Monetary Union Effects on European Stock Market Integration: An International CAPM Approach with Currency Risk

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Abstract

This paper explores the evolution of European stock markets integration with the US stock market, after the formation of European Monetary Union (EMU). To this end, we employ a dynamic version of international CAPM in the absence of purchasing power parity. The conditional covariance matrix of asset returns is estimated employing a parsimonious diagonal BEKK multivariate GARCH-in-mean model. The data sample is daily extending from June 1994 to June 2009. The introduction of world-wide information variables into the system reveals that the formation of monetary union has not exerted positive influence on EMU markets integration with US stock market. Moreover at the same time rolling estimates show that member states domestic or idiosyncratic risks have exhibited a lower volatility level.

Keywords: Market integration, EMU, MGARCH-M specification

1. Introduction

This work investigates the effects of European Monetary Union (EMU) formation on the integration of members' states stock markets with US stock market, a leading partner in international stock markets. The data period extends from June 1994 to June 2009. There is no doubt that capital market integration was a promising side effect of EMU. On January 1, 1999, eleven European Union (EU) countries formed the monetary union (Note 1). Since then, the exchange rates among the EMU countries have been irrevocably fixed, the euro was introduced as the common currency, government bills and bonds were denominated in euro while the European Central Bank (ECB) started operating carrying out the common monetary policy.

There is a large literature that investigates European stock market integration. One recent example of this literature is Hardouvelis *et al.* (2006). They propose a conditional asset pricing model that allows a time-varying degree of integration in order to measure 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 level of integration is closely related to forward interest differentials vis-a-vis Germany. Moreover, they point out that integration increases substantially over time, especially since 1995, when these differentials began shrinking, and by mid-1998, six months before the official date of EMU launch, stock markets in EMU members' states seem to be almost fully integrated. Many researchers that investigate the level of integration have focused mainly on one source of risk. For example, Hardouvelis *et al.* (2006), Fratzscher (2002) and Kim et al. (2005) did not take account currency risk. However, the introduction of euro as a common currency for the EMU does not eliminate currency risk for out of EMU investors. According to standard portfolio theory if the effect of currency risk does not vanish in well-diversified portfolios, exposure to this factor should command a risk premium in the sense that investors are willing to pay a premium to avoid this systematic risk. On the other hand, if currency risk is diversifiable, investors are not willing to pay a premium for firms with active hedging policies since investors can diversify the currency risk themselves. Moreover, in Morana and Beltratti (2002), Hardouvelis *et al*. (2006), Fratzscher (2002) and Yang *et al.* (2003) estimates of post-euro impacts on international stock markets from

European currency unification are outdated. Given the fact that currency risk and market integration have important implications in international finance the purpose of this paper is to provide further evidence on this issue. In particular, we investigate the evolution of European stock markets integration with USA stock market, an important participant in international equity markets as well as trade partner of EMU countries. To achieve this goal, we choose to estimate and test an international capital asset pricing model (ICAPM) using a parsimonious MGARCH-M parameterization. To model the conditional covariance matrix of asset returns we employ a diagonal BEKK parameterization of the MGARCH-M process. The advantage of the multivariate approach is that utilizes the information in the entire variance–covariance matrix of the errors, which in turn, leads to more precise estimates of the parameters of the model.

The remainder of this paper is organized as follows. Section 2 motivates the theoretical dynamic ICAPM and presents the econometric methods used to estimate the model. Section 3 discusses the data and reports the empirical results. Conclusions are offered in Section 4.

2. The dynamic ICAPM

Under the hypotheses of stock market integration and purchasing power parity, a conditional version of the domestic CAPM of Sharpe (1964) and Lintner (1965) can be extended to an international setting. In this case, the conditional version of the model can be formally written as

$$E_{t-1}(r_{i,t}) = \lambda_{usa,t-1} Cov_{t-1}(r_{i.t}, r_{usa,t}) \forall i \tag{1}$$

$$E_{t-1}(r_{USA,t}) = \lambda_{USA,t-1} Var_{t-1}(r_{USA,t}) \tag{2}$$

where $E_t(r_{i,t})$ is the expected excess returns of country's i stock market index conditional on the information up to period t; $E_t(r_{usa,t})$ the conditional expected excess return on the USA stock market index; $\lambda_{usa,t}$ the time varying price of USA market risk; $Cov_t(r_{i,t}, r_{usa,t})$ the conditional covariance between the excess returns of country i 's market index and the USA market index; $Var_t(r_{usa,t})$ is the conditional variance of the excess return of USA market index. Model (1) – (2) assumes that markets are fully integrated and therefore only international risk is priced in global equity markets. The expected returns are not affected by domestic factors. However, a country may not be fully integrated with global financial market. In this case, Errunza and Losq (1985) extend the international CAPM (ICAPM) to account for mild segmentation among markets. Thus, the expected return depends upon two risk factors: exposure to international market risk and exposure to non-diversifiable country-specific risk. The conditional version of the model can be written as

$$E_{t-1}(r_{i,t}) = \lambda_{usa,t-1} Cov_{t-1}(r_{i.t}, r_{usa,t}) + \gamma_i Var_{t-1}(r_{i,t}) \tag{3}$$

Several empirical studies (e.g., Ferson and Harvey, 1994; Dumas and Solnik, 1995; De Santis and Gerard, 1998; among others) reported that, due to violation of PPP, currency risk is priced in global financial markets, especially in short horizons (Note 2). In the absence of PPP, international investors will face different real returns when holding the same assets. In this paper, we rely on the ICAPM, which provides the theoretical basis for selecting the economic fundamentals. The economic fundamentals are the international market and currency risk, so the evidence of integration is based on testing whether idiosyncratic risk, the part that cannot be explained by the international market and currency risk, are statistically significant in describing the return dynamics. Thus, the modified conditional ICAPM, taking into account the EMU formation, can be expressed as

$$r_{i,t} = (1 - ED_i)\lambda_{usa,t-1} h_{iusa,t} + \lambda_{c,t-1} h_{ic,t} + ED_i \gamma_i h_{ii,t} + \varepsilon_{i,t} \forall i \tag{4}$$

$$r_{usa,t} = \lambda_{usa,t-1} h_{usa,t} + \lambda_{c,t-1} h_{cusa,t} + \varepsilon_{usa,t} \tag{5}$$

$$r_{c,t} = \lambda_{usa,t-1} h_{cusa,t} + \lambda_{c,t-1} h_{c,t} + \varepsilon_{c,t} \tag{6}$$

$$h_{ij,t} = \omega_{ij} + a_{ij} u_{i,t-1} u_{jt-1} + \beta_{ij} h_{ij,t-1} \tag{7}$$

where, r_{usa} is the excess return on the USA market index; r_c the return on a currency index; $h_{ii,t}$ the conditional variance of country i 's market index; $h_{c,t}$ the conditional variance of currency returns; $h_{iusa,t}$ the conditional covariance between returns on country i 's market index and the USA market index; $h_{ic,t}$ the conditional covariance between returns on country i 's market index and the currency index; $h_{cusa,t}$ the conditional covariance between currency return and the return on the USA market index; ED_i is a European Monetary Union dummy variable, which is equal to one after the union date (1/1/1999) and zero otherwise. Employing the modified conditional ICAPM, the test of market integration and currency risk pricing can be conducted jointly. In this way we can test, if any residual variation in the returns could be explained by the conditional volatility of the underlying market after accounting for potential international market and currency risk premia. To model the conditional variances and co-variances, several multivariate GARCH models have been proposed such as the diagonal VECH model of Bollerslev, Engle and Wooldridge (1988) the constant correlation (CCORR) model of Bollerslev (1990) the factor ARCH (FARCH) model of Engle and Rothschild (1990) and the BEKK model of Engle and Kroner (1995). We select the BEKK specification, which assumes that A and B matrices are diagonal (Note 3). The diagonal BEKK model is preferred since it yields a positive definite covariance matrix for all values of ε_{t-1} and economizes on parameters relative to other MGARCH specifications (Ding and Engle, 2001). In this case the conditional variance–covariance matrix is given by Eq. (7). Where, Ω is a lower triangular matrix of constants and A, B are $N \times N$ diagonal parameter matrices. We focus on a GARCH (1,1) specification (Note 4) since it has been shown to be a parsimonious representation of conditional variance that can adequately fit the data under examination. We employ full information maximum likelihood (FIML) to estimate Eqs. (4) to (6). In order to account for time-varying international market and currency risk prices, we choose according to the theoretical asset-pricing model developed by Merton (1980). In this model, the price of international market risk is the coefficients of risk aversion of investors and thus, is expected to be positive. Since the theoretical model does not restrict the price of currency risk to be positive we use a linear specification to model the dynamics of $\lambda_{c,t}$ and an exponential function to model the dynamics of $\lambda_{usa,t}$. Therefore, the dynamics of risk prices can be described by $\lambda_{usa,t} = \exp(\phi_{usa}^{'} z_t)$ and $\lambda_{c,t} = \phi_c^{'} z_t$, where z_t = {DUSTP, USDP, USA} is a vector of instruments observed at the end of period t and ϕ 's are time-invariant vectors of weights. To compute excess returns on all indices we use the one-month Eurodollar interest rate as a proxy for the risk-free rate. In particular, the excess stock return is computed by $r_{i,t} = \ln(p_{i,t} / p_{i,t-1}) - 1/365(\ln(1+i_{t-1}^{US\$})$ where $p_{i,t}$ is the market total return index (dividend included) expressed in US dollars at time t and $i_t^{US\$}$ is the annualized 1-month Eurodollar interest rate known at time t. Furthermore, the log first-difference of the trade-weighted U.S. dollar price of the currencies of major industrialized countries (TWFX) is used to proxy currency risk. The selected set of instrumental variables have been widely used in the international asset pricing literature (see e.g., Bekaert and Harvey, 1995; De Santis and Gerard, 1995; 1998; Tai, 2007; Harvey, 1991; Bekaert and Hodrick, 1992; Ferson and Harvey, 1993; among others). Specifically, the instruments are the change in the US term premium, measured by the first difference of the yield difference between ten-year Treasury constant maturity rate and one-month Eurodollar rate (USTP), the US default premium, measured by the yield difference between Barclay's BBB rated and AAA-rated U.S. corporate bonds (USDP) and the lagged excess return on USA market index (USA). Finally all instruments enter with one lag, relative to the excess return series. Under full market integration, γ_i should not be statistically significant, otherwise there are evidence of partial, at least, market integration.

3. Econometric estimation of ICAPM

The data set comprises daily US-dollar denominated returns (Note 5) on stock indices for twelve EMU markets and USA market return index, for the period from June 1994 to June 2009 (3896-data-point time series). All the data are extracted from Datastream. The dynamic ICAPM with time-varying international market and currency risk prices are stated in Eqs. (4)–(6). We first estimate Eq. (4) in the whole sample and then, splitting our data set into two sub-periods, we estimate Eq. (4), without dummy variables, separately for each sub-period. The first sub-period is before and the second sub-period after the formation of monetary union. Table 1 reports the estimation results of the dynamic ICAPM. Note that instrumental variables are first differenced and then lagged once. From the empirical results, reported in Panel A in Table 1, we note that all instruments for currency risk prices are statistically significant. It is interesting that USDP, the credit risk instrument of currency risk price, is statistically significant after the formation of monetary union. This might be explained by the USA sub prime crisis (2007), which affected the price risk factors. Panel B of Table 1 reports the estimates of parameters γ_i. For Eq. (4), we observe that γ_i 's are statistically significant, which shows that EMU idiosyncratic risk factors strengthen after the monetary unification of Europe. These evidences are also supported from estimates of Eq. (4), separately for the period before and after EMU. In the first sub-period most γ_i are not statistically significant, while in the second period these are statistically significant. Specifically, during the first sub-period only Spain, Greece and Austria have statistically significant γ_i. In the second period the role of idiosyncratic risk in all EMU markets strengthens. These results quantify the role played by monetary unification on market integration. There are some explanations about this specific course of evolution of integration. First, after the formation of monetary union the elimination of inter-European exchange risk lifted barriers for investors who are averse to this risk source and as such provided a much-expanded 'domestic' market. Secondly, the adoption of a common monetary policy and the relatively greater alignment of fiscal policy across members' states, together with fewer legal or institutional barriers to investment served to increase the interdependencies between EMU markets.

Table 2 reports diagnostic testing, performed on the standardized residuals, for the purpose of assessing the fit of the dynamic ICAPM. In panel C, Ljung–Box Portmanteau statistics tests the null hypothesis of zero autocorrelation in the standardized residuals. The test statistics LB(654) are reported in Panel C of Table 2. For all levels of significance the null hypothesis is accepted suggesting that the volatility process is correctly specified. However, as suggested by Engle and Ng (1993), the Ljung–Box test may not have much power in detecting misspecifications related to the asymmetric effects. For this purpose we employ the set of diagnostics proposed by Engle and Ng (1993) (Note 6). These tests are based on the news impact curve implied by a particular ARCH-type model. The premise being that if the volatility process is correctly specified, then the standardized residuals should not be predictable based on observed variables. The results reported in Panel C show that most of the test statistics, at one percent level of significance, suggest no strong evidence of misspecification. In Panel D, the parameters of the conditional mean process are all statistically significant, at one percent level, indicating that the MGARCH process is well specified. The condition for covariance stationarity is satisfied in all cases (Note 7). To present a more analytical view of the time variation of the integration process we use a rolling estimation technique. We set a one-year period rolling window, starting from June 1994 and move the window forward by one trading day at a time. Figure 1, shows rolling parameter estimates of γ_i for equations (4)-(6) (Note 8). First, note that in the aftermath of the severe and costly EMU crisis over 1992 – 1993, regional stock markets became more volatile, with high values of γ_i estimates. After this crises, the estimates of the one-year rolling window show high volatility before the formation of EMU and a more stable environment after that. The period from 1997 to late 1998 coincided with the final stages of the treaty of Amsterdam in which political and institutional conditions established to enable the EU to meet the challenges of the future.

4. Conclusions

This paper empirically investigates EMU markets integration with USA stock market. The empirical results show that idiosyncratic risk factors in EMU markets became prominent since the formation of monetary union. These findings suggest that EMU become an expanded "domestic" market which is, however, interdependent with the rest international markets. Rolling estimates of market's idiosyncratic risk show that, after the formation of monetary union, domestic risk has been stabilized. The above results could also be explained from the elimination of inter-European exchange rates, barriers for European investors and greater alignment on fiscal policy across members' states. Finally, lower integration level with international markets implies more opportunities for portfolio diversification, for international investors, and in combination with a less volatile domestic risk, makes EMU a more attractive international market for portfolio diversification.

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Notes

Note 1. These countries were Austria, Belgium, Finland, France, Germany, Ireland, Italy, Luxembourg, Netherlands, Portugal and Spain. Greece fulfilled the EMU criteria and entered EMU at 1/1/2001.

Note 2. Rogoff (1996) provide a detailed discussion on the issue of PPP.

Note 3. In a diagonal system with N assets, the number of unknown parameters in the conditional variance equation is reduced from $2N^2+(N(N+1))/2$ under full BEKK specification to $2N+(N(N+1))/2$ under the diagonal BEKK specification.

Note 4. We estimated the model with alternative lag lengths. The estimation results remain qualitatively similar and are available upon request.

Note 5. As suggested by Bekaert and Harvey (1995), calculating the returns in U.S. dollars eliminates the local inflation.

Note 6. Engle and Ng (1993) asymmetric tests include the sign bias, the negative size bias, and the positive size bias tests. The sign bias test examines the impact of positive and negative innovations on volatility not predicted by the model. The squared standardized residuals are regressed against a constant and a dummy S_t^- that takes the value of unity if ε_{t-1} is negative, and zero otherwise. The test is based on the t statistic for S_t^-. The negative (positive) size bias test examines how well the model captures the impact of large and small negative (positive) innovations, and it is based on the regression of the squared standardized residuals against a constant and $S_t^-\varepsilon_{t-1}((1-S_t^-)\varepsilon_{t-1})$. The computed t-statistic for $S_t^-\varepsilon_{t-1}((1-S_t^-)\varepsilon_{t-1})$ is used in this test.

Note 7. For the conditional covariance process H_t to be covariance stationary, the condition $a_i a_j + b_i b_j < 1 \forall i, j$ has to be satisfied. (see, e.g., Bollerslev, 1986; De Santis and Gerard, 1997; Bekaert and Harvey, 1995).

Note 8. Eq. (4) is estimated without dummies.

Table 1. FIML estimation of Dynamic ICAPM - EMU Markets.

Coefficient estimates of ICAPM: Eqs. (4),(5) and (6)						
Periods of estimation:	*Total period* : [Eq. (4)]		*1st period* : Eq. (4) without dummies		*2nd period* : Eq. (4) without dummies	
Time varying price of risk (Panel A)	6/1994 -	6/ 2009	6/1994 -	1/1999	1/1999 -	6/2009
Φ_{usa} (International risk)	coefficient	Prob.	Coefficient	Prob.	Coefficient	Prob.
DUSTP	162.2166***	0.0000	-816.2360***	0.0000	-143.7519***	0.0000
USDP	1.8751	0.6006	-45.5274	0.1411	2.2184	0.2499
USA	-11.8627***	0.0015	20.4399	0.1610	20.9147***	0.0000
Φ_c (Currency risk)	Coefficient	Prob.	Coefficient	Prob.	Coefficient	Prob.
DUSTP	5749.0950***	0.0032	-371.7114	0.9663	1543.9040	0.5354
USDP	168.4453***	0.0002	-157.6294	0.5547	169.2561***	0.0014
USA	-1481.6070***	0.0000	7040.3310***	0.0000	-1342.354***	0.0000
(Panel B)						
γ_i (Market i risk)	Coefficient	Prob.	Coefficient	Prob.	Coefficient	Prob.
Italy	-2.2286***	0.0000	-1.2037	0.3723	-2.7139***	0.0000
Germany	-1.4332***	0.0000	-1.3443	0.3280	-0.9098**	0.0111
Spain	-7.0028***	0.0000	-20.7798***	0.0000	-7.7184***	0.0000
Netherlands	-3.0484***	0.0000	-1.6630	0.2139	-3.6936***	0.0000
Finland	-1.2944***	0.0000	-0.5537	0.6194	-1.6223***	0.0000
Belgium	-3.8142***	0.0000	2.3584	0.2151	-4.4283***	0.0000
Portogal	-3.1024***	0.0000	-0.6806	0.5784	-3.7781***	0.0000
Greece	-2.6125***	0.0000	2.0455**	0.0341	-2.7918***	0.0000
France	-1.8212***	0.0000	-1.4878	0.4064	-2.1479***	0.0000
Austria	-4.2069***	0.0000	-6.4190***	0.0010	-4.8325***	0.0000
Ireland	-3.5417***	0.0000	2.0775	0.2312	-4.0132***	0.0000
luxemburg	2.6947***	0.0000	3.1206	0.2047	2.4965***	0.0000

*denotes 10% statistical significance, **denotes 5% statistical significance, ***denotes 1% statistical significance

Table 2. Diagnostic Tests and Conditional Variance Process for Dynamic ICAPM

Market **Diagnostic Tests**	**ITA**	**GER**	**SPA**	**NETH**	**FIN**	**BEL**	**PORT**	**GRE**	**FRA**	**AUST**	**IRE**	**LUX**
Engle and Ng Test	*(Panel C)*											
Sign Bias Test	0.16**	0.22***	0.29***	0.22***	0.11	0.12**	0.19***	0.12**	0.15**	0.18***	0.12*	0.08
(t-stat.)	(2.37)	(3.43)	(4.58)	(4.52)	(1.64)	(2.34)	(3.41)	(2.14)	(2.35)	(3.39)	(1.81)	(0.15)
Negative S.B.T	-0.14***	0.14**	-0.19***	-0.20***	0.35***	0.23***	-0.29***	-0.15***	0.14***	0.19***	-0.15**	0.00
(t-stat.)	(-3.23)	(2.32)	(-3.82)	(-4.91)	(6.41)	(5.37)	(-6.04)	(-3.18)	(3.31)	(4.19)	(-2.38)	(-0.12)
Positive S.B.T	-0.12**	-0.18***	-0.20***	-0.22***	-0.14**	-0.09**	-0.10**	-0.13**	-0.17***	-0.17***	0.06	-0.05
(t-stat.)	(-2.59)	(-3.04)	(-3.58)	(-5.05)	(-2.30)	(-2.07)	(-2.08)	(-2.36)	(-3.62)	(-3.48)	(-1.06)	(-1.17)
Ljung Box test (Total period)	EMU markets											
L-B(654) [Q-stat]	128831.1	[0.1001]										
Cond/nal Variance Process (Eq.7)	*(Panel D)*											
	0.27***	0.17***	0.23***	0.26***	0.17***	0.27***	0.25***	0.26***	0.24***	0.22***	0.23***	0.29***
(t-stat)	(41.52)	(32.09)	(41.72)	(38.62)	(36.24)	(41.00)	(45.99)	(34.65)	(35.69)	(38.37)	(32.01)	(96.58)
	0.95***	0.98***	0.96***	0.96***	0.98***	0.95***	0.96***	0.96***	0.96***	0.96***	0.96***	0.95***
(t-stat)	(525.76)	(923.84)	(557.82)	(492.57)	(1420.21)	(477.10)	(776.71)	(471.83)	(465.05)	(582.14)	(529.23)	(1310.12)

*denotes 10% statistical significance, **denotes 5% statistical significance, ***denotes 1% statistical significance.

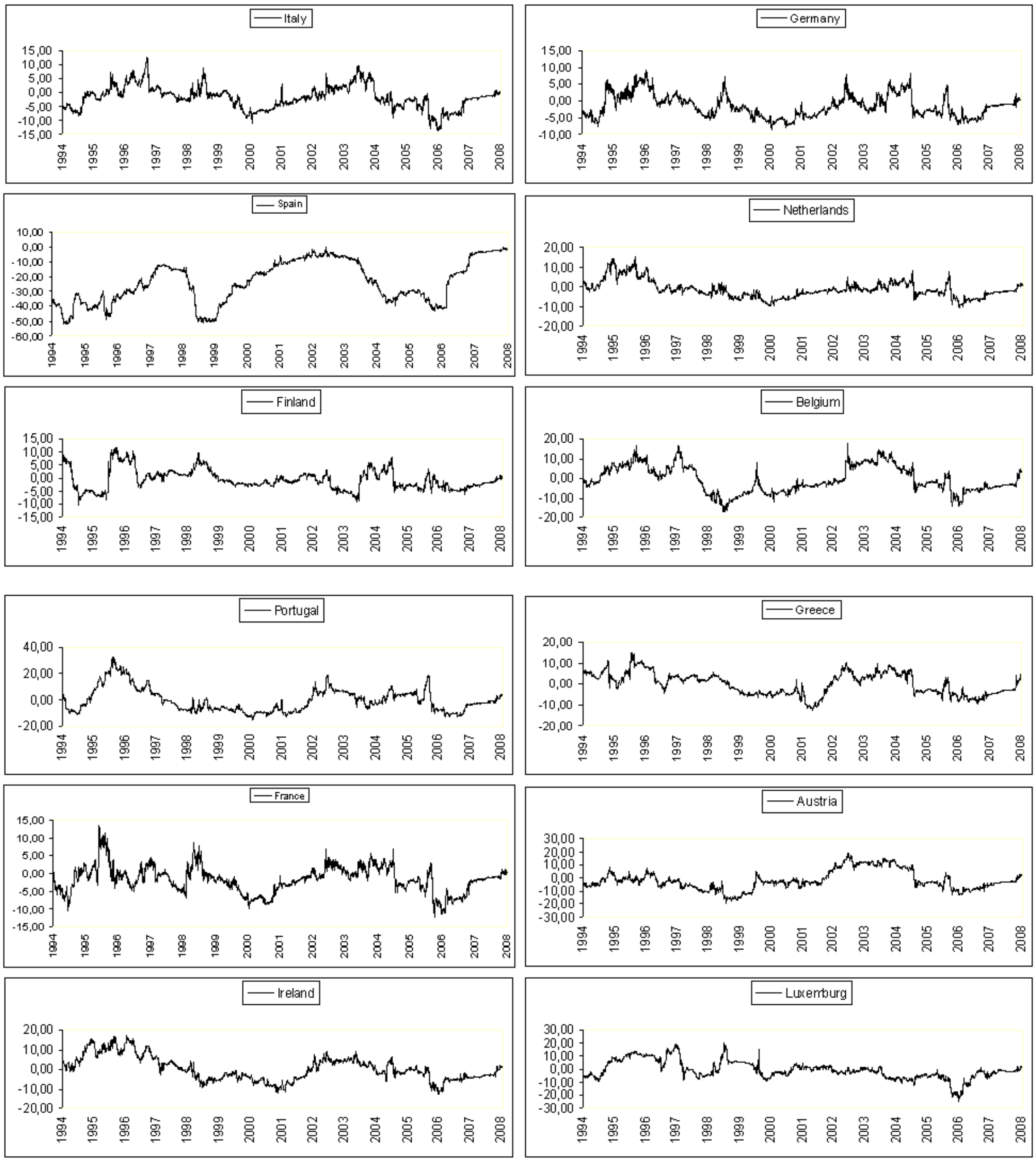

Figure 1. Time-varying domestic risk of EMU stock markets: γ_i estimates.