REGION VERSUS INDUSTRY EFFECTS: VOLATILITY TRANSMISSION

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Region versus Industry effects: volatility transmission [1]

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Abstract

This paper has two main objectives. First, it analyses the relative importance of regional versus industrial effects, as opposed to country versus industrial effects, using a sample including the period after the bursting of the TMT bubble. Second, it analyses volatility transmission patterns *within* an industry *across* regions, in order to assess whether the same international linkages found in aggregate stock market indices exist at the industry level. The results confirm the overall dominance of regional effects over industry effects. In the volatility transmission analysis, the results are suggestive of spillovers, more or less important depending on the industry being analysed.

JEL Classification: C32; F30; G11; G15

Keywords: International financial markets; Multivariate GARCH; Volatility spillovers; Diversification; Industrial structure

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1 Introduction

Whether return variations are driven by national factors or industry factors has long been a challenge to both academics and practitioners. In fact, numerous studies have addressed the question of the relative importance of cross-country versus cross-industry diversification.

The benefits from international diversification have been sooner recognised. Earlier studies, such as Lessard (1974), Solnik (1974) or Grinold *et al.* (1989), suggest that returns are mostly determined by country effects and that correlation between countries is smaller than correlation between sectors. Therefore, diversification across countries would provide greater risk reduction than diversification across industries.

More recently, Heston and Rouwenhorst (1994,1995) and Rouwenhorst (1999) collected individual stock returns and ran cross-sectional regressions on country and industry dummies in order to quantify the country-specific and the industry-specific components of stock returns. Up to the late 1990s, country effects dominated industry effects. Griffin and Karolyi (1998) extended Heston and Rouwenhorst (1994) methodology to stock indices returns and confirmed, regardless of the industry classification, the dominance of country factors. Similar results can be found in Beckers *et al*. (1992), Drummen and Zimmerman (1992), Beckers *et al*. (1996) and Serra (2000).

Therefore, earlier studies generally found a dominance of the country effect over the industry one. However, after the recent integration processes and financial crisis occurred in the last decades, there were a number of legitimate reasons to re-examine this issue. In fact, it is reasonable to expect that diversification across industries may be more important in this new globalization era.

Some recent studies provide evidence that industry effects are becoming increasingly important while countries are losing explanatory power. In general, they propose industry diversification as an alternative to the traditional country diversification. Baca *et al*. (2000) study 10 sectors in the 7 largest countries from 1979 to 1999 and find that the impact of the industrial or sector effect is then roughly equal to that of the country effect. Cavaglia *et al*. (2000) find similar evidence by studying 36 industries in 21 developed countries from 1986 to 1999. Similarly, L' Her *et al*. (2002) suggest that country effects declined significantly during the nineties and global industry effects surpassed country effects in importance in 1999-2000. Wang *et al*.

(2003) use the Heston and Rouwenhorst (1994) methodology and their results indicate that industry effects have significantly dominated country effects in Asian markets since at least 1999. Flavin (2004) examines the relative benefits of industrial versus geographical diversification in the Euro zone before and after the introduction of the common currency. They also employ the empirical model of Heston and Rouwenhorst (1994), but adopting a panel data approach. They also find evidence of a shift in factor importance, from country to industry.

More recently, Brooks and Del Negro (2004) have updated the Heston and Rouwenhorst estimations using an enlarged sample. According to them, industry effects have increased since the mid-1990s and have outgrown country effects since 1999. However, they also find that, excluding the Technology, Media & Telecommunications (TMT) sectors at the heart of the stock market bubble, there is no evidence that industry effects have significantly outgrown country factors in importance. Obviously, this phenomenon could not be detected in previous studies where sample periods ended before 1998. Unlike most recent studies, which only covered the late nineties and early 2000's, the results presented in this paper also suggest that the importance of industry effects has declined gradually following the bursting of the TMT bubble. This new trend is also detected in more recent papers applying methodologies substantially different from that introduced by Heston and Rouwenhorst (1994). For instance, Sell (2005) employs an alternative methodology based on cluster analysis techniques. The groups indicate that companies clearly cluster by country rather than by sector and that this effect has become more pronounced over time.

Therefore it seems that earlier studies, with samples covering periods up to the late nineties, concluded that country effects dominated industry effects. More recent works, including in their samples both the late nineties and the early 2000's, showed that industry effects were gaining importance. And, finally, the most recent works, with samples covering the recovery from the TMT financial crisis, go back to the dominance of the country effects. This paper will analyse this trend on a particular way, changing from a country perspective into a regional one.

Obviously, the mixed empirical results in the literature might be due to the different methodologies used, the different countries and industry classification chosen and, surely, the different periods being analysed. In fact, the mixed results suggest that the importance of country and industry factors may have been changing over time.

Apart from evaluating the relative importance of regional and industry effects, it would be interesting for portfolio mangers and policy makers to know whether the same international linkages found in aggregate stock market indices exist at the industry level. This idea, which has not been included in earlier studies analysing country versus industry effects, could answer several important questions such as: How important are those linkages? Are regional industrial indices related through their second moments? Which industries present a higher level of international interaction?

To our knowledge, few studies have used volatility transmission analysis to better understand information flows within an industry. The issue of volatility transmission is extensively studied in the literature (see Booth *et al*. (1997), Bekaert and Harvey (1997), Kearney and Patton (2000) and Ng (2000), among others), but the major focus has been on either the linkages between stock markets of different countries or different types of markets within a given country. We propose to analyse volatility transmission within an industry across regions through a multivariate GARCH specification. Moreover, we use the asymmetric version of the BEKK model proposed by Engle and Kroner (1995)[2], which allows the entire variance-covariance structure of the model to respond in an asymmetric fashion to positive and negative shocks.

Arshanapalli *et al*. (1997) is one of the few studies that analyses relations within one industry across different regions. They use the common ARCH-feature testing methodology, developed by Engle and Kozicki (1993), to examine the issue of a common volatility process among asset prices of nine industry groups from three economic regions. It is found that industry-return series exhibit intra-industry common time-varying volatility process. The evidence is consistent with the view that world capital markets are related through their second moments implying that a world common time-varying variance specification seems to be appropriate in modelling asset prices. While their empirical evidence suggests that investors can form constant-variance portfolios by investing within an industry across regions, they suggest that investors would be better off if they invested across regions and industries rather than diversify within an industry across different geographical regions.

Therefore, this paper has two main objectives. First, it analyses the relative importance of regional versus industrial effects, as opposed to country versus industrial

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[2] The asymmetric BEKK model is also used by Kroner and Ng (1998), Brooks and Henry (2000), Isakov and Pérignon (2001) and Tai (2004), among others.

effects, using an enlarged sample (1995-2004) including the period after the bursting of the TMT bubble. Second, it analyses volatility transmission patterns in a particular industry across different regions.

We seek to contribute to the existing literature in several ways. To our knowledge, this paper is the first one to focus on specific regions rather than countries. This idea comes from Brooks and Del Negro (2005), who develop a new decomposition that disaggregates country effects into region effects and within-region country effects. They find that half the return variation typically attributed to country effects is actually due to region effects, a result robust across developed and emerging markets. Complementarily, it analyses volatility transmission, through multivariate GARCH models, using industrial indices. This analysis provides further information to portfolio managers willing to achieve optimal portfolio diversification. Other studies, such as Berben and Jansen (2005), have analysed linkages across countries within an industry but they focus their analysis in correlations. Another important difference to other studies is the use of daily data. The vast majority of empirical data uses weekly and monthly data, though portfolio managers are surely interested in the behaviour of daily returns. Finally, as it has already been pointed out, this paper uses a wide sample (1995-2004) that includes the bursting of the TMT bubble.

The remainder of this paper is organised as follows. Section 2 describes the data employed in the study. In section 3, the models used to compare region and industry effects and to analyse volatility spillovers are presented. Section 4 contains the empirical results and, finally, section 5 provides a brief summary and some concluding remarks.

2 Data

The data set consists of daily price indices in US dollars for 10 industry indices in 3 different regions (North America, European Union and Asia), all collected from Datastream International.

The *North America* region covers US and Canada. The *European Union* includes the 15 former EU members from 1995 to 2004 (Germany, Belgium, Denmark, Spain, Finland, France, Greece, Ireland, Italy, Luxembourg, Netherlands, Austria, Portugal, Sweden and United Kingdom) plus Cyprus, Czech Republic, Hungary and Poland. Finally, China, Sri Lanka, Hong Kong, Indonesia, India, Japan, Korea, Malaysia, Philippine, Pakistan, Singapore, Taiwan and Thailand, all are included in the *Asian* region.

We follow the broad distinction of ten economic industries according to the Level 3 of the FTSE Actuaries classification: Resources, Basic Industries, General Industrials, Cyclical Consumer Goods, Non-cyclical Consumer Goods, Cyclical Services, Non-cyclical Services, Utilities, Information Technology and Financials (see Table 1 for a more detailed description).

Datastream indices target 80% coverage of market capitalization and they provide the widest coverage of developed and emerging market equity returns. In the case of sectoral indices, each of them includes all domestic stocks that belong to that industry/sector. Market capitalization for each of the indices is also obtained form Datastream International.

The sample, from January 2, 1995 to December 31, 2004, includes 2610 observations per index. We have computed daily logarithms rates of returns from the price indices.

Finally, the whole sample is divided into three sub-periods in order to better isolate the internet bubble and the TMT financial crisis. A graphical analysis of the time series of the Information Technology (IT), Cyclical and Non-cyclical Services industries, in the three regions, pointed at the period from 1998 to 2001 to account for that particular crisis (Figure 1). In particular, from 1998 to the first quarter of 2000 these industrial indices experienced an important increase and, after then, the bursting of the TMT bubble produced a sharp decrease in these indices. From the beginning of 2002, the TMT related industries started their slow recovery.

3 Methodology

3.1 Region versus industry effects

First of all, we will analyse the relative importance of region and industry effects. In this paper, we use the dummy variable approach (introduced by Heston and Rouwenhorst (1994) and extended by Griffin and Karolyi (1998)) that assumes that the return on a given index in a given industry varies due to a common factor (α), a global industry factor (β), a country factor (γ) and a residual index-specific disturbance (ε). In our case, the return of an index *i* of industry *j* and region *k* at time *t* is given by:

$$R_{i,t} = \alpha_t + \beta_{j,t} + \gamma_{k,t} + \varepsilon_{i,t} \quad (1)$$

We estimate the following equation daily for each region and industry index:

$$R_i = \alpha + \beta_1 I_{i1} + \beta_2 I_{i2} + \ldots + \beta_{10} I_{i10} + \gamma_{NA} RG_{iNA} + \gamma_{EU} RG_{iEU} + \gamma_{AS} RG_{iAS} + \varepsilon_i \quad (2)$$

where I_{ij} is a dummy variable that equals one if the index belongs to industry *j* and zero otherwise, and RG_{ik} is a similar dummy variable that identifies region affiliation. There are *J=10* industries and *K=3* regions in total.

Since each return belongs to both one region and one industry, there is an identification problem if dummy variables are defined for every region and industry. To avoid the interpretation problem of an arbitrary benchmark, we can impose the constraint that, for value weighted portfolios, the sum of the industry coefficients equals zero and the sum of the region coefficients equals zero. We estimate Eq. (2) cross-sectionally for the 10 industry groupings (*I*) in each of the 3 regions (*RG*) subject to the following restrictions:

$$\sum_{j=1}^{10} w_j \beta_j = 0 \quad (3a)$$

$$\sum_{k=1}^{3} v_k \gamma_k = 0 \quad (3b)$$

where w_j and v_k denote the value weights of industry *j* and region *k* in the world market portfolio. The least-squares estimate of the intercept in Eq. (2) can then represent the return on the value-weighted world market portfolio.

Weighted least squares (WLS) estimates for Eq. (2) are computed each day subject to the restrictions in Eqs. (3a) and (3b). The daily cross-sectional regressions yield a time series of the intercept and the region and industry coefficients. We interpret the estimated beta coefficient ($\hat{\beta}$) as the estimated 'pure' industry effect relative to the value-weighted world market portfolio, and the estimated gamma ($\hat{\gamma}$) as the estimated 'pure' region effect relative to the value-weighted world market portfolio. The time series of these coefficients reveals whether region or industry effects have greater variation.

We follow the literature in computing the estimated variances of the industry and region effects. From Eq. (2), the excess returns over the benchmark world portfolio can be decomposed into the weighted sum of industry and region effects. The higher the variance of industry (region) effects, the higher the proportion of the variability in excess returns explained by industry (region) factors. More intuitively, if the variability of industry effects is higher than that of region effects, more risk reduction will be achieved by diversifying across industries than by diversifying across regions.

3.2 Volatility transmission

The econometric model used to analyse interrelations within an industry across different regions has to parts: the mean equation and the variance-covariance equation.

Equation (4) models the index returns in a particular industry *i* as a VAR(1) process[3]:

$$\begin{bmatrix} R_{NA,t} \\ R_{EU,t} \\ R_{AS,t} \end{bmatrix} = \begin{bmatrix} \mu_{NA} \\ \mu_{EU} \\ \mu_{AS} \end{bmatrix} + \begin{bmatrix} d_{11} & d_{12} & d_{13} \\ d_{21} & d_{22} & d_{23} \\ d_{31} & d_{32} & d_{33} \end{bmatrix} \begin{bmatrix} R_{NA,t-1} \\ R_{EU,t-1} \\ R_{AS,t-1} \end{bmatrix} + \begin{bmatrix} \varepsilon_{NA,t} \\ \varepsilon_{EU,t} \\ \varepsilon_{AS,t} \end{bmatrix} \quad (4)$$

where R_t is the vector of daily returns in the three regions at time *t*, μ is a vector of constants, ε_t is a vector of innovations and D is a 3x3 matrix of parameters.

From the mean equation we get the residuals that will be used as input in the variance-covariance equation.

Numerous evidence indicates that stock returns exhibit ARCH effects and that international stock markets are related both at the mean and the variance level. It is reasonable to assume that the same characteristics could hold for industry-level data. We therefore employ a *Generalised Autorregressive Conditional Heteroskedasticity* (GARCH) model to analyse volatility transmission patterns within a particular industry in different regions.

As we are interested in the interrelationship between different industrial indices, a multivariate GARCH framework is necessary. Different multivariate GARCH specifications have been proposed in the literature. The four multivariate GARCH

[3] Lag order selection is based on the AIC criterion.

models mostly used in the literature are the VECH, Diagonal, Constant Conditional Correlation (CCC) and BEKK models. Each one of them imposes different restrictions in the conditional variance. In the VECH model (Bollerslev *et al*. (1988)), certain restrictions must be accomplished in order to assure a positive definite variance-covariance matrix. The Diagonal representation (Bollerslev *et al*. (1988)) reduces the number of parameters to be estimated, but it also removes the potential interactions in the variances of different markets. Bollerslev (1990) proposes a model with constant correlations between markets. However, different studies (see, Longin and Solnik (1995)) have shown that this assumption is violated in international markets. Finally, the BEKK model (Engle and Kroner (1995)) is the specification that best fits our objectives. The main advantage of this specification is that it reduces significantly the number of parameters to be estimated without imposing strong constraints on the shape of the interaction between markets. Moreover, it guarantees that the variance-covariance matrix will be positive definite.

In the BEKK specification, an asymmetry term can be easily introduced. The most common case of volatility asymmetry in stock markets is the negative one, where unexpected falls in prices cause greater volatility than unexpected increases in prices of the same amount. The importance of modelling the asymmetric effect comes from the need of obtaining better model fits. As suggested by several authors, conclusions obtained from volatility transmission models could be erroneous when asymmetries are not modelled (Susmel and Engle (1994) and Bae and Karolyi (1994)).

Therefore, our variance-covariance matrix will follow the BEKK model proposed by Engle and Kroner (1995) and, following Glosten *et al*. (1993), we will capture asymmetry in the variance-covariance structure using a threshold term in the variance. The whole compacted model is written as follows:

$$H_t = C'C + A'\varepsilon_{t-1}\varepsilon_{t-1}^{'}A + B'H_{t-1}B + G'\eta_{t-1}\eta_{t-1}^{'}G \qquad (5)$$

where C, A, B and G are 3x3 matrices of parameters, being C upper triangular, H_t is the 3x3 conditional variance-covariance matrix, ε_t is a 3x1 vector containing the unexpected shocks obtained from equation (4) and η_t is a 3x1 vector containing the threshold terms, where $\eta_{kt} = \max[0, -\varepsilon_{kt}]$ and $k = NA, EU, AS$. This asymmetric BEKK specification requires estimation of 33 parameters.

4 Empirical Results

4.1 Region versus industry effects

First, to determine the relative importance of region and industry effects, we examine the amount of variation explained by the time series of estimated region and industry coefficients. Thus, we computed variance for the pure region and industry effect over time. Table 2 shows the results for the full sample period, from January 1995 to December 2004, and for the sub-periods analysed.

The pure region effects indicate that Asia exhibited the most variation in all periods. This result suggests that Asia is the market most segmented from the other markets and, conversely, North America and the European Union are closer to each other. The Asian region includes several emerging markets, and country effects in these markets are on average much more variable than in mature markets (see Brooks and Del Negro (2004)). On the other hand, North America exhibited the least variation in all periods. This is not surprising since the region is composed by only two mature markets (US and Canada).

The resources industry has the largest variance of pure industry effects. In fact, resources, information technology and utilities account for three of the largest variances shown in Table 2 in all the periods analysed. This is consistent with the findings of Heckman *et al*. (2001), who undertook a study on the relative importance of countries and industries in determining European company returns for the period 1989 to 2000. At the sector level, technology, energy, telecommunication services, utilities, and financial conglomerates were found to have the largest industry effects. Similarly, Ferreira and Ferreira (2005) found the largest variances in the resources and information technology industries in their study of the EMU equity markets.

When we compare the average variance of the region effects to the average variance of the industry effects, we find a ratio of approximately 1:1 when we analyse the full sample period. Region effects are more important at the beginning (1995-1997) and at the end (2002-2004) of the total period. However, in the middle of the sample the importance of industry effects rises dramatically and surpasses that of region effects: for the 1998-2001 period the ratio of country to industry variances is about 3:4. Brooks and Del Negro (2004) find a similar result using the same sub-sample, though they report a ratio of 1:2. Therefore, the sub-periods analysis suggests that, although industry effects dominated region effects during the TMT financial crisis, region effects continue to be the most important determinant of variation in international returns. In fact, in the most current sub-period, the ratio of region effects to industry effects is about 2:1.

4.2 Volatility transmission

In order to analyse volatility transmission patterns *within* an industry *across* regions, the trivariate model in equations (4) and (5) is estimated for each of the 10 industries, following a two-step procedure[4]. First, the VAR(1) model is estimated by Ordinary Least Squares (OLS) applied equation by equation. Second, the Bollerslev and Wooldridge (1992) Quasi-Maximum Likelihood (QML) estimator is used to obtain robust estimates of the asymmetric BEKK model. Estimation results for each of the ten industries can be found in Table 3. This table reports estimated parameters for the mean equation and for the variance-covariance matrix, using the full sample period, from January 1995 to December 2004.

The residual diagnostics in Table 4 indicate that the VAR(1) - asymmetric BEKK model obtains a good fit in all industries analysed. In general, the Ljung–Box Q statistics show no evidence of autocorrelation in the standardised residuals and squared residuals. Given that 26 of the 30 conditional expected return equations provide an adequate description of the data, we can conclude that the conditional mean and variance return equations are correctly specified.

The analysis of coefficient significance in the mean equation appears to support the hypothesis that events in North America cause events in the European Union and Asia, with evidence of feedback only in a couple of industries. The same conclusion applies to mean spillovers from the European Union to Asia.

The significance of the off-diagonal elements in A, B and G is also suggestive of spillovers in variance, more or less important depending on the industry being analysed. In particular, the almost general significance of the parameters in the G matrix suggests that the volatility spillovers depend not only on the size, but also on the sign of the innovations in returns. Thus, there exist asymmetric effects in the volatility transmission patterns analysed.

The significance of the off-diagonal elements in A and B also suggests that Asia is

[4] See Engle and Ng (1993) and Kroner and Ng (1998).

the market relatively most isolated from the other markets, with 1/5 of the off-diagonal estimated parameters non significant. This ratio is lower in the case of the European Union and North America. Similarly, Berben and Jansen (2005), who analyse correlations in US, UK and Japan, find that correlations with respect to Japan are low, suggesting that the Asian market is comparatively disconnected from the others. In contrast, the US and UK markets exhibit a much higher degree of comovement.

In general, in all industries, the diagonal transmission coefficients in A and B are statistically significant, giving evidence of the existence of own GARCH effects in the data. Moreover, the coefficient b_{21} is also significant in all industries (except for the IT industry), suggesting an impact of the lagged variance of the European Union on the North American variance and covariance[5]. The industries with more interaction between their second moments are Basic Industries and General Industrials. In contrast, the Information Technology industry is the less affected by other international markets. These results are also in accordance with the evidence found in Berben and Jansen (2005) when analysing correlations within an industry across countries.

In particular, the results for the Information Technology industry (Table 3, Panel I) indicate that volatility in each region is only affected by own past volatilities. Only a shock originated in the North American region affects volatility in the Asian region. As suggested by Berben and Jansen (2005), the combination of low correlation, high volatility and low degree of international interdependence, could indicate that it is region or country-specific industry shocks that drive the returns of IT shocks.

5 Conclusion

This paper has two main objectives. First, it analyses the relative importance of regional versus industrial effects, as opposed to the extensively analysed in the literature country versus industrial effects, using a wide sample including the period after the bursting of the TMT bubble. Second, it analyses volatility transmission patterns in a particular industry across different regions. This analysis completes the information needed by portfolio managers when deciding in which regions and which industries to invest in order to diversify risks.

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[5] This could be simply caused by the *non-overlapping problem* associated with the use of daily data returns. The three regional markets have different trading hours which are partially overlapped. The Asian market is the first to close, followed by the European Union and North America.

The results confirm the overall dominance of regional effects over industry effects. Although our findings over the whole sample time period suggest that both effects have been relatively similar in importance when determining equity returns, the pattern reveals an increasing relative importance of industrial effects only in periods of sectoral booms. In fact, the sub-periods analysis suggests that, although industry effects dominated region effects during the TMT financial crisis, region effects continue to be the most important determinant of variation in international returns. As Brooks and Del Negro (2004), we see this evidence as suggestive that the rise in industry effects was a temporary phenomenon associated with the TMT bubble. The implications of our research for investors is that, once the TMT financial crisis is over, the traditional strategy of diversifying across countries or regions rather than industries may still be adequate in terms of reducing portfolio risk.

Complementarily, in the volatility transmission analysis, the results are suggestive of spillovers *within* an industry *across* international regions, more or less important depending on the industry being analysed. The industries with more interaction between their second moments are Basic Industries and General Industrials. In contrast, the Information Technology industry is the less affected by other international markets. This again suggests that ignoring location aspects in the diversification strategy could be erroneous.

Finally, this paper could be extended in a number of ways. A complementary study of correlations and impulse-response functions could be added in the mean analysis. Also as a complement, volatility spillovers across industries or sectors within a particular region could be analysed. Lastly, further research should be devoted to check the robustness of the evidence suggesting that the IT industry is the less affected by other international markets. This could be done by estimating the same multivariate GARCH model in the different sub-samples and comparing the results to the ones obtained in the full sample period.

Table 1: FTSE Actuaries classification

BASIC INDUSTRIES	Chemicals Construction & Building Materials Forestry & Paper Steel & Other Metals
CYCLICAL CONSUMER GOODS	Automobiles & Parts Household Goods & Textiles
CYCLICAL SERVICES	General Retailers Leisure & Hotels Media & Entertainment Support Services Transport
FINANCIALS	Banks Insurance Life Assurance Investment Companies Real Estate Speciality & Other Finance
GENERAL INDUSTRIALS	Aerospace & Defence Diversified Industrials Electronic & Electrical Equipment Engineering & Machinery
INFORMATION TECHNOLOGY	Information Tech Hardware Software & Computer Services
NON-CYCLICAL CONSUMER GOODS	Beverages Food Producers & Processors Health Personal Care & Household Products Pharmaceuticals & Biotechnology Tobacco
NON-CYCLICAL SERVICES	Food & Drug Retailers Telecommunication Services
RESOURCES	Mining Oil & Gas
UTILITIES	Electricity Gas Distribution Water

Table 2: Region/Industry effects variances

The table reports the variance of region and industry components for the value-weighted region and industry returns using the Heston and Rouwenhorst (1994) procedure. The full sample period has 2610 daily observations from January 1995 to December 2004. The table also reports the ratio of region to industry effects. The returns are in US dollars and defined in percentages per day.

Region/Industry	Total	Sub-periods		
	1995-2004	1995-1997	1998-2001 TMT crisis	2002-2004
North America	0.0799	0.0229	0.1448	0.0505
European Union	0.4128	0.2409	0.5295	0.4307
Asia	0.9709	0.5051	1.3004	0.9955
Resources	2.3446	0.6692	4.7585	0.8072
Basic Industries	0.2150	0.0554	0.4140	0.1075
General Industrials	0.0918	0.0330	0.1295	0.1008
Cyclical Consumer Goods	0.2411	0.0994	0.4062	0.1632
Non-cyclical Consumer Goods	0.2846	0.0525	0.5197	0.2046
Cyclical Services	0.0731	0.0341	0.1205	0.0493
Non-cyclical Services	0.2649	0.1055	0.4163	0.2237
Utilities	0.3840	0.1235	0.6353	0.3113
Information Technology	0.8230	0.3469	1.2693	0.7050
Financials	0.1246	0.0506	0.2322	0.0555
Region Average	0.4879	0.2563	0.6582	0.4922
Industry Average	0.4847	0.1570	0.8902	0.2728
Region/Industry Ratio	1.0066	1.6322	0.7395	1.8043

Table 3: Estimation results for the VAR(1) - asymmetric BEKK model

This table shows the estimation of the model defined in equations (4) and (5) for the 10 industries considered. P-values appear in brackets. In all cases, the necessary conditions for the stationarity of the process are satisfied.

Panel (A). Resources			
	$R_{NA,t}$	$R_{EU,t}$	$R_{AS,t}$
μ	0.0409 (0.098)	0.0288 (0.210)	-0.0083 (0.715)
$R_{NA,t-1}$	0.0443 (0.043)	0.4218 (0.000)	0.0721 (0.000)
$R_{EU,t-1}$	-0.0240 (0.275)	-0.1421 (0.000)	0.0815 (0.000)
$R_{AS,t-1}$	0.0395 (0.062)	-0.0037 (0.848)	0.0765 (0.000)

$$\hat{C} = \begin{bmatrix} \underset{(0.000)}{0.8405} & \underset{(0.000)}{-0.1323} & \underset{(0.779)}{-0.0214} \\ \underset{(0.000)}{0} & \underset{(0.000)}{0.1079} & \underset{(0.000)}{0.2687} \\ \underset{(0.000)}{0} & \underset{(0.000)}{0} & \underset{(0.999)}{-0.0001} \end{bmatrix} \quad \hat{B} = \begin{bmatrix} \underset{(0.000)}{-0.2494} & \underset{(0.004)}{-0.0469} & \underset{(0.942)}{0.0009} \\ \underset{(0.000)}{-0.4865} & \underset{(0.000)}{-0.9410} & \underset{(0.335)}{-0.0494} \\ \underset{(0.004)}{0.1869} & \underset{(0.000)}{0.1941} & \underset{(0.000)}{0.9301} \end{bmatrix}$$

$$\hat{A} = \begin{bmatrix} \underset{(0.000)}{0.1802} & \underset{(0.006)}{-0.0731} & \underset{(0.001)}{-0.0757} \\ \underset{(0.000)}{-0.1810} & \underset{(0.000)}{0.2360} & \underset{(0.108)}{0.0373} \\ \underset{(0.028)}{0.0771} & \underset{(0.361)}{-0.0136} & \underset{(0.000)}{-0.2166} \end{bmatrix} \quad \hat{G} = \begin{bmatrix} \underset{(0.000)}{0.4282} & \underset{(0.010)}{0.0741} & \underset{(0.810)}{0.0091} \\ \underset{(0.012)}{-0.1359} & \underset{(0.027)}{0.1019} & \underset{(0.647)}{0.0159} \\ \underset{(0.557)}{0.0324} & \underset{(0.615)}{0.0143} & \underset{(0.000)}{0.2738} \end{bmatrix}$$

Panel (B). Basic Industries

	$R_{NA,t}$	$R_{EU,t}$	$R_{AS,t}$
μ	0.0416 (0.148)	0.0124 (0.575)	-0.0549 (0.144)
$R_{NA,t-1}$	0.1550 (0.000)	0.3021 (0.000)	0.2278 (0.000)
$R_{EU,t-1}$	0.0018 (0.963)	-0.0389 (0.217)	0.0211 (0.692)
$R_{AS,t-1}$	0.0343 (0.150)	-0.0261 (0.155)	0.1096 (0.000)

$$\hat{C} = \begin{bmatrix} \underset{(0.000)}{0.6275} & \underset{(0.000)}{-0.2029} & \underset{(0.000)}{-0.0997} \\ \underset{(0.000)}{0} & \underset{(0.000)}{0.1340} & \underset{(0.000)}{0.0633} \\ \underset{(0.000)}{0} & \underset{(0.000)}{0} & \underset{(0.227)}{0.0355} \end{bmatrix} \quad \hat{B} = \begin{bmatrix} \underset{(0.000)}{-0.3001} & \underset{(0.000)}{-0.0816} & \underset{(0.000)}{-0.1335} \\ \underset{(0.000)}{-0.4857} & \underset{(0.000)}{-0.8359} & \underset{(0.000)}{0.1694} \\ \underset{(0.004)}{-0.0236} & \underset{(0.000)}{-0.0228} & \underset{(0.000)}{-0.9702} \end{bmatrix}$$

$$\hat{A} = \begin{bmatrix} \underset{(0.000)}{0.2163} & \underset{(0.000)}{0.0928} & \underset{(0.000)}{0.1188} \\ \underset{(0.000)}{0.2771} & \underset{(0.000)}{0.2344} & \underset{(0.092)}{0.0325} \\ \underset{(0.000)}{0.1009} & \underset{(0.000)}{-0.0622} & \underset{(0.000)}{0.0846} \end{bmatrix} \quad \hat{G} = \begin{bmatrix} \underset{(0.000)}{0.1416} & \underset{(0.000)}{0.0965} & \underset{(0.018)}{-0.0626} \\ \underset{(0.000)}{0.2678} & \underset{(0.000)}{-0.1142} & \underset{(0.000)}{-0.1559} \\ \underset{(0.000)}{-0.1910} & \underset{(0.008)}{0.0302} & \underset{(0.000)}{0.3525} \end{bmatrix}$$

Panel (C). General Industrials

	$R_{NA,t}$	$R_{EU,t}$	$R_{AS,t}$
μ	0.0457 (0.074)	0.0173 (0.400)	-0.0139 (0.542)
$R_{NA,t-1}$	0.0230 (0.282)	0.2710 (0.000)	0.2944 (0.000)
$R_{EU,t-1}$	0.0510 (0.057)	0.0051 (0.812)	0.2072 (0.000)
$R_{AS,t-1}$	-0.0526 (0.014)	-0.0250 (0.149)	-0.0185 (0.332)

$$\hat{C} = \begin{bmatrix} \underset{(0.000)}{0.7447} & \underset{(0.000)}{-0.2932} & \underset{(0.000)}{-0.1926} \\ \underset{(0.000)}{0} & \underset{(0.999)}{-0.0001} & \underset{(0.999)}{-0.0001} \\ \underset{(0.000)}{0} & \underset{(0.000)}{0} & \underset{(0.999)}{0.0000} \end{bmatrix} \quad \hat{B} = \begin{bmatrix} \underset{(0.000)}{0.1911} & \underset{(0.000)}{-0.0775} & \underset{(0.051)}{0.0324} \\ \underset{(0.000)}{0.4534} & \underset{(0.000)}{0.5909} & \underset{(0.000)}{0.0633} \\ \underset{(0.004)}{-0.6332} & \underset{(0.000)}{-0.7547} & \underset{(0.004)}{0.0894} \end{bmatrix}$$

$$\hat{A} = \begin{bmatrix} \underset{(0.000)}{-0.1798} & \underset{(0.001)}{0.0672} & \underset{(0.001)}{0.0894} \\ \underset{(0.000)}{0.3111} & \underset{(0.004)}{-0.1084} & \underset{(0.000)}{0.1451} \\ \underset{(0.045)}{-0.1106} & \underset{(0.000)}{0.1177} & \underset{(0.000)}{0.1052} \end{bmatrix} \quad \hat{G} = \begin{bmatrix} \underset{(0.000)}{0.3060} & \underset{(0.151)}{0.0507} & \underset{(0.000)}{0.1299} \\ \underset{(0.000)}{0.3107} & \underset{(0.000)}{0.2238} & \underset{(0.316)}{0.0658} \\ \underset{(0.208)}{-0.1166} & \underset{(0.004)}{0.0706} & \underset{(0.000)}{0.1358} \end{bmatrix}$$

Panel (D). Cyclical Consumer Goods

	$R_{NA,t}$	$R_{EU,t}$	$R_{AS,t}$
μ	0.0233 (0.343)	0.0142 (0.526)	0.0040 (0.881)
$R_{NA,t-1}$	-0.0094 (0.659)	0.2596 (0.000)	0.2072 (0.000)
$R_{EU,t-1}$	0.0303 (0.191)	0.0259 (0.220)	0.2113 (0.000)
$R_{AS,t-1}$	-0.0319 (0.071)	-0.0378 (0.019)	-0.0919 (0.000)

$$\hat{C} = \begin{bmatrix} \underset{(0.000)}{0.7764} & \underset{(0.000)}{-0.2420} & \underset{(0.037)}{-0.1244} \\ \underset{(0.000)}{0} & \underset{(0.847)}{-0.0085} & \underset{(0.000)}{0.2014} \\ \underset{(0.000)}{0} & \underset{(0.000)}{0} & \underset{(0.999)}{0} \end{bmatrix} \quad \hat{B} = \begin{bmatrix} \underset{(0.000)}{0.1755} & \underset{(0.000)}{-0.0957} & \underset{(0.915)}{-0.0026} \\ \underset{(0.000)}{-0.6526} & \underset{(0.000)}{-0.8767} & \underset{(0.769)}{0.0050} \\ \underset{(0.009)}{-0.0914} & \underset{(0.066)}{0.0182} & \underset{(0.004)}{-0.9419} \end{bmatrix}$$

$$\hat{A} = \begin{bmatrix} \underset{(0.000)}{0.2788} & \underset{(0.030)}{0.0672} & \underset{(0.246)}{-0.0282} \\ \underset{(0.053)}{0.0780} & \underset{(0.000)}{0.2553} & \underset{(0.011)}{0.1056} \\ \underset{(0.030)}{-0.1216} & \underset{(0.180)}{-0.0226} & \underset{(0.000)}{0.2149} \end{bmatrix} \quad \hat{G} = \begin{bmatrix} \underset{(0.859)}{-0.0124} & \underset{(0.000)}{0.1619} & \underset{(0.414)}{-0.0448} \\ \underset{(0.000)}{-0.3771} & \underset{(0.306)}{-0.0753} & \underset{(0.000)}{0.3131} \\ \underset{(0.000)}{-0.1966} & \underset{(0.000)}{-0.1289} & \underset{(0.000)}{-0.1755} \end{bmatrix}$$

Panel (E). Non-cyclical Consumer Goods

	$R_{NA,t}$	$R_{EU,t}$	$R_{AS,t}$
μ	0.0409 (0.051)	0.0262 (0.137)	-0.0036 (0.851)
$R_{NA,t-1}$	0.0299 (0.149)	0.3099 (0.000)	0.1186 (0.000)
$R_{EU,t-1}$	0.0139 (0.553)	-0.0437 (0.028)	0.1539 (0.000)
$R_{AS,t-1}$	-0.0343 (0.102)	-0.0421 (0.017)	-0.0475 (0.014)

$$\hat{C} = \begin{bmatrix} \underset{(0.000)}{-0.6903} & \underset{(0.014)}{0.0657} & \underset{(0.314)}{-0.0345} \\ \underset{(0.000)}{0} & \underset{(0.660)}{-0.0162} & \underset{(0.154)}{0.0611} \\ \underset{(0.000)}{0} & \underset{(0.000)}{0} & \underset{(0.999)}{0} \end{bmatrix} \quad \hat{B} = \begin{bmatrix} \underset{(0.000)}{0.2828} & \underset{(0.648)}{0.0097} & \underset{(0.981)}{0.0007} \\ \underset{(0.000)}{0.2846} & \underset{(0.000)}{0.9620} & \underset{(0.083)}{0.0346} \\ \underset{(0.009)}{-0.1260} & \underset{(0.006)}{-0.0271} & \underset{(0.000)}{0.9491} \end{bmatrix}$$

$$\hat{A} = \begin{bmatrix} \underset{(0.108)}{0.1196} & \underset{(0.472)}{-0.0199} & \underset{(0.403)}{0.0256} \\ \underset{(0.000)}{0.4036} & \underset{(0.000)}{0.2230} & \underset{(0.251)}{0.0551} \\ \underset{(0.701)}{0.0286} & \underset{(0.530)}{-0.0234} & \underset{(0.000)}{0.2246} \end{bmatrix} \quad \hat{G} = \begin{bmatrix} \underset{(0.000)}{-0.3763} & \underset{(0.342)}{0.0416} & \underset{(0.752)}{-0.0125} \\ \underset{(0.497)}{0.0732} & \underset{(0.007)}{0.1781} & \underset{(0.000)}{0.3794} \\ \underset{(0.000)}{-0.3041} & \underset{(0.000)}{-0.2004} & \underset{(0.022)}{-0.1312} \end{bmatrix}$$

Panel (F). Cyclical Services			
	$R_{NA,t}$	$R_{EU,t}$	$R_{AS,t}$
μ	0.0367 (0.130)	0.0138 (0.416)	-0.0176 (0.421)
$R_{NA,t-1}$	0.0771 (0.000)	0.2597 (0.000)	0.1651 (0.000)
$R_{EU,t-1}$	-0.0179 (0.532)	0.0417 (0.039)	0.1646 (0.000)
$R_{AS,t-1}$	-0.0351 (0.108)	-0.0409 (0.007)	-0.0012 (0.950)

$$\hat{C}=\begin{bmatrix} \underset{(0.000)}{0.7656} & \underset{(0.014)}{-0.2290} & \underset{(0.000)}{-0.1503} \\ \underset{(0.000)}{0} & \underset{(0.144)}{0.0557} & \underset{(0.000)}{-0.1338} \\ \underset{(0.000)}{0} & \underset{(0.000)}{0} & \underset{(0.999)}{0} \end{bmatrix} \quad \hat{B}=\begin{bmatrix} \underset{(0.000)}{0.1581} & \underset{(0.000)}{0.0701} & \underset{(0.766)}{0.0039} \\ \underset{(0.000)}{0.6664} & \underset{(0.000)}{0.8797} & \underset{(0.395)}{0.0115} \\ \underset{(0.130)}{0.0604} & \underset{(0.002)}{-0.0258} & \underset{(0.000)}{0.9299} \end{bmatrix}$$

$$\hat{A}=\begin{bmatrix} \underset{(0.000)}{0.2430} & \underset{(0.005)}{-0.0521} & \underset{(0.398)}{0.0187} \\ \underset{(0.006)}{-0.2046} & \underset{(0.000)}{0.1670} & \underset{(0.000)}{-0.1215} \\ \underset{(0.112)}{0.0698} & \underset{(0.000)}{-0.1084} & \underset{(0.000)}{-0.2284} \end{bmatrix} \quad \hat{G}=\begin{bmatrix} \underset{(0.000)}{-0.4010} & \underset{(0.000)}{-0.0943} & \underset{(0.007)}{-0.0853} \\ \underset{(0.000)}{-0.4960} & \underset{(0.007)}{-0.1910} & \underset{(0.005)}{0.1501} \\ \underset{(0.000)}{0.1978} & \underset{(0.348)}{0.0198} & \underset{(0.000)}{-0.2502} \end{bmatrix}$$

Panel (G). Non-cyclical Services			
	$R_{NA,t}$	$R_{EU,t}$	$R_{AS,t}$
μ	0.0170 (0.500)	0.0285 (0.300)	-0.0180 (0.545)
$R_{NA,t-1}$	-0.0255 (0.224)	0.2311 (0.000)	0.2429 (0.000)
$R_{EU,t-1}$	0.0548 (0.004)	0.0365 (0.080)	0.2316 (0.000)
$R_{AS,t-1}$	0.0010 (0.949)	-0.0710 (0.000)	0.0377 (0.045)

$$\hat{C}=\begin{bmatrix} \underset{(0.000)}{0.9038} & \underset{(0.000)}{-0.1053} & \underset{(0.518)}{-0.0220} \\ \underset{(0.000)}{0} & \underset{(0.000)}{-0.0727} & \underset{(0.000)}{0.1682} \\ \underset{(0.000)}{0} & \underset{(0.000)}{0} & \underset{(0.875)}{0.0158} \end{bmatrix} \quad \hat{B}=\begin{bmatrix} \underset{(0.000)}{-0.2869} & \underset{(0.000)}{0.0605} & \underset{(0.961)}{0.0010} \\ \underset{(0.000)}{0.5267} & \underset{(0.000)}{0.9306} & \underset{(0.009)}{-0.0238} \\ \underset{(0.000)}{-0.1090} & \underset{(0.000)}{-0.3207} & \underset{(0.000)}{-0.9450} \end{bmatrix}$$

$$\hat{A}=\begin{bmatrix} \underset{(0.000)}{-0.1674} & \underset{(0.002)}{0.0573} & \underset{(0.300)}{-0.0261} \\ \underset{(0.000)}{-0.0778} & \underset{(0.000)}{0.1649} & \underset{(0.089)}{-0.0396} \\ \underset{(0.021)}{0.0591} & \underset{(0.06)}{-0.0222} & \underset{(0.000)}{-0.2306} \end{bmatrix} \quad \hat{G}=\begin{bmatrix} \underset{(0.000)}{-0.1421} & \underset{(0.000)}{0.1046} & \underset{(0.000)}{0.1073} \\ \underset{(0.000)}{-0.1161} & \underset{(0.000)}{-0.2631} & \underset{(0.004)}{0.1012} \\ \underset{(0.000)}{-0.1449} & \underset{(0.148)}{-0.0264} & \underset{(0.000)}{-0.2832} \end{bmatrix}$$

Panel (H). Utilities			
	$R_{NA,t}$	$R_{EU,t}$	$R_{AS,t}$
μ	0.0164 (0.400)	0.0328 (0.032)	-0.0051 (0.765)
$R_{NA,t-1}$	0.0667 (0.00)	0.0748 (0.00)	0.0473 (0.006)
$R_{EU,t-1}$	0.0114 (0.653)	0.0496 (0.013)	0.1004 (0.00)
$R_{AS,t-1}$	-0.0519 (0.021)	-0.0470 (0.007)	0.0100 (0.609)

$$\hat{C} = \begin{bmatrix} \underset{(0.063)}{-0.1589} & \underset{(0.000)}{-0.6490} & \underset{(0.498)}{-0.0422} \\ \underset{(0.000)}{0} & \underset{(0.776)}{0.1324} & \underset{(0.088)}{-0.0753} \\ \underset{(0.000)}{0} & \underset{(0.000)}{0} & \underset{(0.999)}{0} \end{bmatrix} \quad \hat{B} = \begin{bmatrix} \underset{(0.039)}{0.0621} & \underset{(0.000)}{0.1890} & \underset{(0.636)}{-0.0047} \\ \underset{(0.000)}{-0.0060} & \underset{(0.539)}{0.0559} & \underset{(0.037)}{-0.0874} \\ \underset{(0.000)}{0.2030} & \underset{(0.000)}{-0.1608} & \underset{(0.000)}{0.9379} \end{bmatrix}$$

$$\hat{A} = \begin{bmatrix} \underset{(0.000)}{0.4341} & \underset{(0.000)}{0.1305} & \underset{(0.808)}{0.0036} \\ \underset{(0.042)}{-0.0762} & \underset{(0.000)}{0.1764} & \underset{(0.945)}{-0.0015} \\ \underset{(0.517)}{-0.0212} & \underset{(0.034)}{-0.0564} & \underset{(0.000)}{0.2462} \end{bmatrix} \quad \hat{G} = \begin{bmatrix} \underset{(0.000)}{0.2849} & \underset{(0.000)}{-0.2941} & \underset{(0.013)}{0.0580} \\ \underset{(0.000)}{0.3829} & \underset{(0.000)}{0.4746} & \underset{(0.728)}{0.0165} \\ \underset{(0.101)}{-0.0873} & \underset{(0.000)}{-0.1554} & \underset{(0.000)}{-0.2212} \end{bmatrix}$$

Panel (I). Information Technology			
	$R_{NA,t}$	$R_{EU,t}$	$R_{AS,t}$
μ	0.0436 (0.299)	0.0304 (0.431)	-0.0097 (0.749)
$R_{NA,t-1}$	0.0023 (0.913)	0.4385 (0.000)	0.2767 (0.000)
$R_{EU,t-1}$	0.0294 (0.186)	-0.0693 (0.000)	0.1377 (0.000)
$R_{AS,t-1}$	-0.0206 (0.410)	-0.0955 (0.000)	0.0918 (0.000)

$$\hat{C} = \begin{bmatrix} \underset{(0.000)}{0.7856} & \underset{(0.355)}{0.1265} & \underset{(0.963)}{0.0047} \\ \underset{(0.000)}{0} & \underset{(0.000)}{0.3614} & \underset{(0.769)}{0.0223} \\ \underset{(0.000)}{0} & \underset{(0.000)}{0} & \underset{(0.000)}{-0.2722} \end{bmatrix} \quad \hat{B} = \begin{bmatrix} \underset{(0.000)}{-0.1894} & \underset{(0.063)}{0.0320} & \underset{(0.294)}{-0.0251} \\ \underset{(0.776)}{-0.0447} & \underset{(0.000)}{-0.9019} & \underset{(0.954)}{0.0013} \\ \underset{(0.910)}{-0.0130} & \underset{(0.471)}{0.0190} & \underset{(0.000)}{-0.9101} \end{bmatrix}$$

$$\hat{A} = \begin{bmatrix} \underset{(0.010)}{0.1678} & \underset{(0.138)}{-0.0593} & \underset{(0.000)}{-0.1129} \\ \underset{(0.147)}{-0.1089} & \underset{(0.000)}{-0.2098} & \underset{(0.144)}{-0.0487} \\ \underset{(0.438)}{-0.0540} & \underset{(0.483)}{-0.0314} & \underset{(0.000)}{-0.2936} \end{bmatrix} \quad \hat{G} = \begin{bmatrix} \underset{(0.000)}{-0.3310} & \underset{(0.397)}{0.0516} & \underset{(0.037)}{-0.1185} \\ \underset{(0.000)}{-0.5031} & \underset{(0.000)}{-0.3530} & \underset{(0.426)}{0.0478} \\ \underset{(0.023)}{0.2238} & \underset{(0.189)}{0.0953} & \underset{(0.357)}{0.0903} \end{bmatrix}$$

Panel (J). Financial			
	$R_{NA,t}$	$R_{EU,t}$	$R_{AS,t}$
μ	0.0515 (0.037)	0.0208 (0.311)	-0.0328 (0.185)
$R_{NA,t-1}$	0.0632 (0.003)	0.2900 (0.000)	0.2500 (0.000)
$R_{EU,t-1}$	0.0077 (0.762)	-0.0017 (0.933)	0.1410 (0.000)
$R_{AS,t-1}$	-0.0278 (0.150)	-0.0295 (0.066)	0.0762 (0.000)

$$\hat{C} = \begin{bmatrix} \underset{(0.000)}{-0.8059} & \underset{(0.000)}{0.1232} & \underset{(0.085)}{0.0931} \\ \underset{(0.000)}{0} & \underset{(0.007)}{-0.1100} & \underset{(0.000)}{-0.1548} \\ \underset{(0.000)}{0} & \underset{(0.000)}{0} & \underset{(0.999)}{0} \end{bmatrix} \quad \hat{B} = \begin{bmatrix} \underset{(0.000)}{0.2035} & \underset{(0.250)}{0.0174} & \underset{(0.023)}{-0.0348} \\ \underset{(0.000)}{0.4295} & \underset{(0.000)}{0.9478} & \underset{(0.137)}{0.1243} \\ \underset{(0.000)}{-0.2059} & \underset{(0.000)}{-0.2500} & \underset{(0.000)}{-0.9601} \end{bmatrix}$$

$$\hat{A} = \begin{bmatrix} \underset{(0.000)}{-0.3881} & \underset{(0.547)}{-0.0118} & \underset{(0.507)}{0.0162} \\ \underset{(0.000)}{0.3503} & \underset{(0.000)}{0.2116} & \underset{(0.082)}{0.0483} \\ \underset{(0.196)}{0.0320} & \underset{(0.501)}{0.0095} & \underset{(0.000)}{0.2243} \end{bmatrix} \quad \hat{G} = \begin{bmatrix} \underset{(0.000)}{-0.3829} & \underset{(0.000)}{-0.0951} & \underset{(0.000)}{-0.1298} \\ \underset{(0.002)}{-0.2007} & \underset{(0.000)}{-0.2123} & \underset{(0.000)}{0.1308} \\ \underset{(0.037)}{-0.1061} & \underset{(0.733)}{0.0064} & \underset{(0.000)}{0.2040} \end{bmatrix}$$

Table 4: Residual diagnostics of the VAR(1) - asymmetric BEKK model

Q(12) and Q²(12) are Ljung-Box tests for twelfth order serial correlation in the standardised residuals and squared residuals. P-values in brackets. An (*) indicates significant coefficients at the 0.05 critical level.

Panel (A). Summary statistics for the standardised residuals of the Resources industry						
Q(12)	24.8254*	[0.0096]	26.0681*	[0.0063]	9.0799	[0.6145]
Q²(12)	0.9617	[0.9999]	0.8201	[0.9999]	0.0010	[0.9999]

Panel (B). Summary statistics for the standardised residuals of the Basic Industries industry						
Q(12)	13.7870	[0.2450]	12.8225	[0.3050]	9.1544	[0.6076]
Q²(12)	0.0529	[0.9999]	4.6826	[0.9455]	0.0038	[0.9999]

Panel (C). Summary statistics for the standardised residuals of the General Industrials industry						
Q(12)	8.7030	[0.6492]	6.6864	[0.8238]	16.2182	[0.1332]
Q²(12)	0.1387	[0.9999]	6.3828	[0.8466]	0.0052	[0.9999]

Panel (D). Summary statistics for the standardised residuals of the Cyclical Consumer Goods industry						
Q(12)	2.2153	[0.9975]	12.6630	[0.3159]	16.0702	[0.1385]
Q²(12)	0.0001	[0.9999]	10.7180	[0.4671]	0.0167	[0.9999]

Panel (E). Summary statistics for the standardised residuals of the Non-cyclical Consumer Goods industry						
Q(12)	15.9127	[0.1444]	26.3416*	[0.0057]	4.9918	[0.9315]
Q²(12)	0.1064	[0.9999]	21.8354*	[0.0256]	0.0009	[0.9999]

Panel (F). Summary statistics for the standardised residuals of the Cyclical Services industry						
Q(12)	10.6193	[0.4756]	8.7850	[0.6417]	9.8634	[0.5427]
Q²(12)	0.3209	[0.9999]	44.5911*	[0.0000]	0.0015	[0.9999]

Panel (G). Summary statistics for the standardised residuals of the Non-cyclical Services industry						
Q(12)	9.5995	[0.5667]	23.2098*	[0.0165]	11.0003	[0.4432]
Q²(12)	69.5340*	[0.0000]	0.7748	[0.9999]	0.0048	[0.9999]

Panel (H). Summary statistics for the standardised residuals of the Utilities industry						
Q(12)	5.7107	[0.8919]	6.4022	[0.8452]	16.1535	[0.1355]
Q²(12)	0.0039	[0.9999]	0.0022	[0.9999]	0.0067	[0.9999]

Panel (I). Summary statistics for the standardised residuals of the Information Technology industry						
Q(12)	12.8899	[0.3005]	6.5424	[0.8348]	18.6582	[0.0675]
Q²(12)	0.3156	[0.9999]	0.0199	[0.9999]	0.0407	[0.9999]

Panel (J). Summary statistics for the standardised residuals of the Financial industry						
Q(12)	3.7196	[0.9774]	11.7017	[0.3864]	16.0182	[0.1404]
Q²(12)	0.0105	[0.9999]	0.6220	[0.9999]	0.0076	[0.9999]

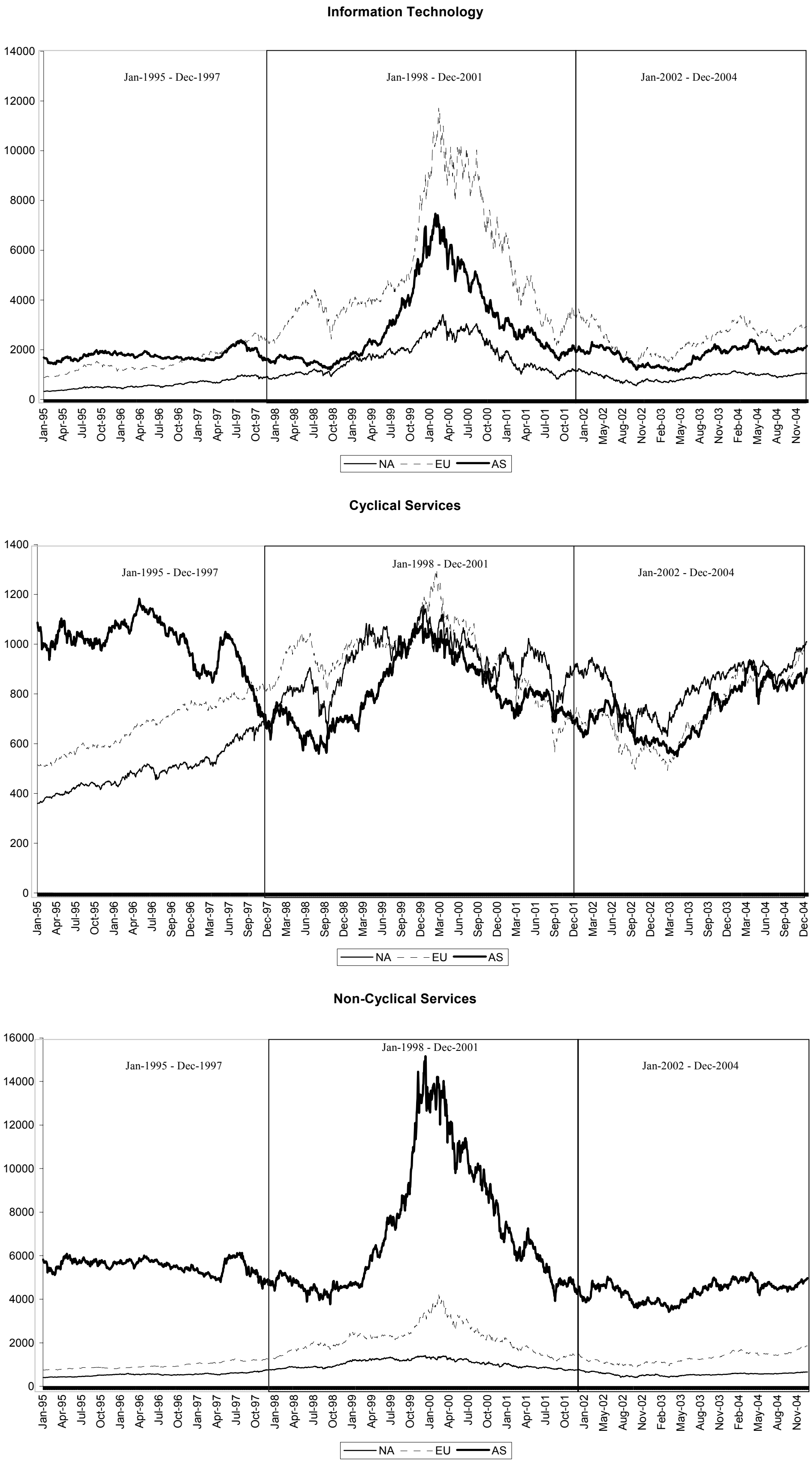

Figure 1. Time series of the Technology, Media and Telecommunications (TMT) related industrial indices.

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