069
Finland	0.128^{**}	0.120^{**}	0.121^{*}	0.057	0.505^{**}	0.274^{**}
France	-0.025	0.022	-0.046	0.011	0.782^{**}	0.348^{**}
Germany	0.007	$0.091^{\dagger}$	0.045	0.105^{*}	0.730^{**}	0.189^{**}
Ireland	0.046	0.066	0.032	-0.027	0.658^{**}	0.384^{**}
Italy	0.064	0.088	-0.026	0.039	0.555^{**}	0.495^{**}
Netherlands	-0.060	0.200^{**}	0.153^{**}	0.190^{**}	0.773^{**}	0.236^{**}
Portugal	0.203^{**}	0.151^{**}	0.317^{**}	0.122^{**}	0.384^{**}	0.176^{**}
Spain	0.160^{**}	$0.100^{\dagger}$	0.072	0.046	0.689^{**}	0.483^{**}
U.K.	$-0.098^{\dagger}$	0.138^{**}	0.021	0.013	0.858^{**}	0.472^{**}
EU-12	-0.035	0.131^{**}	-0.045	-0.001	1.000	0.493^{**}
CUR	-0.007	0.086	0.039	0.130^{**}	0.493^{**}	1.000

Table III
Predictability of Excess Returns

For each of the countries and a value-weighted index of the EU-12, listed in column 1, we report Wald tests of the null hypothesis of no predictability $a = \mathbf{b} = 0$, from the following regression:

$$r_{i,t} = a + \mathbf{b}\mathbf{X}_{t-1} + e_{i,t}$$

where $r_{i,t}$ is the weekly excess return on the ith country in Deutschmark, $\mathbf{X}_{t-1}$ is a vector of instrumental variables that includes both EU-12 instruments ($\mathbf{X}_{t-1}^{EU}$) and local instruments ($\mathbf{X}_{t-1}^{L}$), and $e_{i,t}$ is an error term. The instruments are as follows: $\mathbf{X}_{t-1}^{EU}$: the EU-12 dividend yield in excess of the one month euro-DM deposit rate, the change in the spread between the long term yield on ECU government bonds and the one month ECU rate, the default spread — defined as the value-weighted average of the yield on corporate bonds in the six biggest markets (UK, Germany, France, Italy, Netherlands and Spain) minus the ECU long bond yield — and the change in the one month ECU rate. $\mathbf{X}_{t-1}^{L}$: the local market dividend yield in excess of the local market one month euro-deposit rate, the change in the spread between the long term yield on local government bonds and the one month euro-deposit rate, the change in the one month euro-deposit rate, and the first lag of the local market excess return. Note, due to lack of data on short term interest rates, there is no term structure instrument or change in short term interest rate for Ireland. Instead we use the dividend yield in excess of the long term yield on government bonds, the change in the long term government bond yield and the first lag of excess returns as instruments. Given the evidence of non-normality of returns and heteroskedasticity, we estimated the equation above with White's (1980) robust variance-covariance matrix. Columns 2, 4, 6 report Wald tests of exclusion restrictions. Figures in brackets (columns 3, 5, 7) denote probability values of the respective test reported in the preceding column. Column 2 reports a $\chi^2(5)$ test that the four EU-12 instruments and the constant have zero coefficients. Column 4 reports a $\chi^2(5)$ test that the four local instruments and the constant have zero coefficients (note in Ireland this is a $\chi^2(4)$ test). Column 6 reports a $\chi^2(9)$ test that the all nine instruments (including the constant) have zero coefficients (note in Ireland this is a $\chi^2(8)$ test). Data are sampled weekly. Column 8 reports the adjusted R^2 in percentage points of the regression of $r_{i,t}$ on all instruments. Column 9 reports the sample period of the estimation.

Country	Exclude $\mathbf{X}_{t-1}^{EU}$		Exclude $\mathbf{X}_{t-1}^{L}$		Exclude $\mathbf{X}_{t-1}^{EU} + \mathbf{X}_{t-1}^{L}$		$\overline{R}^2$ %	Sample
	χ^2	p-value	χ^2	p-value	χ^2	p-value		
Austria	9.196	[0.10]	3.819	[0.57]	12.203	[0.20]	-0.12	13:9:91-26:6:98
Belgium-Lux.	16.213	[0.00]	26.973	[0.00]	41.421	[0.00]	4.75	25:1:91-26:6:98
Finland	11.362	[0.04]	1.467	[0.91]	12.880	[0.16]	-2.36	20:1:95-26:6:98
France	10.554	[0.06]	7.037	[0.21]	14.842	[0.09]	0.48	25:1:91-26:6:98
Germany	10.767	[0.05]	6.472	[0.26]	22.713	[0.00]	-0.35	25:1:91-26:6:98
Ireland	35.976	[0.00]	11.406	[0.02]	45.910	[0.00]	6.49	18:1:91-26:6:98
Italy	7.777	[0.16]	5.272	[0.38]	14.076	[0.12]	1.10	15:3:91-26:6:98
Netherlands	32.966	[0.00]	16.358	[0.00]	36.303	[0.00]	2.85	25:1:91-26:6:98
Portugal	14.808	[0.01]	13.880	[0.01]	33.111	[0.00]	3.19	20:1:95-26:6:98
Spain	17.213	[0.00]	10.373	[0.06]	31.402	[0.00]	3.46	10:4:92-26:6:98
U.K.	20.276	[0.00]	21.530	[0.00]	37.156	[0.00]	5.46	25:1:91-26:6:98
EU-12	28.697	[0.00]					3.45	25:1:91-26:6:98
CUR	24.723	[0.00]					7.21	25:1:91-26:6:98

Table IV
Forward Interest Differentials: Summary Statistics

For each of the countries we report summary statistics of forward interest differentials vis-á-vis Germany. The forward interest differentials are calculated from swap rates between fixed and floating rate government bonds as follows: define $w_{i,\tau}$ as the swap rate for an interest rate contract on government bonds of country i in which the interest payments of a variable rate government bond with τ years to maturity are exchanged against the interest payments of a fixed rate government bond with the same years to maturity. Let $f_{i,T}^{n}$ denote the n-year forward rate T years from now. From the swap rates we can calculate the forward rates as:

$$f_{i,T}^{n} = \left[\frac{(1 + w_{i,T+n})^{T+n}}{(1 + w_{i,T})^{T}} \right]^{\frac{1}{n}} - 1$$

We set $n = 8$ and $T = 2$ and hence for each market the eight year forward rate in two years time is calculated. From this we calculate interest differentials for each market vis-á-vis Germany: $s_{i,t} = f_{i,2}^{8} - f_{GE,2}^{8}$. For Germany the forward interest differential is calculated against the ECU: $s_{GE,t} = f_{GE,2}^{8} - f_{ECU,2}^{8}$. For Ireland and the UK interest rate swap yields are annualized according to the formula:

$$(1 + (\text{annual yield}/100)) = (1 + (\text{semi-annual yield}/200))^2$$

due to the semi-annual coupon payment frequency in these countries. Interest rate swap yields for Belgium, Ireland and the UK are converted to a 360 day year by multiplying by (360/365). In all other countries the day count basis is 360. The interest rate swap data are Friday quotes of the all-in cost of the fixed-side of the swap outright from Datastream International. The data are sampled weekly from 29:6:91 to 26:6:98, except for the following countries: Portugal and Austria (6:1:95 to 26:6:98), Finland (18:10:96 to 26:6:98) and Ireland (2:8:96 to 26:6:98).

Country	Mean	Standard Deviation	Minimum	Maximum
Austria	0.0079	0.0624	-0.1058	0.1683
Belgium-Luxembourg	0.4151	0.3207	-0.0918	1.0419
Finland	0.6840	0.5445	-0.0451	1.7531
France	0.3033	0.4677	-0.3277	1.3391
Germany	-0.5523	0.3892	-1.7790	0.0359
Ireland	0.2801	0.2611	-0.1792	1.0513
Italy	2.8718	1.5134	0.0092	5.7336
Netherlands	0.0566	0.1550	-0.1865	0.4382
Portugal	1.8712	1.7038	-0.0253	4.8195
Spain	2.5754	1.5101	-0.0160	5.7039
U.K.	1.2437	0.4036	0.3089	2.5597

Table V
Market Correlations and Forward Interest Differentials

This table reports results from estimating the following regression:

$$\rho_{i,t} = a_o + a_1|s_{i,t}| + v_{i,t}$$

where $\rho_{i,t}$ is a 52-week rolling estimate of the cross-correlation coefficient between country's i return and the EU-12 index return (both in Deutschmark) for weeks t through $t + 52$, $|s_{i,t}|$ is the absolute value of the forward interest differential vis-á-vis Germany (for Germany vis-á-vis the ECU) and $v_{i,t}$ is an error term. The data are sampled weekly from 29:6:91 to 26:6:98. The regression is estimated using ordinary least squares with a Newey-West (1987) correction for a moving average of order 51 in the residuals due to overlaping observations. Row EU-7 reports estimation results for the equally-weighted average correlation of the seven local market returns with the EU-12 index return. No results are available for Austria, Finland, Ireland and Portugal because of an insufficient number of observations for the forward interest differential. ** indicates statistically significant at the 1% level, * indicates statistically significant at the 5% level and † indicates statistically significant at the 10% level.

Country	a_0	t-ratio	a_1	t-ratio	$\bar{R}^2(\%)$
Belgium-Luxembourg	0.614**	6.16	-0.830**	-4.50	50.2
France	0.814**	200.99	-0.080**	-2.76	26.3
Germany	0.851**	89.51	-0.234**	-3.90	38.6
Italy	0.733**	58.54	-0.053*	-2.26	17.0
Netherlands	0.823**	144.01	-0.297**	-3.15	18.1
Spain	0.781**	66.01	-0.037	-1.24	15.2
U.K.	0.958**	132.36	-0.073**	-4.45	22.7
EU-7	0.896**	35.93	-0.215**	-8.14	78.8

Table VI
The Price of EU-12 Market Risk and the Price of Currency Risk

Panel A reports results from estimating the price of EU-12 market risk and the price of currency risk. The estimated model is:

$$r_{EU,t} = h_{EU,t}(\lambda_{EU,t-1}) + h_{EU,C,t}(\lambda_{C,t-1}) + \varepsilon_{EU,t}$$

$$r_{C,t} = h_{EU,C,t}(\lambda_{EU,t-1}) + h_{C,t}(\lambda_{C,t-1}) + \varepsilon_{C,t}$$

$$\lambda_{EU,t-1} = \exp(\boldsymbol{\delta}'_{EU}\mathbf{X}^{EU}_{t-1})$$

$$\lambda_{C,t-1} = (\boldsymbol{\delta}'_{C}\mathbf{X}^{EU}_{t-1})$$

$$h_{EU,t} = c_{0,EU} + c^2_{1,EU}\varepsilon^2_{EU,t-1} + c^2_{2,EU}h_{EU,t-1}$$

$$h_{C,t} = c_{0,C} + c^2_{1,C}\varepsilon^2_{C,t-1} + c^2_{2,C}h_{C,t-1}$$

$$h_{EU,C,t} = d + (c_{1,EU})(c_{1,C})\varepsilon_{EU,t-1}\varepsilon_{C,t-1} + (c_{2,EU})(c_{2,C})h_{EU,C,t-1}$$

where $r_{EU,t}$ is the excess return on the EU-12 stock index in Deutschmark, $r_{C,t}$ is the excess currency return, $h_{EU,t}$ is the conditional variance of the EU-12 excess return, $h_{C,t}$ is the conditional variance of the excess currency return, $h_{EU,C,t}$ is the conditional covariance between the excess return on the EU-12 index and the excess currency return, λ_{EU} is the price of EU-12 market risk, λ_C is the price of currency risk, $\mathbf{X}^{EU}_{t-1}$ is a vector of predetermined EU-12 instrumental variables where the coefficient vector $\boldsymbol{\delta}$ is related to the instruments as follows: δ_0 is a constant, δ_1 is the EU-12 dividend yield in excess of the one month euro-DM deposit rate, δ_2 is the change in the spread between the long term yield on ECU government bonds (ten-year benchmark) and the one month ECU rate, δ_3 is the default spread — defined as the value-weighted average of the corporate bond yield in the six biggest markets (UK, Germany, France, Italy, Netherlands and Spain) minus the ECU long bond yield — and δ_4 is the change in the one month ECU deposit rate. $\varepsilon_{EU,t}$, and $\varepsilon_{C,t}$ are error terms. $c_{0,j}$, $c_{1,j}$ $c_{2,j}$ and d (j =EU and C) are coefficients to be estimated in the conditional variance and covariance equations. Panel B reports residual analysis and tests of the model. P.E. (%) reports the average weekly percentage pricing error, R^2 is the pseudo R^2, N is the Bera-Jarque test statistic for normality of the residuals, H is a test statistic for 4th order serial correlation of the squared standardised residuals, S.C. is test statistic for 4th order serial correlation of the standardised residuals, EN is the Engle-Ng joint test for asymmetries in conditional volatility. Constant P.R. is a robust Wald test of the null hypothesis that the price of risk is constant ($\delta_k = 0,\ k = 1,2,3,4$), Zero P.R. is a robust Wald test of the null hypothesis that price of risk is zero ($\delta_k = 0,\ k = 0,1,2,3,4$). **indicates statistically significant at the 1% level, * indicates statistically significant at the 5% level, † indicates statistically significant at the 10% level. Standard errors are in parentheses and probability values are in square brackets.

Panel A: Model Estimates

	δ_0	δ_1	δ_2	δ_3	δ_4	c_0	c_1	c_2	d
EU-12	1.095**	0.167*	-9.348**	0.652†	-8.264**	1.1E-5**	0.305**	0.942**	4.4E-6*
	(0.278)	(0.073)	(1.281)	(0.359)	(1.363)	(1.6$E-6$)	(0.008)	(0.003)	(1.0E-7)
C	-14.119	30.075**	155.091**	128.432**	25.812	2.5E-6**	0.204**	0.908**	
	(9.165)	(2.089)	(37.362)	(17.034)	(41.256)	(3.9$E-8$)	(0.017)	(0.002)	

Panel B: Residual Analysis

	P.E. (%)	R^2(%)	N $\chi^2(2)$	H $\chi^2(4)$	S.C. $\chi^2(4)$	EN $\chi^2(3)$	Constant P.R.	Zero P.R.
EU-12	0.003	3.14	4.14	1.63	6.78	3.67	95.41	114.29
			[0.12]	[0.80]	[0.15]	[0.29]	[0.00]	[0.00]
C	-0.002	6.96	2382.68	0.87	1.94	1.89	281.42	283.88
			[0.00]	[0.92]	[0.74]	[0.59]	[0.00]	[0.00]

Table VII
Time-Varying Integration and Expected Returns

Panel A reports estimates from the time-varying integration model:

$$r_{i,t} = \phi_{i,t-1}(h_{EU,i,t}(\widehat{\lambda}_{EU,t-1}) + h_{C,i,t}(\widehat{\lambda}_{C,t-1})) + (1-\phi_{i,t-1})(h_{i,t}(\lambda_{i,t-1})) + \varepsilon_{i,t}$$

$$\lambda_{i,t-1} = \exp(\boldsymbol{\gamma}_i' \mathbf{X}_{t-1}^L)$$

$$\phi_{i,t-1} = g_0 + \exp\left(g_1 \left|s_{i,t-1}\right|\right)$$

$$h_{i,t} = c_{0,i} + c_{1,i}^2 \varepsilon_{i,t-1}^2 + c_{2,i}^2 h_{i,t-1}$$

$$h_{EU,i,t} = d_{EU,i} + (\widehat{c}_{1,EU})(c_{1,i})\widehat{\varepsilon}_{EU,t-1}\varepsilon_{i,t-1} + (\widehat{c}_{2,EU})(c_{2,i})h_{EU,i,t-1}$$

$$h_{C,i,t} = d_{C,i} + (\widehat{c}_{1,C})(c_{1,i})\widehat{\varepsilon}_{C,t-1}\varepsilon_{i,t-1} + (\widehat{c}_{2,C})(c_{2,i})h_{EU,i,t-1}$$

where $r_{i,t}$ is the excess return on the ith local stock market in Deutschmark, $h_{EU,i,t}$ is the conditional covariance between excess returns on the ith local stock market and the excess return on the EU-12, $h_{C,i,t}$ is the conditional covariance between the excess returns on the ith local stock market and the excess currency return, $h_{i,t}$ is the conditional variance the ith local market excess return. $\widehat{x}$ denotes an estimate of x from the first step. $\widehat{\lambda}_{EU,t}$ is the price of EU-12 market risk, $\widehat{\lambda}_{C,t}$ is the price of currency risk, λ_i is the price of local risk. $\phi_{i,t}$ is the estimate of the level of integration, s_t is the forward interest differential vis-á-vis Germany, exp(.) denotes exponentiation, $\mathbf{X}_{t-1}^L$ is a vector of predetermined local instrumental variables where the coefficient vector $\boldsymbol{\gamma}_i$ is related to the instruments as follows: $\gamma_{0,i}$ multiplies a constant term, $\gamma_{1,i}$ multiplies the local market dividend yield in excess of the local market one month euro-deposit rate, $\gamma_{2,i}$ the change in the spread between the long term yield on local government bonds (ten-year benchmark) and the local one month euro-deposit rate, $\gamma_{3,i}$ the change in the local one month euro-deposit rate, and $\gamma_{4,i}$ the first lag of the local market excess return. Note, due to lack of data on short term interest rates, there is no term structure instrument or change in short term interest rate for Ireland. Instead, we use the dividend yield in excess of the long term yield on government bonds ($\gamma_{1,IR}$), the change in the long term government bond yield ($\gamma_{2,IR}$), and the first lag of excess returns ($\gamma_{3,IR}$) as instruments. $\varepsilon_{i,t}$, is an error term. $c_{0,i}$, $c_{1,i}$ $c_{2,i}$ are coefficients to be estimated in the conditional variance and $d_{EU,i}$ and $d_{C,i}$ are constants in the conditional covariance equations. Panel B reports residual analysis and tests of the model. P.E. (%) reports the average weekly percentage pricing error, R^2 is the pseudo R^2, N is the Bera-Jarque test statistic for normality of the standardized residuals, H is a test statistic for 4th order serial correlation of the squared standardised residuals, S.C. is test statistic for 4th order serial correlation of the standardised residuals, EN is the Engle-Ng joint test for asymmetries in conditional volatility. Constant L.P.R. is a robust Wald test of the null hypothesis that the price of local risk is constant ($\gamma_{i,k} = 0,\ k = 1, 2, 3, 4$). **indicates statistically significant at the 1% level, * indicates statistically significant at the 5% level, † indicates statistically significant at the 10% level. Standard errors are in parentheses and probability values are in square brackets. Country codes are as follows: AU: Austria, BL: Belgium-Luxembourg, FN: Finland, FR: France, GE: Germany, IR: Ireland, IT: Italy, NL: Netherlands, PO: Portugal, SP: Spain, UK: United Kingdom. Data are weekly from 6:7:91 to 26:6:98, except for the following countries: Portugal and Austria (13:1:95 to 26:6:98), Finland (25:10:96 to 26:6:98) and Ireland (9:8:96 to 26:6:98).

Panel A: Model Estimates of Mean Return Equation

Country	γ_0	γ_1	γ_2	γ_3	γ_4	g_1
AU	-1.710	-232.350**	3.987**	-36.900**	-4.706	-0.990**
	(1.92)	(47.28)	(1.20)	(7.99)	(8.86)	(0.02)
BL	5.626**	-21.689	1.909**	-8.749**	-3.484**	-0.289**
	(0.73)	(14.07)	(0.33)	(1.09)	(1.06)	(0.03)
FN	9.531	-48.465	12.873**	-24.341**	-9.123	-0.276**
	(0.49)	(9.14)	(0.67)	(2.621)	(6.184)	(0.03)
FR	3.169**	-48.539^{**}	0.596*	$-1.031^{\dagger}$	-0.166	-0.813**
	(1.08)	(17.34)	(0.25)	(0.62)	(0.59)	(0.08)
GE	5.398**	-48.278^{**}	1.444**	4.199†	13.915**	-0.646**
	(0.51)	(16.05)	(0.17)	(2.52)	(5.02)	(0.05)
IR	5.821**	59.178*	0.971**	2.753	–	-0.908**
	(0.85)	(28.1)	(0.21)	(5.98)		(0.10)
IT	1.182**	-8.583	0.378**	0.968**	-0.456**	-0.410**
	(0.46)	(15.28)	(0.06)	(0.16)	(0.16)	(0.16)
NL	4.431**	-36.439	9.635	-4.554	-7.087	-0.390**
	(1.59)	(32.64)	(18.44)	(6.37)	(4.96)	(0.02)
PO	-0.526	68.551**	-0.355^{**}	-1.376	-0.224	-0.219
	(0.36)	(25.37)	(0.14)	(2.62)	(2.02)	(0.61)
SP	9.477**	45.017**	1.702**	3.509	2.848	-0.124**
	(1.17)	(16.45)	(0.13)	(2.66)	(3.72)	(0.04)
UK	3.259**	-38.502**	-0.041**	-5.288**	-5.728**	-0.088**
	(0.11)	(6.95)	(0.04)	(1.21)	(1.04)	(0.03)

Panel B: Model Estimates of Conditional Variance Equation

Country	c_0	c_1	c_2	d_{EU}	d_C
AU	1.3E-4** (9.0E-6)	0.242** (0.09)	0.707** (0.02)	1.6E-4** (1.0E-5)	9.1E-6** (3.6E-6)
BL	1.0E-4** 5.6E-6	0.357** (0.04)	0.662** (0.02)	1.6E-4** (5.8E-6)	1.2E-5** (1.8E-6)
FN	7.3E-4** (5.3E-5)	0.201 (0.24)	0.178 (1.98)	2.8E-4** (1.3E-5)	-7.3E-6 (6.8E-6)
FR	1.9E-4** (4.3E-6)	0.164** (0.05)	0.709** (0.01)	2.7E-4** (1.3E-6)	2.6E-5** (1.5E-6)
GE	6.7E-5** (3.0E-6)	0.229** (0.03)	0.844** (0.01)	1.8E-4** (3.6E-6)	9.8E-5** (1.8E-6)
IR	7.2E-4** 7.1E-5	0.211** (0.04)	0.889** (0.01)	2.6E-4** (1.2E-5)	3.9E-5** (5.0E-6)
IT	5.9E-4** (2.2E-5)	0.158** (0.07)	0.679** (0.01)	3.6E-4** (1.5E-6)	6.8E-5 ** $(3.6E-6)$
NL	3.9E-5** (1.7E-6)	0.284** (0.01)	0.864** (0.004)	1.7E-4** (3.0E-6)	1.3E-5** (1.3E-6)
PO	5.8E-6** (7.8E-7)	0.168** (0.01)	0.980** (0.001)	1.4E-4** (1.6E.5)	1.3E-5* (5.7E-6)
SP	3.4E-4** (1.2E-5)	0.100† (0.06)	0.643** (0.02)	3.1E-4** (6.7E-6)	4.8E-5** (3.2E-6)
UK	2.6E-4** (3.3E-6)	0.349** (0.03)	0.347** (0.01)	2.4E-4** (9.1E-6)	3.3E-5** (1.1E-6)

Panel C: Residual Analysis

Country	P.E.(%)	R^2(%)	N $\chi^2(2)$	H $\chi^2(4)$	S.C. $\chi^2(4)$	EN$\chi^2(3)$	Constant L.P.R.
AU	0.095	5.22	7.29 [0.03]	28.86 [0.00]	6.21 [0.04]	3.64 [0.30]	55.43 [0.00]
BL	0.119	2.79	1.27 [0.52]	9.40 [0.05]	7.91 [0.10]	2.66 [0.45]	110.29 [0.00]
FN	0.522	-0.27	15.52 [0.00]	6.36 [0.17]	4.96 [0.29]	0.94 [0.82]	473.43 [0.00]
FR	0.029	2.84	0.79 [0.67]	10.23 [0.04]	0.95 [0.92]	3.48 [0.32]	16.26 [0.00]
GE	0.073	2.04	9.12 [0.01]	10.02 [0.04]	2.41 [0.66]	2.28 [0.52]	127.78 [0.00]
IR	0.429	4.37	0.37 [0.82]	6.31 [0.18]	1.72 [0.79]	1.06 [0.78]	21.26 [0.00]
IT	0.045	1.53	3.83 [0.15]	3.90 [0.41]	5.38 [0.25]	3.08 [0.38]	91.99 [0.00]
NL	0.179	2.50	70.59 [0.00]	9.04 [0.06]	10.19 [0.04]	0.97 [0.81]	4.040 [0.40]
PO	0.396	0.41	47.21 [0.00]	7.32 [0.12]	8.20 [0.08]	3.96 [0.27]	31.96 [0.00]
SP	-0.014	3.14	5.84 [0.05]	2.21 [0.69]	6.65 [0.16]	2.30 [0.51]	61.95 [0.00]
UK	-0.070	5.98	1.06 [0.59]	8.91 [0.06]	8.54 [0.07]	3.73 [0.29]	80.96 [0.00]

Table VIII
Decomposing Expected Returns into Rewards for Different Risk Premia

This table reports decompositions of annualized expected returns estimated from the model that allows for partial integration (PI) — see table VII for details. Panel A reports decompositions over the period 1991-1995. All data are sample means with standard errors in parentheses. Panel B reports decompositions over the period 1996-1998. Column 2 reports the total expected return, E(R^{Total}). In columns 3 and 4, the total expected return is broken down into the component due to local risk, E(R^{Local}), and the component due to EU risk, E(R^{EU}). In columns 5 and 6, EU risk is broken down into market risk, E(R^{Market}), and currency risk, E($R^{Currency}$). Row EU-12 reports cross-country averages. Row EU-11 reports cross-country averages excluding the UK. All returns are expressed in percentage points per annum. Data are weekly from 6:7:91 to 26:6:98, except for the following countries: Portugal and Austria (13:1:95 to 26:6:98), Finland (25:10:96 to 26:6:98) and Ireland (9:8:96 to 26:6:98).

Panel A: 1991-1995

	E(R^{Total})	E(R^{Local})	E(R^{EU})	E(R^{Market})	E($R^{Currency}$)
AU	2.778 (5.38)	0.003 (0.01)	2.775 (5.38)	3.728 (2.97)	−0.953 (4.57)
BL	3.924 (8.56)	2.202 (6.36)	1.722 (6.92)	3.543 (6.14)	−1.822 (3.57)
FN	–	–	–	–	–
FR	4.619 (12.42)	2.617 (7.08)	2.002 (10.90)	4.958 (10.99)	−2.956 (4.43)
GE	4.474 (10.01)	2.131 (7.25)	2.344 (7.23)	3.451 (7.13)	−1.124 (2.26)
IR	–	–	–	–	–
IT	1.760 (10.97)	2.065 (9.51)	−0.305 (5.87)	2.111 (5.94)	−2.416 (3.37)
NL	5.500 (10.14)	3.416 (5.37)	2.084 (8.195)	4.346 (7.62)	−2.262 (3.75)
PO	8.049 (6.58)	6.954 (6.40)	1.095 (1.96)	1.530 (1.19)	−0.434 (1.56)
SP	4.752 (15.96)	5.751 (11.04)	−0.998 (11.83)	5.098 (10.14)	−6.096 (7.76)
UK	12.113 (20.01)	11.917 (15.99)	0.196 (12.23)	5.718 (10.03)	−5.522 (8.68)
EU-12	5.330	4.117	1.213	3.831	-2.621
EU-11	4.482	3.142	1.340	3.595	-2.260

Panel B: 1996-1998

	E(R^{Total})	E(R^{Local})	E(R^{EU})	E(R^{Market})	E($R^{Currency}$)
AU	8.830	1.929	6.902	4.809	2.093
	(20.31)	(19.71)	(5.77)	(5.21)	(2.32)
BL	15.140	7.183	7.958	5.460	2.499
	(15.41)	(12.09)	(6.49)	(5.85)	(2.76)
FN	15.329	8.395	6.934	7.553	−0.619
	(34.39)	(34.22)	(5.77)	(5.49)	(1.13)
FR	16.655	3.666	12.989	8.174	4.815
	(16.17)	(12.22)	(10.59)	(9.03)	(5.21)
GE	11.49	3.769	7.725	5.901	1.849
	(11.97)	(9.87)	(6.65)	(6.28)	(2.08)
IR	18.74	7.837	10.905	6.913	3.995
	(17.03)	(12.74)	(9.59)	(7.79)	(5.88)
IT	13.876	0.777	13.099	6.954	6.144
	(9.78)	(0.62)	(9.60)	(7.12)	(7.66)
NL	10.780	1.960	8.820	6.038	2.782
	(17.82)	(16.48)	(7.26)	(6.39)	(3.16)
PO	8.886	3.068	5.818	3.837	1.981
	(8.41)	(6.75)	(4.43)	(3.92)	(2.31)
SP	29.937	13.407	16.530	8.710	7.821
	(24.56)	(20.10)	(12.85)	(9.51)	(8.56)
UK	20.375	6.963	13.412	7.496	5.916
	(12.52)	(6.75)	(10.35)	(8.01)	(6.40)
EU-12	15.458	5.359	10.010	6.531	3.570
EU-11	14.967	5.200	9.768	6.435	3.336

Table IX
Model Diagnostics

This table reports diagnostic tests of the time-varying integration model. The tests are based on three regressions related to the orthogonality conditions of the residuals with respect to three information sets: the EU-12 instruments ($\mathbf{X}_{t-1}^{EU}$), the local instruments ($\mathbf{X}_{t-1}^{L}$) and global instruments ($\mathbf{X}_{t-1}^{G}$). $\mathbf{X}_{t-1}^{EU}$: the EU-12 dividend yield in excess of the one month euro-DM deposit rate, the change in the spread between the long term yield on ECU government bonds and the one month ECU rate, the default spread and the change in the one month ECU deposit rate. $\mathbf{X}_{t-1}^{L}$: the local market dividend yield in excess of the local market one month euro-deposit rate, the change in the spread between the long term yield on local government bonds and the one month euro-deposit rate, the change in the one month euro-deposit rate, the first lag of the local market excess return. Note, due to lack of data on short term interest rates, there is no term structure instrument or change in short term interest rate for Ireland. Instead, for Ireland we use the dividend yield in excess of the long term yield on government bonds, the change in the long term government bond yield and the first lag of excess returns as instruments. $\mathbf{X}_{t-1}^{G}$: the world stock market dividend yield in excess of the one month euro-dollar deposit rate, the change in the spread between the yield on US government ten-year benchmark bonds and the one month euro-dollar rate, the change in the default spread defined as the yield on US AAA corporate bonds minus the US ten-year government bond yield, the change in the one month euro-dollar deposit rate. The tests are distributed $\chi^2(5)$ except for Ireland where the test for orthogonality with respect to the local instruments is distributed $\chi^2(4)$.

Country	Orthogonal to $\mathbf{X}_{t-1}^{EU}$		Orthogonal to $\mathbf{X}_{t-1}^{L}$		Orthogonal to $\mathbf{X}_{t-1}^{G}$	
	χ^2	p-value	χ^2	p-value	χ^2	p-value
AU	3.672	[0.60]	3.342	[0.65]	4.507	[0.47]
BL	9.399	[0.10]	5.951	[0.31]	8.617	[0.12]
FN	5.169	[0.39]	5.309	[0.38]	9.912	[0.08]
FR	0.859	[0.97]	4.239	[0.52]	3.605	[0.61]
GE	3.786	[0.58]	3.092	[0.69]	7.782	[0.17]
IR	4.077	[0.54]	7.120	[0.13]	4.368	[0.50]
IT	4.662	[0.45]	4.767	[0.44]	4.467	[0.48]
NL	8.896	[0.11]	11.661	[0.02]	11.238	[0.02]
PO	11.771	[0.04]	10.97	[0.05]	9.170	[0.10]
SP	2.633	[0.56]	3.353	[0.65]	6.546	[0.25]
UK	3.963	[0.55]	6.802	[0.24]	6.802	[0.24]
EU-12	4.613	[0.46]			4.022	[0.54]
CUR	0.384	[0.99]			5.418	[0.36]

Table X
Integration Weights: How Sensitive are they to Alternative Specifications on the Probability of EMU Convergence and the Price of Risk?

This table compares the estimated integration weights, $\phi_{i,t}$, from three alternative models. The first is the model reported in tables VI and VII which assumes the prices of market risk and local risk are positive (PPR). The second is a model which uses a measure of the forward interest differential that is orthogonal to the US forward interest differential against Germany (OS). The third is a model that does not impose the restriction that the prices of market risk and local risk are positive (FPR). Column 1 lists the countries, columns 2, 3, and 4 list the mean value of the integration weight along with the standard error in parentheses. Column 5 reports the correlation between the integration weight from the model with positive prices of market and local risk and the integration weight from the model with the orthogonal forward interest differential. Column 6 reports the correlation between the integration weight from the model with positive prices of market and local risk and the integration weight from the model with unrestricted prices of market risk and local risk.

Country	Mean PPR	Mean, OS	Mean, FPR	$\rho_{ppr,os}$	$\rho_{ppr,fpr}$
AU	0.9598 (0.034)	0.9035 (0.024)	0.9391 (0.029)	0.4825	0.9999
BL	0.8733 (0.08)	0.8796 (0.069)	0.9411 (0.37)	0.9914	0.9998
FN	0.9518 (0.048)	0.9785 (0.018)	0.9446 (0.043)	0.3310	0.9999
FR	0.7869 (0.197)	0.8681 (0.152)	0.7819 (0.232)	0.9948	0.9992
GE	0.7847 (0.173)	0.7031 (0.206)	0.8197 (0.027)	0.9990	0.9988
IR	0.8280 (0.149)	1.109 (0.027)	0.9154 (0.154)	0.5163	0.9999
IT	0.3695 (0.260)	0.2336 (0.290)	0.9237 (0.039)	0.9825	0.9687
NL	0.9714 (0.041)	0.9011 (0.032)	0.9204 (0.087)	0.9137	0.9996
PO	0.7295 (0.232	0.6670 (0.304)	0.5102 (0.353)	0.3256	0.9984
SP	0.7449 (0.149)	0.7749 (0.109)	0.9062 (0.056)	0.9701	0.9983
UK	0.8738 (0.032)	0.6958 (0.125)	0.7605 (0.086)	0.6118	0.9979

Table XI
Fully Integrated Model

This table reports diagnostic tests from estimating a model that assumes the countries in the sample are completely integrated into the EU-12:

$$r_{i,t} = (h_{EU,i,t}(\widehat{\lambda}_{EU,t-1}) + h_{C,i,t}(\widehat{\lambda}_{C,t-1})) + \varepsilon_{i,t}$$

$$h_{i,t} = c_{0,i} + c_{1,i}^2 \varepsilon_{i,t-1}^2 + c_{2,i}^2 h_{i,t-1}$$

$$h_{EU,i,t} = d_{EU,i} + (\widehat{c}_{1,EU})(c_{1,i})\widehat{\varepsilon}_{EU,t-1}\varepsilon_{i,t-1} + (\widehat{c}_{2,EU})(c_{2,i})h_{EU,i,t-1}$$

$$h_{C,i,t} = d_{C,i} + (\widehat{c}_{1,C})(c_{1,i})\widehat{\varepsilon}_{C,t-1}\varepsilon_{i,t-1} + (\widehat{c}_{2,C})(c_{2,i})h_{C,i,t-1}$$

where $r_{i,t}$ is the excess return on the ith local stock market, $h_{EU,i,t}$ is the conditional covariance between excess returns on the ith local stock market and the excess return on the EU-12, $h_{C,i,t}$ is the conditional covariance between the excess returns on the ith local stock market and the currency risk, $h_{i,t}$ is the conditional variance of the ith local market excess return. $\widehat{x}$ denotes an estimate of x from the first step. $\widehat{\lambda}_{EU,t}$ is the price of EU-12 market risk and $\widehat{\lambda}_{C,t}$ is the price of currency risk. $\varepsilon_{i,t}$, is an error term. $c_{0,i}$, $c_{1,i}$ $c_{2,i}$ are coefficients to be estimated in the conditional variance and $d_{EU,i}$ and $d_{C,i}$ are constants in the conditional covariance equations. The table reports residual analysis and tests of the model. Column 2 reports the average weekly percentage pricing error. Column 3 reports the pseudo R^2. Column 4 reports the annualized difference in percentage points between expected returns of the model with partial integration and expected returns of the model with full integration (E.R. Dif.). Columns 5, 6 and 7 report tests that are based on three regressions related to the orthogonality conditions of the residuals with respect to three information sets: the EU-12 instruments ($\mathbf{X}_{t-1}^{EU}$), the local instruments ($\mathbf{X}_{t-1}^{L}$) and global instruments ($\mathbf{X}_{t-1}^{G}$). ($\mathbf{X}_{t-1}^{EU}$: the EU-12 dividend yield in excess of the one month euro-DM deposit rate, the change in the spread between the long term yield on ECU government bonds and the one month ECU rate, the default spread — defined as the value-weighted average of the yield on corporate bonds of the six biggest markets (UK, Germany, France, Italy, Netherlands and Spain) minus the ECU long bond yield — and the change in the one month ECU deposit rate. $\mathbf{X}_{t-1}^{L}$: the local market dividend yield in excess of the local market one month euro-deposit rate, the change in the spread between the long term yield on local government bonds and the one month euro-deposit rate, the change in the one month euro-deposit rate, the first lag of the local market excess return. Note, due to lack of data on short term interest rates, there is no term structure instrument or change in short term interest rate for Ireland. Instead, we use the dividend yield in excess of the long term yield on government bonds, the change in the long term government bond yield and the first lag of excess returns as instruments. X^G_{t-1}: the world stock market dividend yield in excess of the one month euro-dollar deposit rate, the change in the spread between the long term yield on US government bonds and the one month euro-dollar rate, the default spread defined as the yield on US AAA corporate bonds minus the US long bond yield, the change in the one month euro-dollar deposit rate). The tests are distributed $\chi^2(5)$ except for Ireland where the test for orthogonality with respect to the local instruments is distributed $\chi^2(4)$. Probability values are in square brackets. Data are weekly from 6:7:91 to 26:6:98, except for the following countries: Portugal and Austria (13:1:95 to 26:6:98), Finland (25:10:96 to 26:6:98) and Ireland (9:8:96 to 26:6:98).

Country	P.E. (%)	R^2(%)	E.R. Dif. (%)	Orthogonality Tests		
				$\mathbf{X}^{EU}_{t-1}$	$\mathbf{X}^{L}_{t-1}$	$\mathbf{X}^{G}_{t-1}$
AU	0.110	0.69	0.782	3.716 [0.59]	1.884 [0.86]	4.576 [0.46]
BL	0.189	2.10	3.706	12.60 [0.03]	13.84 [0.02]	11.583 [0.04]
FN	0.622	0.10	5.225	7.082 [0.21]	6.632 [0.27]	15.512 [0.01]
FR	0.082	1.19	2.794	1.294 [0.94]	6.034 [0.30]	3.005 [0.69]
GE	0.116	0.52	2.261	4.905 [0.43]	5.453 [0.36]	8.212 [0.15]
IR	0.568	0.14	7.434	7.702 [0.17]	9.084 [0.04]	9.002 [0.10]
IT	0.035	1.71	-0.521	3.259 [0.66]	3.615 [0.60]	4.475 [0.58]
NL	0.231	2.23	2.740	11.929 [0.04]	17.716 [0.00]	19.038 [0.00]
PO	0.429	0.35	1.731	11.455 [0.04]	12.995 [0.02]	9.057 [0.10]
SP	0.159	3.74	9.461	3.933 [0.56]	9.778 [0.08]	6.715 [0.24]
UK	0.093	0.23	9.384	2.734 [0.74]	21.073 [0.00]	6.209 [0.29]

Table XII
Cumulative Effect of Integration on the Cost of Capital

This table reports the cross-country average cumulative effect of integration on the cost of capital in percentage points. For each country, the change in the cost of capital due to integration is calculated as follows:

$$\frac{\vartheta E_{t-1}[r_{i,t}]}{\vartheta \phi_{i,t-1}} \Delta\phi_{i,t-1} = [h_{EU,i,t}\lambda_{EU,t-1} + h_{C,i,t}\lambda_{C,t-1} - h_{i,t}\lambda_{i,t-1}] \left[\phi_{i,t-1} - \phi_{i,t-2}\right]$$

The above individual country changes in the cost of capital are then cumulated in order to obtain an estimate of the cumulative effect of integration on the cost of capital. The change in the cost of capital can be decomposed into three parts: 1. the effect due to market risk, $h_{EU,i,t}\lambda_{EU,t-1}$ $(\phi_{i,t-1} - \phi_{i,t-2})$. 2. the effect due to currency risk, $h_{C,i,t}\lambda_{C,t-1}$ $(\phi_{i,t-1} - \phi_{i,t-2})$. 3. the effect due to local risk, $-h_{i,t}\lambda_{i,t-1}$ $(\phi_{i,t-1} - \phi_{i,t-2})$. Row 1 of the table reports the market weighted average saving across 7 countries with a full sample over the period 15:5:92 to 26:6:98 (EU-7: Belgium - Luxembourg, France, Germany, Italy, Netherlands, Spain, U.K.). Row 2 of the table reports the market weighted average saving across all 12 countries over the period 6:12:96 to 26:6:98 (EU-12). Column 2 reports the total average saving in percentage points. Columns 3-5 report the market, currency, and local risk components of the cumulative average saving, respectively. Asymptotic standard errors are given in parentheses. These are calculated as the square root of the number of observations times the standard error of the change in the cost of capital (component), under the assumption that the series are *i.i.d.*

Cross-Country Averages

	Period	Total Effect	Decomposition of Total Effect		
			Market	Currency	Local
EU-7	15:5:92-26:6:98	-1.90	1.00	0.24	-3.14
		(1.33)	(0.43)	(0.23)	(1.38)
EU-12	6:12:96-26:6:98	-1.26	0.62	0.15	-2.03
		(0.55)	(0.06)	(0.05)	(0.60)

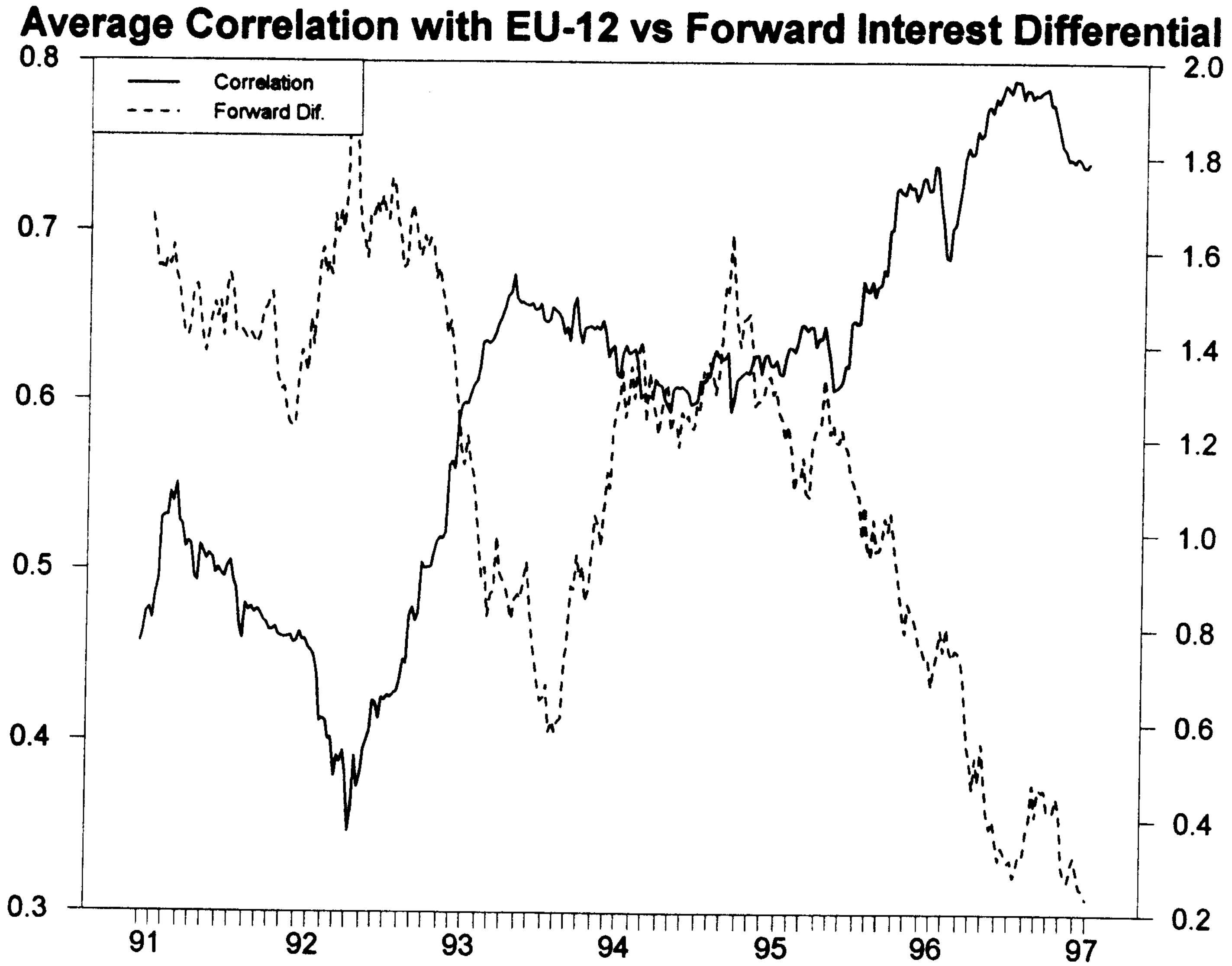


Figure 1
Stock Markets' Cross-Correlation with EU-12 and Forward Interest Differentials

The Figure displays on the left scale a 52-week rolling estimate of the average cross-correlation coefficient between local stock returns and the EU-12 market return. Individual cross-correlations of the 12 countries with the EU-12 market return are equally weighted. The right scale of the Figure displays the average forward interest differential vis-á-vis Germany for the seven countries for which data on interest rate swaps are available over a longer sample (Belgium - Luxembourg, France, Germany, Italy, Netherlands, Spain, U.K.). The forward interest differential contains information about the expected eight-year interest rate differential vis-á-vis Germany in two years time. The German forward interest differential is calculated vis-á-vis the ECU.

Figure 2
EU-12 Price of Market Risk and Price of Currency Risk

Panel A displays the estimate of the price of EU-12 market risk and Panel B displays the estimate of the price of currency risk. The estimated model is:

$$r_{EU,t} = h_{EU,t}(\lambda_{EU,t-1}) + h_{EU,C,t}(\lambda_{C,t-1}) + \varepsilon_{EU,t}$$

$$r_{C,t} = h_{EU,C,t}(\lambda_{EU,t-1}) + h_{C,t}(\lambda_{C,t-1}) + \varepsilon_{C,t}$$

$$\lambda_{EU,t-1} = \exp(\boldsymbol{\delta}'_{EU}\mathbf{X}^{EU}_{t-1})$$

$$\lambda_{C,t-1} = (\boldsymbol{\delta}'_{C}\mathbf{X}^{EU}_{t-1})$$

$$h_{EU,t} = c_{0,EU} + c^2_{1,EU}\varepsilon^2_{EU,t-1} + c^2_{2,EU}h_{EU,t-1}$$

$$h_{C,t} = c_{0,C} + c^2_{1,C}\varepsilon^2_{C,t-1} + c^2_{2,C}h_{C,t-1}$$

$$h_{EU,C,t} = d + (c_{1,EU})(c_{1,C})\varepsilon_{EU,t-1}\varepsilon_{C,t-1} + (c_{2,EU})(c_{2,C})h_{EU,C,t-1}$$

where $r_{EU,t}$ is the excess return on the EU-12 stock index, $r_{C,t}$ is the excess currency return, $h_{EU,t}$ is the conditional variance of the EU-12, $h_{C,t}$ is the conditional variance of the excess currency return, $h_{EU,C,t}$ is the conditional covariance between the excess return on the EU-12 index and the excess currency return, λ_{EU} is the price of EU-12 market risk and λ_C is the price of currency risk. $\mathbf{X}^{EU}_{t-1}$ is a vector of predetermined EU-12 instrumental variables where the coefficient vector $\boldsymbol{\delta}$ is related to the instruments as follows: δ_0 is a constant, δ_1 is the EU-12 dividend yield in excess of the one month euro-DM deposit rate, δ_2 is the change in the spread between the long term yield on ECU ten year government bonds and the one month ECU deposit rate, δ_3 is the default spread defined as the value-weighted average of the yield on corporate bonds in the six biggest markets (UK, Germany, France, Italy, Netherlands and Spain) minus the ECU long bond yield, δ_4 is the change in the one month ECU rate. $\varepsilon_{EU,t}$, and $\varepsilon_{C,t}$ are error terms. $c_{0,j}$, $c_{1,j}$ $c_{2,j}$ and d (j=EU and C) are coefficients to be estimated in the conditional variance and covariance equations.

EU-12 Price of Risk

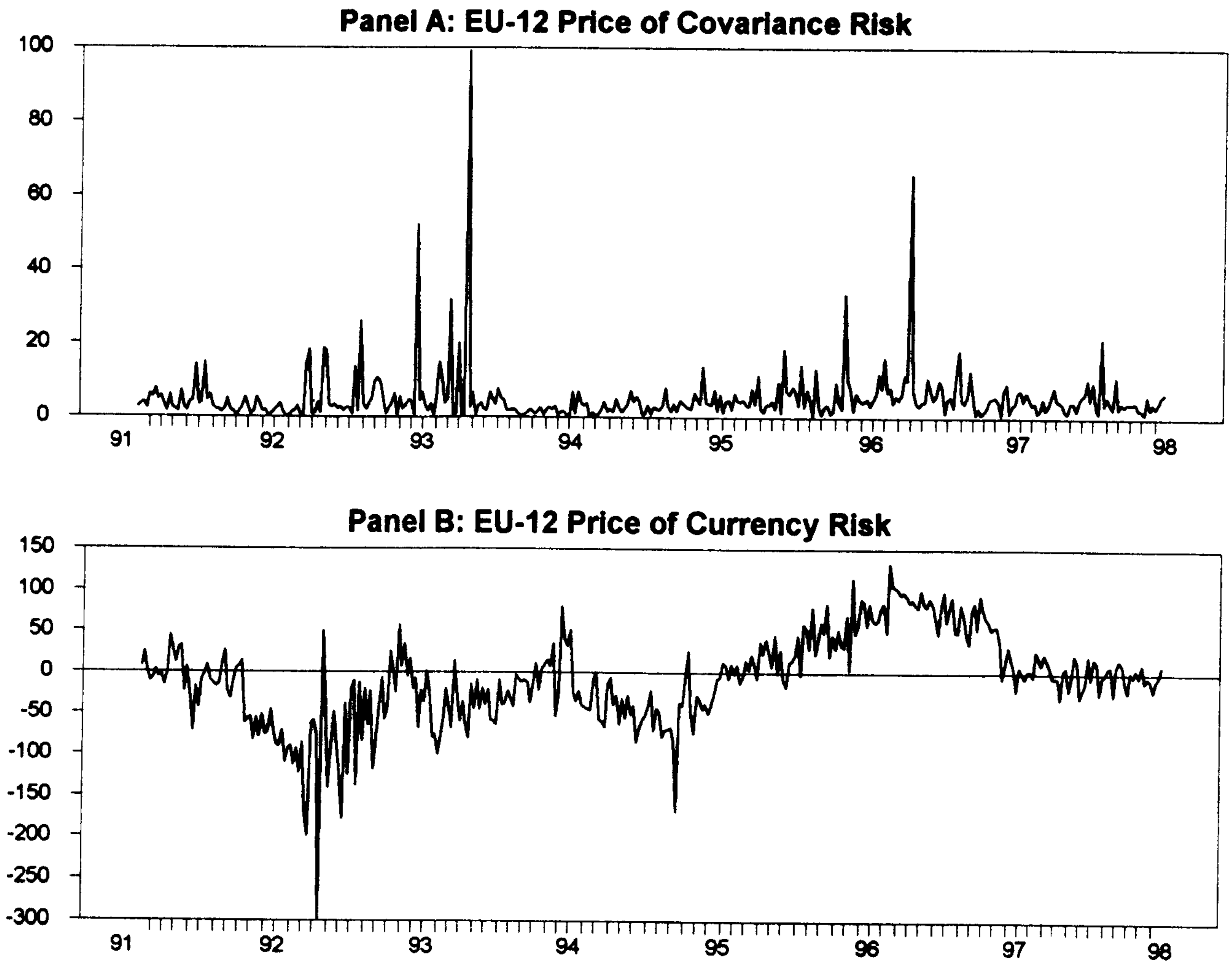


Figure 3
Estimates of the Integration Weights

Panels A through to K plot the estimated integration weights ϕ_i, for each of the eleven countries. The integration weights are estimated from the following:

$$r_{i,t} = \phi_{i,t-1}(h_{EU,i,t}(\widehat{\lambda}_{EU,t-1}) + h_{C,i,t}(\widehat{\lambda}_{C,t-1})) + (1-\phi_{i,t-1})(h_{i,t}(\lambda_{i,t-1})) + \varepsilon_{i,t}$$

$$\lambda_{i,t-1} = \exp(\gamma' \mathbf{X}^L_{t-1})$$

$$\phi_{i,t-1} = g_0 + \exp\left(g_1 \left|s_{i,t-1}\right|\right)$$

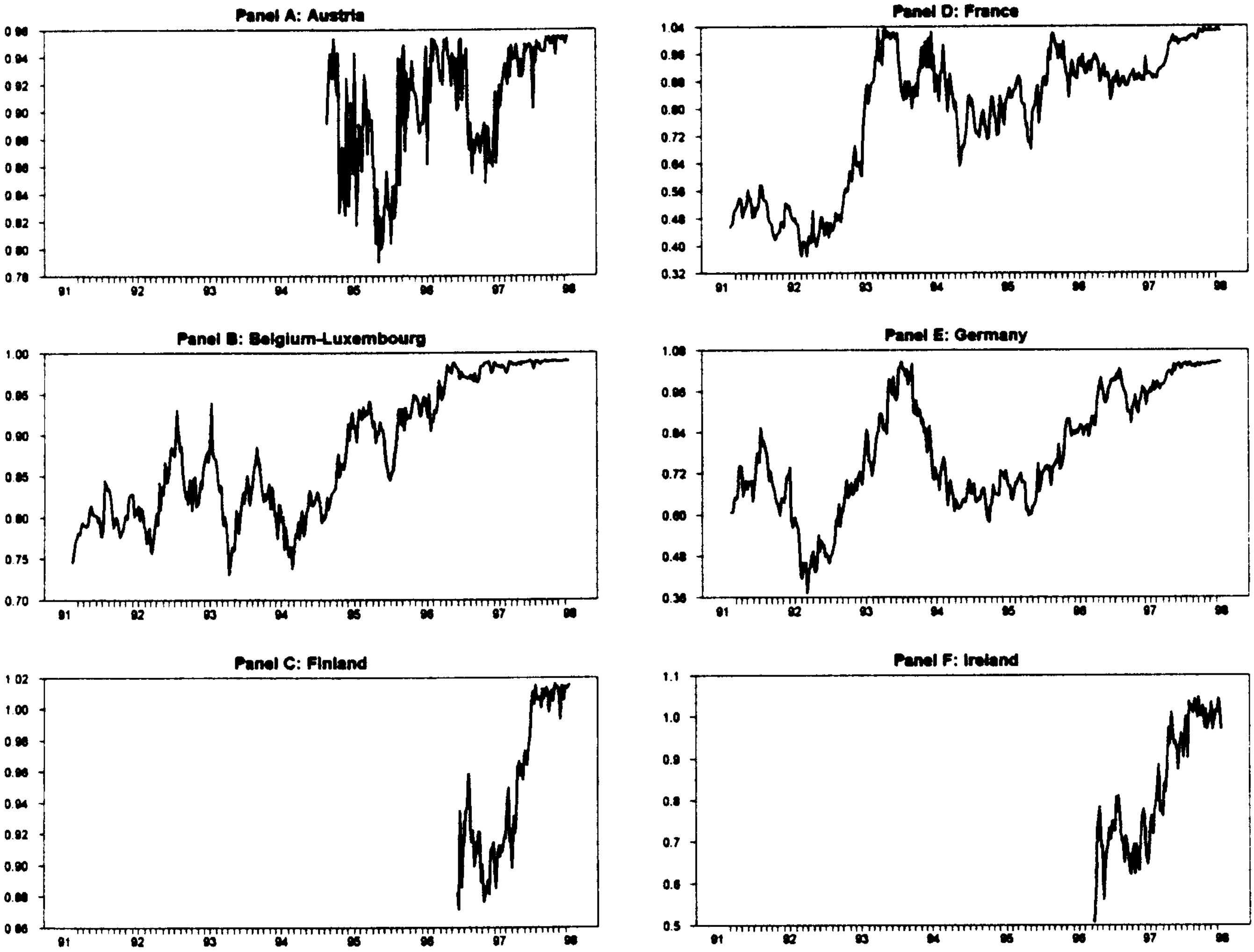
$$h_{i,t} = c_{0,i} + c^2_{1,i}\varepsilon^2_{i,t-1} + c^2_{2,i}h_{i,t-1}$$

$$h_{EU,i,t} = d_{EU} + (\widehat{c}_{1,EU})(c_{1,i})\widehat{\varepsilon}_{EU,t-1}\varepsilon_{i,t-1} + (\widehat{c}_{2,EU})(c_{2,i})h_{EU,i,t-1}$$

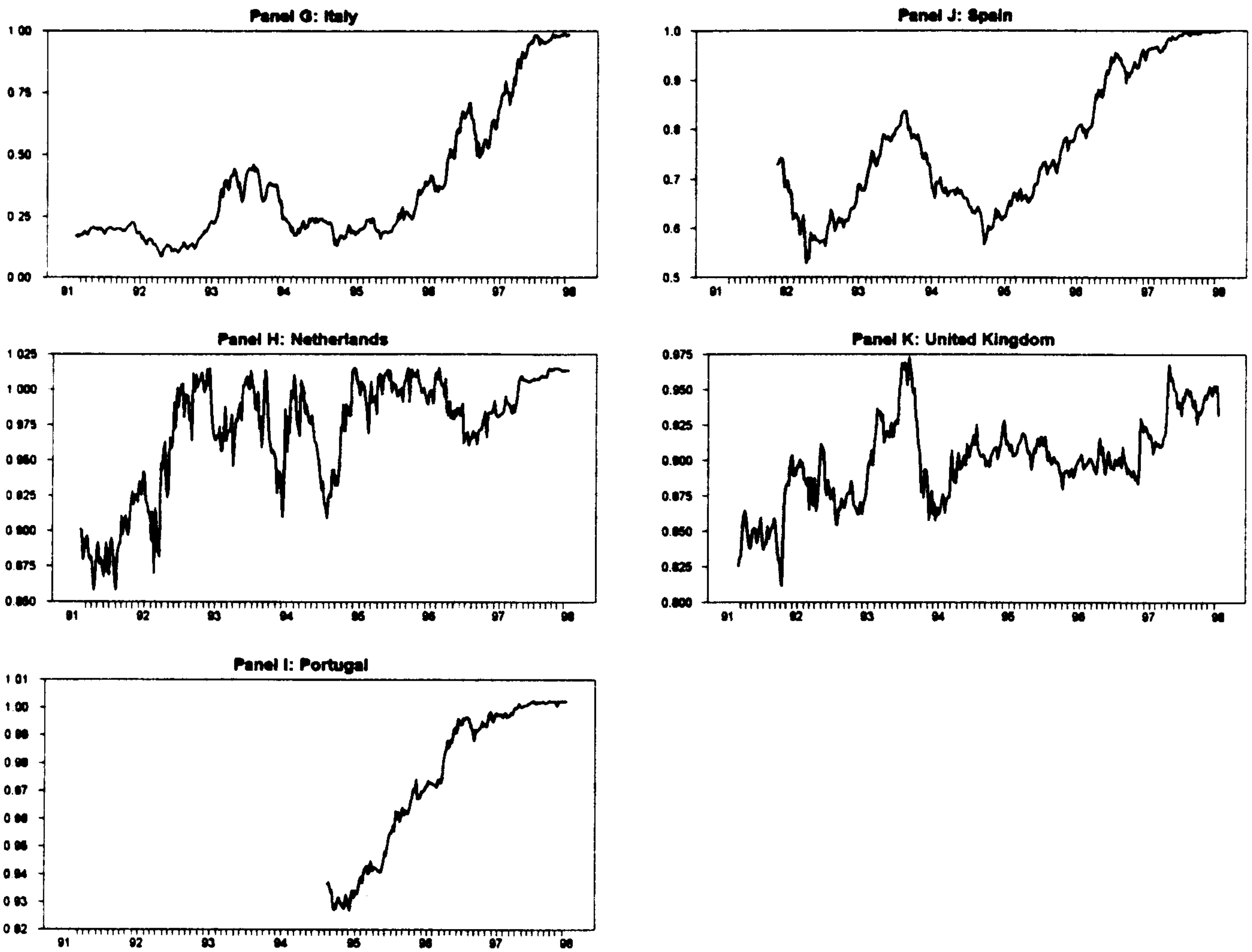
$$h_{C,i,t} = d_C + (\widehat{c}_{1,C})(c_{1,i})\widehat{\varepsilon}_{C,t-1}\varepsilon_{i,t-1} + (\widehat{c}_{2,C})(c_{2,i})h_{C,i,t-1}$$

where $r_{i,t}$ is the excess return on the ith local stock market, $h_{EU,i,t}$ is the conditional covariance between excess returns on the ith local stock market and the excess return on the EU-12, $h_{C,i,t}$ is the conditional covariance between the excess returns on the ith local stock market and the excess currency return, $h_{i,t}$ is the conditional variance the ith local market excess return. $\widehat{x}$ denotes a an estimate of x from the first step. $\widehat{\lambda}_{EU,t}$ is the price of EU-12 market risk, $\widehat{\lambda}_{C,t}$ is the price of currency risk, λ_i is the price of local risk. $\phi_{i,t}$ is the estimate of the level of integration, s_t is the forward interest differential, exp(.) denotes exponentiation, $\mathbf{X}^L_{t-1}$ is a vector of predetermined local instrumental variables where the coefficient vector γ is related to the instruments as follows: γ_0 is a constant, γ_1 is the local market dividend yield in excess of the local market one month euro-deposit rate, γ_2 is the change in the spread between the long term yield on local government bonds and the local one month euro-deposit rate, γ_3 is the change in the local one month euro-deposit rate, and γ_4 is the first lag of the local market excess return. Note, due to lack of data on short term interest rates, there is no term structure instrument or change in short term interest rate for Ireland. Instead, we use the dividend yield in excess of the long term yield on government bonds (γ_1), the change in the long term government bond yield (γ_2), and the first lag of excess returns (γ_3) as instruments). $\varepsilon_{i,t}$, is an error term. $c_{0,i}$, $c_{1,i}$ $c_{2,i}$ are coefficients to be estimated in the conditional variance and d_{EU} and d_C are the constants in the conditional covariance equations.

Estimates of Integration Weight



Estimates of Integration Weight



Cumulative Effect of Integration on the Cost of Capital

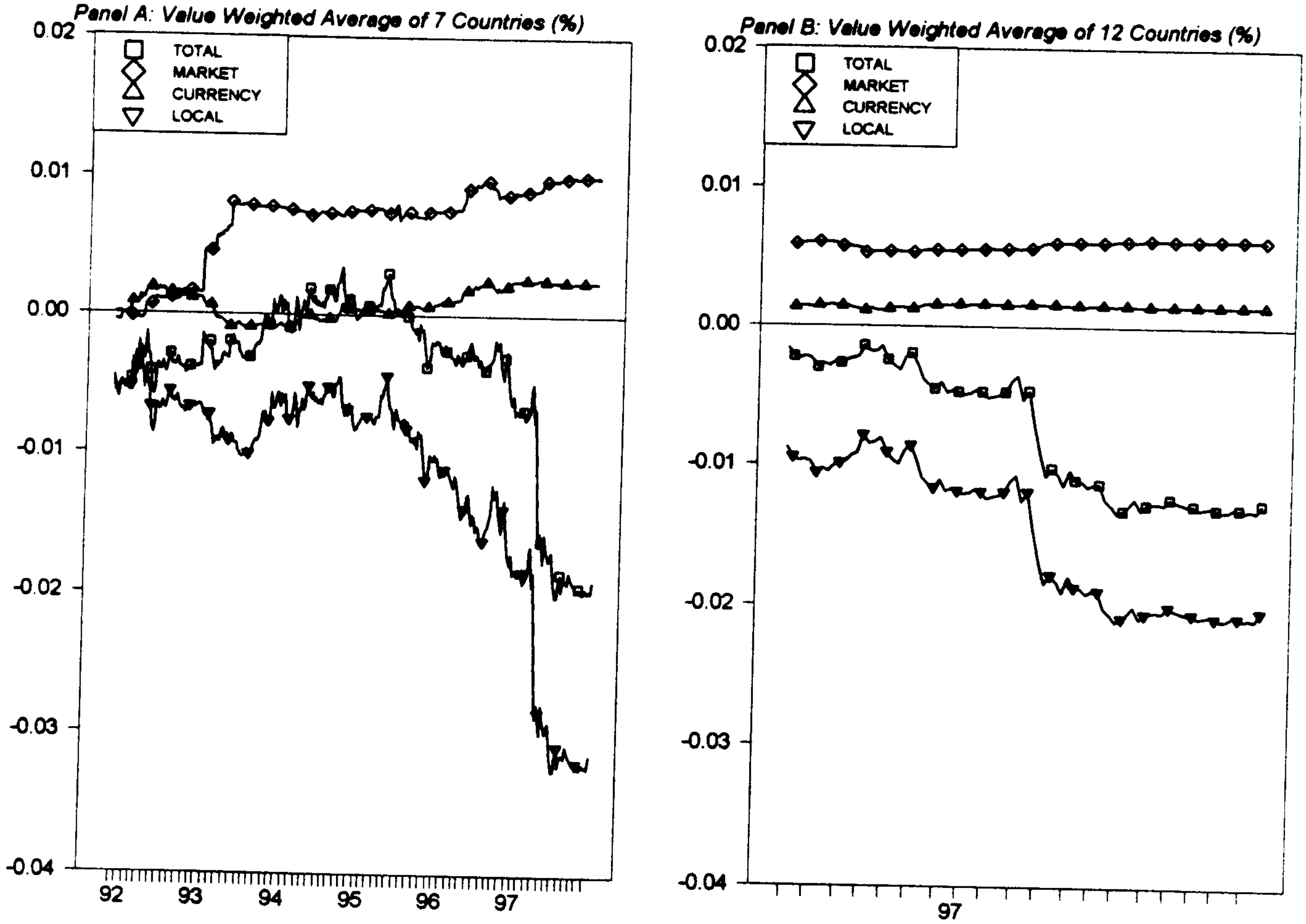


Figure 4
Cumulative Effect of Integration on the Cost of Capital

The Figure displays the cumulative effect of integration of European stock markets on the cost of capital in percentage points. Panel A displays the cross-country average cumulative saving and its components in the 7 countries with full sample (Belgium - Luxembourg, France, Germany, Italy, Netherlands, Spain, U.K.) over the period May 1992 to June 1998. Panel B displays the cross-country average cumulative saving and its components in all 12 countries over the period December 1996 to June 1998. The saving in the cost of capital is calculated for each date over the sample as the value-weighted average across countries of the product between risk premia and the change in the degree of integration (see Table XII for details). Negative numbers indicate saving in cost of capital.