Stock Markets Integration and European Monetary Union

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Abstract

We evaluate changes in international spillovers of equity price shocks with EMU by estimating BEKK-GARCH models over 1993-98 and 1999-2004. Results are consistent with EMU market integration via sectoral allocation, but not autonomy from the external influence of the US.

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1 Introduction

The introduction of EMU is widely considered to have led to heightened international integration of financial markets, see for example Baele et al (2004). In this paper we seek to assess a key aspect of the behavior of euro area equity markets, namely the degree of international spillovers of equity price shocks, both intra-EMU and vis-à-vis the US. We estimate a series of BEKK-GARCH models and evaluate the changes in significance and size of coefficients in the period 1999-2004 compared to the equivalent period before EMU 1993-1998. Our results cast light both on the degree of integration of EMU equities markets and on the autonomy or dominance they have collectively established in the global market. We note that it was widely anticipated both that there would be greater integration (with intra EMU shock spilling over from country to country) but also greater autonomy from the US.

Kanas (1998) looked at volatility spillovers between the three major EU markets, those of the UK, Germany and France over 1984-1993, using a simple EGARCH specification. He found reciprocal spillovers from the UK to France and France to Germany, but only unidirectional spillovers from the UK to Germany. He also found that there was a larger spillover for bad news (price falls) than good news (price rises) and some evidence of greater interdependence in the post-1987 crash period.

Ng (2000) sought to assess spillovers by extending a CAPM model to two factors where the idiosyncratic return to an individual market are driven not just by local idiosyncratic shocks but also by shocks from regional and global markets. She finds that US and UK shocks account for more than 10% of weekly variations in returns in Continental markets.

Billio and Pelizzon (2003) look at volatility spillovers in the Euro zone using a multivariate switching regime model, and find that volatility spillovers from the world index and the German market have increased since EMU for most European stock markets. They argue that by allowing for switches between high and low volatility states, the method reduces persistence in second moments that could underestimate volatility in the high volatility states and the opposite in the low volatility states, and also it allows for time varying conditional correlations.

Concerning studies using a methodology comparable to ours, Fratzscher (2001) uses a multivariate GARCH to assess the changes in integration of EU financial markets since the mid-1980s. He finds growing EU integration and also a rising weight of EU markets in the world since 1996. Christiansen (2004) decomposes equity and bond market volatility in a multivariate GARCH model, and finds that it is mainly "own market" effects which predominate. The study finds a structural break from EMU.

Our study is distinct from earlier work in focusing on all of the multivariate AR-GARCH cross-coefficients, not merely volatility spillovers, thus providing a broader picture of changes with EMU. Second, by including the US market (and in some cases the entire eurozone) in the comparison, we allow for integration both within and outside EMU. Third, by estimating over a considerable period of five years since EMU, and an equivalent five year period before, we should obtain greater accuracy in assessing the impact of EMU.

2 The model

In this section, we introduce the multivariate GARCH process we employ to estimate the international transmission of stock returns' volatility. We model the joint processes governing the rates of returns of two stock indices with the following bivariate GARCH model[1]:

$$\mathbf{r}_t = \boldsymbol{\alpha} + \boldsymbol{\beta}\mathbf{r}_{t-1} + \mathbf{u}_t \tag{1}$$

where the residual vector $\mathbf{u}_t = (e_{1,t}, e_{2,t})$ is bivariate and normally distributed $\mathbf{u}_t \mid I_{t-1} \sim (\mathbf{0}, H_t)$ with its corresponding conditional variance covariance matrix given by:

$$H_t = \begin{bmatrix} h_{1t} & h_{12t} \\ h_{12t} & h_{2t} \end{bmatrix} \tag{2}$$

The parameter vector of the mean return equation (1) is defined by the constant $\boldsymbol{\alpha} = (\alpha_1, \alpha_2)$ and the autoregressive[2] term $\boldsymbol{\beta} = (\beta_{11}, \beta_{12} \mid \beta_{21}, \beta_{22})$, while the parameter matrices for the variance equation (2) are defined as C_0, which is restricted to be upper triangular, and two unrestricted matrices A_{11} and G_{11}. Therefore, the second moment will take the following form:

$$\begin{aligned} H_t &= C_0'C_0 + \begin{bmatrix} a_{11} & a_{12} \\ a_{21} & a_{22} \end{bmatrix}' \begin{bmatrix} e_{1,t-1}^2 & e_{2,t-1}e_{1,t-1} \\ e_{1,t-1}e_{2,t-1} & e_{2,t-1}^2 \end{bmatrix} \begin{bmatrix} a_{11} & a_{12} \\ a_{21} & a_{22} \end{bmatrix} \\ &\quad + \begin{bmatrix} g_{11} & g_{12} \\ g_{21} & g_{22} \end{bmatrix}' H_{t-1} \begin{bmatrix} g_{11} & g_{12} \\ g_{21} & g_{22} \end{bmatrix} \end{aligned} \tag{3}$$

Equation (2) models the dynamic process of H_t as a linear function of its own past values H_{t-1} and past values of the squared innovations $\left(e_{1,t-1}^2, e_{2,t-1}^2\right)$, in both cases allowing for own-market and cross-market influences in the conditional variance. The important feature of this specification is that it allows the conditional variances and covariances of the two series to affect each other, thereby enabling one to test the null hypothesis of no volatility spillover effects in one or even both directions. Furthermore, it does not require the estimation of many parameters (eight for the bivariate system excluding constant, without any loss of generality). Even more importantly, the BEKK model guarantees by construction that the covariance matrices in the system are positive definite.

Given a sample of T observations, a vector of unknown parameters[3] θ and a 2×1 vector of returns r_t, the conditional density function for the model (1) is:

$$f\left(r_t | I_{t-1}; \theta\right) = (2\pi)^{-1} \left|H_t\right|^{-1/2} \exp\left(-\frac{\mathbf{u}_t'\left(H_t^{-1}\right)\mathbf{u}_t}{2}\right) \tag{4}$$

The log likelihood function

[1] The model is based on the bivariate GARCH(1,1)-BEKK representation proposed by Engle and Kroner (1995).

[2] Parameters β_{12} and β_{21}in equation (1) allows us to also investigate the dynamic interactions between stock market returns.

[3] Standard errors are calculated using the quasi-maximum likelihood method of Bollerslev and Wooldridge (1992), which is robust to the distribution of the underlying residuals.

$$L = \sum_{t=1}^{T} \log f\left(r_t | I_{t-1}; \theta\right) \quad (5)$$

is maximized numerically using the Broyden, Fletcher, Goldfarb and Shanno algorithm.

3 Empirical results

We use daily data (five days per week) for six countries (France, Germany, Netherlands, Spain, UK and US) plus the European Dow Jones over the period 1/1/1993 - 1/7/2004, for a total of 2868 observations. The data were all obtained from Datastream. We define daily returns as logarithmic differences of stock indices.

A sample regression for the France-US relation is shown in Table 1, while the results of all the regressions are summarised in Tables 2-4.

Table 1 illustrates that most of the variables in the France (1) –US (2) BEKK are significant, both pre and post EMU, with satisfactory statistical properties. In looking at spillovers we may focus first on the coefficients β_{12} and β_{21}, which show the cross country spillovers of share price movements within the conditional mean equation. Here we see a consistently strong and significant spillover effect from the US market movement to French ones in β_{21}, whereas a smaller French effect on the US becomes insignificant after EMU. Then we have the cross country spillovers of share price volatility shown by g_{12} and g_{21}. Here we see that there is a reversal, with French volatility spilling over to the US prior to EMU but the US volatility being significant for France thereafter. Finally, there is the cross country spillover of shocks onto volatility i.e. a_{21} and a_{12}, and we find here again that an impact of French shocks on US volatility is absent post EMU, whereas shocks from the US affect French volatility consistently (note that the sign is not relevant).

Insert Tables 1-4

From the results summary for all the bilateral BEKKs, the following points are noteworthy. Table 2 shows that there are generally less cross country spillovers of share price movements since EMU within Europe. So for example, German share price movements affected three countries significantly before EMU and only one since. Declines in spillovers are also seen for Spain, the Netherlands and the UK. On the other hand, the degree of spillover from the US is consistent and significant in all cases except the UK post EMU. Looking at the countries affected by spillovers, the Netherlands is shown to be consistently affected by spillovers from all countries both before and since EMU. More broadly, there are less countries affected by others since EMU than before it. For example, a significant spillover effect from Spain, the Netherlands and the UK on Germany disappear with EMU, although one from France is established at the time of EMU. The UK and US markets are autonomous in this system and not affected by spillovers from Continental Europe at all except France in the US pre EMU. There is also a spillover of the US on the UK pre EMU.

As regards the Euro area equity market, it is affected by both the UK and US market movements both before and after EMU but does not affect the US in either case, which is shown to be the lead market. On the other hand the Euro area market does affect the UK post EMU, suggesting a degree of UK integration with EMU markets (and possibly also cross listing).

Turning to Table 3, which shows cross-country spillovers of volatility, a similar pattern can be discerned. There is a marked increase in volatility transfer from the US in the post EMU period, from 2 countries (Germany and the Netherlands) to all six European countries. Meanwhile, there is a decline in volatility spillovers between European countries in the case of the Netherlands and the UK. Interestingly, there is some evidence of spillovers of volatility from Europe to the US notably in the pre-EMU period (from France and Germany), which disappears after EMU. On the other hand, significant spillovers emerge after EMU for Spain and the UK to the US. Again, as regards the Euro area, this is subject to volatility spillovers from the US in the post-EMU period that are not reciprocated.

Finally in respect of Table 4, we see that share price shocks affect volatility differentially in the pre and post EMU period. There is a marked dominance of the UK as well as the US market in this respect. Shocks to US prices affect volatility in all the EMU countries both before and after EMU, with a larger absolute coefficient thereafter. Meanwhile, the UK coefficient becomes significant after EMU. Shocks in the UK are significant for all markets but the US pre EMU and all but Germany post EMU. Shocks to both UK and US markets consistently affect EMU share indices. Within the Euro area, there is a rise in spillover of shocks post EMU in France and Germany. Shocks to France consistently affect UK volatility, as do Spanish shocks post EMU. Shocks to the Euro area consistently affect UK volatility, and, interestingly, also US volatility post EMU.

As in the other cases the Dutch market volatility is most susceptible to shocks and the US the least. Before EMU French and German shocks affect US volatility but thereafter it is only UK shocks. Unlike Billio and Pelizzon (2003) we do not find an increase in influence of the German stock market.

4 Conclusions

Broadly speaking, the results imply a growing dominance of the US and to a lesser extent the UK market vis a vis those in Continental Europe. The results are consistent with a reduction of country allocation in favour of sector allocation in the EU, as well as a growing dominance of the US market on a worldwide basis. Integration has hence occurred, but not in the way that some had anticipated (with greater intra-EMU spillovers and lesser extra-EMU ones). A key aspect underlying this pattern may be the scope of international investment in EMU, much of it from the UK and US, which is much greater in continental Europe than in the UK and the US. For example Byrne and Davis (2003) found that in 2000 15% of the German stock market was foreign owned and 37% of the French compared to 9% in the US. Owing to a degree of home asset preference for institutional investors, shocks in the domestic market of these investors may often lead to sharp adjustments in international holdings. Overall, although the results are consistent with a rise in euro area integration, the outcome does not reflect greater autonomy, let alone global dominance. The vulnerability to external shocks may mean that some of the beneficial effects of securities market integration with EMU (notably a lower equity risk premium) may not be realised as yet. Euro area countries are also more susceptible to systemic shocks generated in the US since EMU.

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TABLE 1

Estimated BEKK-GARCH(1,1) models for France and the US stock return index

	Pre-EMU sample 1/1/93-31/12/98		Post-EMU sample 1/1/99-1/7/04	
Parameters	Coef.	S.E.	Coef.	S.E.
α_1	**0.0007**	0.0001	0.0003	0.0002
β_{11}	**0.0776**	0.0241	−0.0391	0.0253
β_{12}	**0.0331**	0.0161	0.0164	0.0292
α_2	0.0003	0.0002	0.0003	0.0002
β_{21}	**0.4421**	0.0403	**0.3891**	0.0322
β_{22}	**−0.0687**	0.0271	**−0.1696**	0.0252
c_{11}	**0.0011**	0.0003	−0.0007	0.0006
c_{12}	**0.0009**	0.0002	0.0013	0.0008
c_{22}	−0.0002	0.0002	0.0009	0.0012
g_{11}	**0.9461**	0.0331	**1.0159**	0.0998
g_{12}	**0.7102**	0.1257	**0.1246**	0.2212
g_{21}	−0.0138	0.0949	**−0.8502**	0.1326
g_{22}	**−0.9947**	0.0355	**−1.0066**	0.0811
a_{11}	**0.2807**	0.0474	**0.2774**	0.0494
a_{12}	**0.1046**	0.0454	**0.0771**	0.0516
a_{21}	**0.0594**	0.0244	**−0.2457**	0.0623
a_{22}	**0.1463**	0.0265	**−0.3077**	0.0412
LogLik	12475.97		11430.09	
$LB_{Fr(10)}$	9.5381		6.2157	
$LB^2_{Fr(10)}$	3.1254		10.5398	
$LB_{US(10)}$	3.2769		10.8555	
$LB^2_{US(10)}$	4.4171		4.5715	

Note: Quasi-maximum likelihood standard errors (S.E.) based on Bollerslev and Wooldridge (1992) are reported. Statistically significant parameters (5%) are reported in bold. LB(10) and $LB^2(10)$ are respectively the Ljung-Box test (1978) of significance of autocorrelations of ten lags in the standardized and standardized squared residuals. The covariance stationary condition is also satisfied by all the estimated models, all the eigenvalues of $A_{11} \otimes A_{11} + G_{11} \otimes G_{11}$ being less than one in modulus.

TABLE 2

Cross country spillovers of share price movements

Effect of	Effect on	France	Germany	Spain	Neths	UK	US	Euro	Significant
France	pre-EMU	x	-0.02	-0.01	**0.09**	-0.02	**0.03**		2
	post-EMU	x	**0.19**	-0.06	**0.13**	0.03	0.02		2
Germany	pre-EMU	**0.29**	x	**-0.07**	**-0.04**	-0.01	0.01		3
	post-EMU	-0.03	x	0.03	**0.13**	0.07	0.02		1
Spain	pre-EMU	0.04	**0.25**	x	**0.3**	-0.02	0.02		2
	post-EMU	0.02	-0.01	x	**0.3**	0.028	0.04		1
Neths	pre-EMU	0.04	**0.27**	0.04	x	-0.01	0.02		1
	post-EMU	-0.04	-0.05	0.02	x	-0.03	0.01		0
UK	pre-EMU	0.04	**0.34**	-0.04	**0.17**	x	-0.02	**0.11**	2
	post-EMU	0.05	0.02	-0.02	**0.13**	x	-0.06	**-0.07**	1
US	pre-EMU	**0.44**	**0.56**	**0.36**	**0.45**	**0.09**	x	**0.34**	5
	post-EMU	**0.39**	**0.31**	**0.25**	**0.33**	0.054	x	**0.31**	4
Euro area	pre-EMU					-0.01	0.01	x	
	post-EMU					**0.09**	0.01	x	
Significant	pre-EMU	2	4	2	5	1	1		
excl. euro	post-EMU	1	2	1	5	0	0		

Note: Estimates reported refer to parameters β_{12} and β_{21} in equation (1). Statistically significant parameters (5%) are reported in bold.

TABLE 3

Cross country spillovers of conditional volatilities

Effect of	Effect on	France	Germany	Spain	Neths	UK	US	Euro	Significant
France	pre-EMU	x	**0.32**	**0.94**	**-0.07**	**1.03**	**0.71**		4
	post-EMU	x	**0.29**	-0.02	**-0.04**	**0.33**	0.12		3
Germany	pre-EMU	**1.16**	x	0.01	**0.24**	**0.53**	**0.31**		4
	post-EMU	**-0.3**	x	0.00	**1.04**	0.06	0.16		2
Spain	pre-EMU	**0.69**	0.02	x	-0.2	**-1.09**	0.13		2
	post-EMU	-0.01	0.01	x	**0.94**	**1.58**	**0.09**		3
Neths	pre-EMU	0.02	**-0.21**	**0.49**	x	0.01	**0.82**		3
	post-EMU	0.01	**-0.82**	-0.07	x	0.09	**0.28**		2
UK	pre-EMU	**0.39**	**0.91**	**0.81**	**-0.03**	x	-0.03	0.19	4
	post-EMU	-0.16	-0.05	**-0.07**	**-1.32**	x	**-0.61**	0.01	3
US	pre-EMU	-0.01	**-0.24**	-0.05	**-0.67**	0.052	x	0.01	2
	post-EMU	**-0.85**	**-0.93**	**-0.12**	**-0.66**	**0.32**	x	**-0.31**	5
Euro area	pre-EMU					-0.15	0.01		
	post-EMU					0.03	0.02		
Significant	pre-EMU	3	4	3	3	3	3		
excl. euro	post-EMU	2	3	2	5	3	3		

Note: Estimates reported refer to parameters g_{12} and g_{21} in equation (3). Statistically significant parameters (5%) are reported in bold.

TABLE 4

Cross country spillovers of share price shocks

Effect of	Effect on	France	Germany	Spain	Neths	UK	US	Euro	Significant
France	pre-EMU	x	-0.02	0.01	-0.07	**0.31**	**0.11**		2
	post-EMU	x	**-0.27**	0.02	**0.13**	**0.41**	0.08		3
Germany	pre-EMU	-0.09	x	-0.01	**-0.09**	0.09	**0.24**		2
	post-EMU	**0.34**	x	-0.04	**-0.1**	-0.16	0.08		2
Spain	pre-EMU	-0.12	-0.023	x	**0.09**	-0.19	-0.14		1
	post-EMU	0.06	0.07	x	**-0.33**	**0.37**	0.14		2
Neths	pre-EMU	-0.01	**0.13**	0.01	x	0.04	-0.1		1
	post-EMU	-0.01	**0.13**	0.05	x	0.01	-0.01		1
UK	pre-EMU	**0.05**	**0.22**	**0.11**	**0.09**	x	0.09	**0.21**	4
	post-EMU	**0.08**	0.16	**-0.12**	**0.11**	x	**-0.09**	**0.08**	4
US	pre-EMU	**0.06**	**0.19**	**0.12**	**0.22**	-0.05	x	**0.07**	4
	post-EMU	**-0.25**	**-0.28**	**-0.19**	**0.22**	**0.3**	x	**0.68**	5
Euro area	pre-EMU					**0.16**	-0.01		
	post-EMU					**0.06**	**-0.44**		
Significant	pre-EMU	2	3	2	4	1	2		
excl. euro	post-EMU	3	3	2	5	3	1		

Note: Estimates reported refer to parameters a_{12} and a_{21} in equation (3). Statistically significant parameters (5%) are reported in bold.