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Return relationships among European equity sectors: a comparative analysis across selected sectors in small and large economies

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Abstract

This paper examines return interrelationships between numbers of equity sectors across several European markets. The markets comprise six Member States of the European Union (EU): namely, Belgium, Finland, France, Germany, Ireland and Italy. The five sectors include the consumer discretionary, consumer staples, financial, industrials and materials sectors. Generalised Autoregressive Conditional Heteroskedasticity in Mean (GARCH-M) models are used to consider the impact of returns in other European markets on the returns in each market across each sector. The results indicate that there are relatively few significant interrelationships between sectors in different markets, with most of these accounted for by the larger markets in France, Germany and Italy. The evidence also suggests the consumer discretionary, financial and materials sectors are relatively more interrelated than the consumer staples and industrials sectors. This has clear implications for portfolio diversification and asset pricing in the EU.

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RETURN RELATIONSHIPS AMONG EUROPEAN EQUITY SECTORS: A COMPARATIVE ANALYSIS ACROSS SELECTED SECTORS IN SMALL AND LARGE ECONOMIES

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This paper examines return interrelationships between numbers of equity sectors across several European markets. The markets comprise six Member States of the European Union (EU): namely, Belgium, Finland, France, Germany, Ireland and Italy. The five sectors include the consumer discretionary, consumer staples, financial, industrials and materials sectors. Generalised Autoregressive Conditional Heteroskedasticity in Mean (GARCH-M) models are used to consider the impact of returns in other European markets on the returns in each market across each sector. The results indicate that there are relatively few significant interrelationships between sectors in different markets, with most of these accounted for by the larger markets in France, Germany and Italy. The evidence also suggests the consumer discretionary, financial and materials sectors are relatively more interrelated than the consumer staples and industrials sectors. This has clear implications for portfolio diversification and asset pricing in the EU.

JEL classification codes: C32, F36, G15

Key words: Risk and return, volatility, autoregressive conditional heteroskedasticity

I. Introduction

In recent years, the interrelationships among the world's equity markets have increased dramatically, and concomitantly a voluminous empirical literature concerned with analysing these interrelationships has arisen. Justification for this interest is not hard to find. Although the gradual lifting of restrictions on capital movements, relaxation of exchange controls and improved accessibility to information have led to a substantial increase in international stock market activities and the flow of global capital, they have also increased the vulnerability of individual markets to global shocks. Substantial interrelationships then calls for greater

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cooperation between prudential and monetary regulators in different markets to handle these shocks, particularly in groups sharing a common currency or with substantial trade and investment links. Moreover, if equity markets have significant interrelationships between them, then the benefits of international diversification are reduced. If as hypothesised, high correlations of returns exist between markets, diversification may not allow investors to reduce portfolio risk while holding expected return constant [for early work in this area see Levy and Sarnat (1970) and Solnik (1974)].

Interrelationships in stock price fluctuations exist for four main reasons. To start with, interrelationships may arise where economies as a whole are more integrated, such as within the European Union, and especially given the introduction of the single currency. In this case, substantial trade and investment linkages, common institutional and regulatory structures and shared macroeconomic conditions imply equity pricing more closely reflects regional, rather than national, factors. A second source of interrelationships may arise from country-specific shocks that are rapidly transmitted to other markets. This transmission can occur through the international capital market provoking a reaction in domestic capital markets (known as market contagion). This hypothesis also suggests that markets that are larger in size and are more dominant are likely to exert a greater influence on smaller markets. The third source of interrelationships arises from shocks specific to sectors of each economy. For example, if a technology shock affects a particular sector, stock price interrelationships may arise from connections between this and other sectors within a market. Lastly, a final source of interrelationships is from shared investor groups. For example, when two countries are geographically proximate and have similar groups of investors in their markets, these markets are also likely to influence each other.

Equity markets within the European Union represent a pertinent context within which to examine such comovements. Not only do these geographically close and globally important markets have extensive trade and investment linkages in the first instance, the institutional, regulatory and macroeconomic harmonisation brought about by the common market and currency implies a very strongly interrelated regional market. Moreover, European equity markets have increasingly attracted non-European investors to the potential benefits of international diversification, and the eastwards expansion of the EU in the next several years will only increase its share of global capitalisation. However, it has also been persuasively argued [see, for example, Akdogan (1995), Meric and Meric (1997), Friedman and Shachmurove (1997) and Cheung and Lai (1999)] that comparatively recent developments in the EU to deepen both political and economic integration have diminished the prospects for diversification. Akdogan (1995: 111), for example, suggests "…in light of recent developments towards greater financial integration within the Union, one might argue that European equities are priced in an integrated market and not according to the domestic systematic risk content".

Unfortunately, "although a number of articles dealing with the co-movements of the world's equity markets are available, articles focusing solely on European equity markets are virtually non-existent" (Meric and Meric 1997). Furthermore, even when European equity markets are examined in a broader multilateral context (that is, in conjunction with North American and Asian capital markets), an emphasis is usually placed upon the larger economies. For example, Darbar and Deb (1997) included only the U.K. in their study of international capital market integration, Kwan *et al*. (1995), Francis and Leachman (1998) and Masih and Masih (1999) added Germany, Arshanapalli and Doukas (1993) excluded Germany and focused on France and the U.K., Cheung and Lai (1999) removed the U.K. and added Italy to France and Germany, and Solnik *et al*. (1996) and Longin and Solnik (1995) included Germany, France, Switzerland and the U.K. This bias is equally noticeable in studies that concentrate on European equity markets, including Espitia and Santamaria (1994), Abbott and Chow (1993), Shawky *et al*. (1997), Ramchand and Susmel (1998), Richards (1995) and Chelley-Steeley and Steeley (1999) where only the larger European economies were included.

A more startling omission in the literature is that despite the widespread use of advanced techniques to examine interrelationships among national markets, little use of these techniques has been made to examine the interrelationships between sectors in different national markets [see, for example, Baca et al. (2000)]. While some work on the decomposition of European equity returns according to global, regional, country and industry factors has been undertaken [see, for instance, Grinold *et al*. (1989), Becker *et al*. (1992, 1996), Drummen and Zimmerman (1992), Heston and Rouwenhorst (1994, 1999), Griffin and Karolyi (1998) and Arshanapalli *et al*. (1997)] few have employed the techniques common in national analyses. This is important in a global context as the extent to which sectors in different markets are interrelated is likely to be related to the differing nature of these sectors, the extent of multilateral and bilateral trade liberalisation, and capital flows and control. These are likely to vary across sectors, such that some sectors in a market may be more or less related to sectors in another, than suggested by the market itself. Such differences are likely to be especially important in the European Union where the substantive liberalisation of the flows of goods and services, capital and labour owes much to regional policy and regulation.

Accordingly, the purpose of the present paper is to examine the interrelationships between selected sectors in several different markets within the European Union's regional market. The paper itself is divided into four main areas. Section II briefly discusses the data employed in the analysis. Section III explains the methodology. The results are dealt with in Section IV. The paper ends with some brief concluding remarks in Section V.

II. Data Description

The data employed in the study is composed of value-weighted equity sector indices for six selected European Union markets; namely, Belgium (BEL), Finland (FIN), France (FRA), Germany (GER), Ireland (IRE) and Italy (ITL). The markets selected are thought to be representative of the diversity within the EU, encompassing both large and small markets. All data is obtained from Morgan Stanley Capital International (MSCI) and encompasses the period 1 January 1999 to 29 February 2002. MSCI indices are widely employed in the financial literature on the basis of the degree of comparability and avoidance of dual listing [see, for instance, Meric and Meric (1997), Yuhn (1997) and Roca (1999)]. Daily data is specified.

The sector indices analysed are classified according to the Global Industry Classification Standard (GICS)[SM]. The GICS assigns each company to a sub-industry, and to a corresponding industry, industry group and sector, according to the definition of its principal business activity. Ten sectors, twenty-three industry groups, fifty-nine industries and one hundred and twenty-three sub-industries currently represent these four levels. The potential sectors are Consumer Discretionary (CND), Consumer Staples (CNS), Energy (ENG), Financials (FNL), Healthcare (HLT), Industrials (IND), Information Technology (INF), Materials (MTL), Telecommunications (TEL) and Utilities (UTL), from which the following are selected:

I. Consumer Discretionary (CND) – encompassing those industries that tend to be most sensitive to economic cycles. The manufacturing segment includes automotive, household durable goods, textiles and apparel and leisure equipment. The services segment includes hotels, restaurants and other leisure facilities, media production and services and consumer retailing.

II. Consumer Staples (CNS) – comprising companies whose businesses are less sensitive to economic cycles. It includes manufacturers and distributors of food, beverages and tobacco and producers of non-durable household goods and personal products, along with food and drug retailing companies.

III. Financials (FNL) – containing companies involved in activities such as banking, consumer finance, investment banking and brokerage, asset management, insurance and investment and real estates.

IV. Industrial (IND) – including companies whose businesses are dominated by one of the following activities: the manufacture and distribution of capital goods, including aerospace and defence, construction, engineering and building products, electrical equipment and industrial machinery.

V. Materials (MTL) – counting a wide range of commodity-related manufacturing industries. Included in this sector are companies that manufacture chemicals, construction materials, glass, paper, forest products and related packaging products, metals, minerals and mining companies, including producers of steels.

The basic hypotheses concerning these markets and sectors are as follows. First, past research on European markets generally indicate that larger economies dominate smaller economies in terms of both the magnitude and significance of interrelationships. Second, evidence regarding industry factors tends to suggest that sectors that have greater involvement in foreign trade (i.e., chemicals, electrical, oil, gas, pharmaceuticals, etc.) tend to have more interrelationships than industries that mostly supply domestic goods (i.e., retailing, utilities, real estate, etc.). Moreover, larger industrialised capital markets such as Italy and Germany tend to have larger industry effects, that is, more globally interrelated industries.

Table 1 presents descriptive statistics of the daily returns for the five sectors across the six markets. Sample means, medians, maximums, minimums, standard deviations, skewness, kurtosis, Jacque-Bera (JB) test statistics and *p*-values and Augmented Dickey-Fuller (ADF) test statistics are reported. By and large, the distributional properties of all thirty daily return series appear non-normal. Eight (ten) of the thirty return series are significantly negatively (positively) skewed indicating the greater probability of large decreases (increases) in returns than increases (decreases). This is also suggestive of volatility clustering in daily sector returns.

<TABLE 1 HERE>

The kurtosis, or degree of excess, in all of the return series is also large, ranging from 3.8681 in the industrials (IND) sector for Germany (GER) to 22.9294 in the financials (FNL) sector for Finland (FIN), thereby indicating leptokurtic distributions. The calculated Jarque-Bera statistics and corresponding *p*-values in Table 1 are used to test the null hypotheses that the distribution of the returns is normally distributed. All the *p*-values are smaller than the .01 level of significance indicating the null hypothesis can be rejected. These series are then not well approximated by the normal distribution. For the purposes of commenting on the time series properties of these returns, Table 1 also presents the ADF unit root tests for the thirty return series where the null hypothesis of nonstationarity is tested. All of the ADF test statistics are significant at the 0.01 level, thereby indicating stationarity.

III. Empirical Methodology

The distributional properties of the sector returns in all markets indicate that generalized autoregressive conditional heteroskedastistic (GARCH) models can be used to examine the dynamics of the return generation process. Autoregressive conditional heteroscedasticity (ARCH) models and generalised ARCH (GARCH) models that take into account the time-varying variances of time series data have already been widely employed. Suitable surveys of ARCH modeling in general and/or its widespread use in finance applications may be found in Bollerslev et al. (1990), Bera and Higgins (1993) and MacAleer and Oxley (2002).

The specific GARCH(p,q)-M model used in this analysis is considered appropriate for several reasons. First, the capital asset pricing. model (CAPM) and the arbitrage pricing theory (APT) establish the well-known (positive) relationship between asset risk and return. At a theoretical level, asset risk in both CAPM and APT is measured by the conditional covariance of returns with the market or the conditional variance of returns. ARCH models are specifically designed to model and forecast conditional variances and by allowing risk to vary over time provide more efficient estimators and more accurate forecasts of returns than those conventionally used to model conditional means.

Second, an approach incorporating GARCH(p,q) can quantify both longer and shorter-term volatility effects. While ARCH allows for a limited number of lags in deriving the conditional variance, and as such is considered to be a short-run model, GARCH allows all lags to exert an influence and thereby constitutes a longer-run model. This reflects an important and well-founded characteristic of asset returns in the tendency for volatility clustering to be found, such that large changes in returns are often followed by other large changes, and small changes in returns are often followed by yet more small changes. The implication of such volatility clustering is that volatility shocks today will influence the expectation of volatility many periods in the future and GARCH(p,q) measures this degree of continuity or persistence in volatility.

Finally, the GARCH in mean (GARCH-M) model is very often used in financial applications where the expected return on an asset is directly related to the expected asset risk such that the estimated coefficient on risk is a measure of the risk-return trade-off. In these models the mean of the return series is specified as an explicit function of the conditional variance of the process, allowing for both the fundamental trade-off between expected returns and volatility while capturing the dynamic pattern of the changing risk premium over time. Of course, other time series models could have been used. Engle and Kroner (1995), for example, specify a multivariate GARCH (MGARCH) model allowing for multiple interactions in conditional mean and variance, while Cheung and Ng (1996) develop a test for causality in variance and illustrate its usefulness concerning temporal dynamics and the interaction between financial time series. A clear limitation then of the approach chosen is that intermarket effects are only allowed for in the conditional mean equation and not in the conditional variance equation. This is somewhat offset by its straightforwardness.

The GARCH(p,q)-M model for a given sector is described by the following:

$$r_{m,t} = \alpha_{m,0} + \sum_{m' \in M} \alpha_{m,m'} r_{m',t-1} + \gamma_{m,0} h_{m,t} + \varepsilon_{m,t} \quad (1)$$

$$h_{m,t} = \beta_{m,0} + \sum_{i=1}^{p} \beta_{m,i} \varepsilon_{m,t-i}^{2} + \sum_{j=1}^{q} \delta_{m,j} h_{m,t-j} \quad (2)$$

$$\varepsilon_{m,t} \left| \Omega_{m,t-1} \right. \sim N\left(0, h_{m,t}\right) \quad (3)$$

where the variables in the mean equation for each market in Equation (1) are as follows: $r_{m,t}$ is the return on the mth market at time t (where $m \in M$={BEL, FIN, FRA, GER, IRE and ITL}), $r_{i,t-1}$ is the lagged return of market m and the lagged returns in the other markets, $h_{m,t}$ measures the return volatility or risk of market m at time t, and $\varepsilon_{m,t}$ is the error term which is normally distributed with zero mean and a variance of $h_{m,t}$, as described by the distribution in Equation (3). The sensitivity of each market at t to itself and the other markets are measured by $\alpha_{m,i}$ while $\alpha_{m,0}$ is the constant term. The conditional variance $h_{m,t}$ follows the process described in Equation (2) and for the mth market is determined by the past squared error terms ($\varepsilon^{2}_{m,t-i}$) and past behaviour of the variance ($h_{m,t-j}$), $\beta_{m,0}$ is the time-invariant component of risk for the market, $\beta_{m,i}$ are the ARCH parameter(s) and $\delta_{m,j}$ are the GARCH parameter(s). The robustness of the model depends on the sum of the ARCH and GARCH parameters being less than unity. Heteroskedasticity consistent covariance matrices are estimated.

IV. Empirical Results

The estimated coefficients and standard errors for the conditional mean return equations are presented in Table 2. Different GARCH(p,q) models were initially fitted to the data and compared on the basis of the Akaike and Schwarz Information Criteria (results not shown) from which a GARCH(1,1) model was deemed most appropriate for modelling the daily return process for all sectors. This specification has generally been shown to be a parsimonious representation of conditional variance that adequately fits most financial time series. However, the F-statistic of the null hypothesis that all coefficients are jointly zero in Table 3 is only significant for some markets and sectors: namely, BEL (CNS, FNL, MTL), FIN (CND, CNS, MTL), FRA (CND, FNL), GER (MTL), IRE (CND, FNL, IND, MTL) and ITL (CND). We may then question the contribution of sector returns in each market and sector returns in the other markets in explaining the return generation process in the remaining models.

A basic hypothesis examined is whether volatility is a significant factor in pricing, or equivalently, whether an intertemporal tradeoff exists between risk and return in each sector in each market. As indicated by the significance of the estimated coefficient for the GARCH parameter in the mean equation, only in the case of CNS in IRE, FNL in BEL, GER and ITL, IND in BEL and MTL in ITL is it significant. Theory suggests that the equilibrium price of systematic risk should be significant and positive, but as a measure of total rather than non-diversifiable systematic risk an increase in volatility need not always be accompanied by a significant increase in the risk premium. This is especially the case if fluctuations in volatility are mostly due to shocks to unsystematic, as against systematic, risk. Nonetheless, all of the GARCH parameters, when significant, are positive.

<TABLE 2 HERE>

Table 2 also includes the estimated coefficients, standard errors and p-values for the sector parameters included in the analysis. The significance, magnitude and sign on the estimated coefficients vary across the different sectors. Of the one hundred and eighty slope coefficients estimated across the five sectors and six markets, 35 (19 percent) are significant at the .10 level or higher. Most of the significant coefficients are positive. Consider returns on the industrial sector (IND) in Ireland (IRE). All other things being equal, industrial (IND) sector returns in Ireland (IRE) are positively caused by lagged industrial sector returns in both itself and Germany (GER). Alternatively, in Germany (GER) its returns are positively associated only with its own lagged returns in the consumer disposable (CND), consumer staples (CNS) and materials (MTL) sectors. Overall, and outside of the GARCH terms, Germany accounts for eleven of the significant causal relationships, Italy eight, Finland seven, and Belgium, France and Ireland five. However, of the significant causal relationships from Belgian, Finnish and Irish sectors only three, four and two are to markets outside themselves, respectively.

Table 3 presents the estimated coefficients for the conditional variance equations in the GARCH models. The constant term (*CON*) in the variance equation constitutes the time-independent component of volatility and reflects the volatility if no ARCH (last period's shock) or GARCH (previous period's shocks) effect is significant. In the case of nearly all of the thirty models the estimated coefficient is significant and positive, though its magnitude is very small, suggesting all or nearly all volatility in sector returns is made up of time-varying components. The own-innovation spillovers (ARCH) in nearly all sector returns are also significant as are the lagged volatility spillovers (GARCH). However, the magnitude of the GARCH terms is always larger than the ARCH terms. This implies that the last period's volatility shocks in sector returns have a lesser effect on its future volatility than previous surprises.

<TABLE 3 HERE>

The sum of the ARCH and GARCH coefficients measures the overall persistence in each market's own and lagged conditional volatility and is also presented in Table 3. The average persistence in the five sectors across the six markets is 0.8437 (CND), 0.8328 (CNS), 0.8634 (FNL), 0.8817 (IND) and 0.9144 (MTL). These imply volatility half-lives, defined as the time taken for the volatility to move halfway back towards its unconditional mean following a deviation from it, of 4.08 days for returns in the consumer disposables sector, 3.78 days in consumer staples, 4.72 days in financials, 5.51 days in industrials and 7.74 days in materials, where $HL = -\log(2)/\log(ARCH + GARCH)$. This means that volatility shocks in the materials and industrials sectors will tend to persist over what seem relatively long periods of time.

The average persistence for the six markets across the five sectors also varies with 0.9103 (BEL), 0.6055 (FIN), 0.9247 (FRA), 0.9495 (GER), 0.8796 (IRE) and 0.9337 (ITL). Interestingly, this implies volatility half-lives of between 1.38 and 13.38 days with the relatively smaller Belgian, Finnish and Irish markets having shorter half-lives than those in France, Germany and Italy. Conventionally, the suggestion is that the former markets are better able to absorb the shocks to which they are exposed than the latter. One possibility is that even though these markets are relatively small they are also relatively more efficient at absorbing shocks from sectors in other markets, especially since they are less important and more isolated in the context of European sector returns than France, Germany and Italy.

5. Concluding Remarks

This paper investigates the interrelationships among five sectors and six European equity markets during the period 1999 to 2002. A generalised autoregressive conditional heteroskedasticity in mean (GARCH-M) technique is used to model the daily return generation process in these markets. As far as the authors are aware, this represents the first application of this methodology to sector markets in Europe and adds significantly to our knowledge of the interrelationships that systematically affect returns within a multivariate framework. One of most important results is that there is much variation in the time-series properties among the sectors and markets included in the sample, despite the fact that they are all Member States of the European Union and have many commonalities in capital, product and factor markets. While all of the returns exhibit the volatility clustering and predictability expected, the persistence of this volatility varies markedly with half-lives anywhere between slightly more than a day to nearly fourteen days with persistence in the materials and industrials sectors being generally higher than in the consumer durables, consumer staples and financial sectors.

In marked contrast to overwhelming evidence elsewhere that European equity markets share many significant interrelationships, relatively few are found at the sector level. Several significant causal linkages exist among the different sectors and markets, though these vary among the sectors with the consumer discretionary, financial and materials sectors having many more significant interrelationships than the consumer staples and industrials sectors. And in general, sectors in the large markets of France, Germany and Italy have more influence on sectors in Belgium, Finland and Ireland than vice versa. Clearly, while broad structural and institutional changes and criteria aimed at achieving a high degree of sustainable economic convergence have ensured developments in the European monetary sector has gone far towards quickening the pace of overall financial integration, various impediments to the full integration of individual sectors has prevented this being reflected at the sector level.

That said it is also possible that the fundamental lead-lag relationships between European stock markets may also have changed following the introduction of the single currency and that the results of this analysis may reflect this change, rather than impediments to integration at the sector level. Westermann (2003), for example, argues that lead-lag relationships within major European markets disappeared after the introduction of the single currency, and that reduced cross-country linkages in the current period are in accordance with the predictions of an international model of feedback trading. Unfortunately, the period analysed in this study is not able to provide insights on whether the fundamental relationships between European sectors have changed from that existing before the introduction of the single currency.

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Table 1. Selected Descriptive Statistics for European Markets and Sectors

Sector	Market	Mean	Median	Maximum	Minimum	Std. Dev.	Skewness	Kurtosis	JB	*p*-value	ADF
CND	BEL	-0.0011	0.0000	0.1644	-0.1091	0.0225	0.1628	7.9222	8.70E+02	0.0000	-14.1189
	FIN	0.0004	0.0000	0.0671	-0.0666	0.0178	0.1605	4.0035	3.97E+01	0.0000	-18.4591
	FRA	0.0002	0.0000	0.0836	-0.0880	0.0165	-0.0285	5.1999	1.73E+02	0.0000	-11.6542
	GER	-0.0007	-0.0004	0.0634	-0.0839	0.0166	-0.2387	5.2865	1.95E+02	0.0000	-19.7418
	IRE	0.0002	0.0001	0.0949	-0.1054	0.0170	-0.1999	8.2400	9.87E+02	0.0000	-6.3355
	ITL	-0.0001	0.0000	0.0823	-0.0860	0.0172	-0.0421	5.1840	1.71E+02	0.0000	-8.5043
CNS	BEL	-0.0005	0.0000	0.1110	-0.1633	0.0162	-1.0694	18.4311	8.68E+03	0.0000	-12.2214
	FIN	0.0001	0.0000	0.1558	-0.1073	0.0193	0.4362	11.8048	2.80E+03	0.0000	-7.6367
	FRA	0.0000	0.0003	0.0603	-0.0903	0.0150	-0.2467	5.6394	2.58E+02	0.0000	-13.8588
	GER	0.0005	0.0004	0.0824	-0.1005	0.0228	-0.1247	4.4915	8.18E+01	0.0000	-16.3846
	IRE	0.0001	0.0000	0.0406	-0.0776	0.0108	-0.3748	7.8318	8.55E+02	0.0000	-21.8947
	ITL	-0.0002	-0.0009	0.0883	-0.0638	0.0150	0.2441	5.7670	2.82E+02	0.0000	-9.6758
FNL	BEL	-0.0003	0.0000	0.0902	-0.0770	0.0152	0.2180	6.6066	4.72E+02	0.0000	-8.1196
	FIN	0.0001	0.0001	0.1054	-0.2315	0.0207	-1.4241	22.9294	1.45E+04	0.0000	-8.3183
	FRA	0.0003	0.0000	0.0729	-0.1055	0.0165	-0.2915	6.1963	3.77E+02	0.0000	-10.1751
	GER	0.0000	0.0000	0.1183	-0.1474	0.0188	-0.1272	10.7008	2.12E+03	0.0000	-11.8980
	IRE	0.0000	0.0000	0.0814	-0.1050	0.0170	-0.1250	6.0063	3.25E+02	0.0000	-7.3919
	ITL	-0.0002	-0.0001	0.0868	-0.0801	0.0153	0.1554	7.2029	6.35E+02	0.0000	-9.5020
IND	BEL	0.0002	0.0000	0.0929	-0.0571	0.0152	0.2241	5.1133	1.67E+02	0.0000	-12.9032
	FIN	0.0005	0.0000	0.0659	-0.0684	0.0138	0.0596	4.9444	1.36E+02	0.0000	-12.3682
	FRA	0.0005	0.0003	0.0466	-0.0738	0.0145	-0.4439	5.2157	2.04E+02	0.0000	-9.2184
	GER	0.0004	0.0007	0.0813	-0.0926	0.0221	-0.1320	3.8681	2.94E+01	0.0000	-15.3271
	IRE	0.0012	0.0000	0.0970	-0.1319	0.0192	-0.0385	10.1569	1.83E+03	0.0000	-19.8894
	ITL	-0.0006	-0.0004	0.0832	-0.0714	0.0147	0.1353	6.2070	3.70E+02	0.0000	-6.1976
MTL	BEL	0.0002	0.0000	0.0719	-0.0559	0.0141	0.3580	5.5009	2.42E+02	0.0000	-15.9143
	FIN	0.0005	0.0001	0.0819	-0.1050	0.0194	-0.2522	4.9304	1.42E+02	0.0000	-10.8592
	FRA	0.0003	0.0000	0.0767	-0.0558	0.0146	0.2670	5.2053	1.84E+02	0.0000	-18.5299
	GER	0.0001	0.0000	0.1030	-0.0940	0.0166	0.0373	6.8929	5.42E+02	0.0000	-8.8471
	IRE	0.0005	0.0005	0.0758	-0.0573	0.0167	0.1960	4.5128	8.73E+01	0.0000	-20.7757
	ITL	0.0002	0.0000	0.1297	-0.0696	0.0142	0.7048	11.7715	2.82E+03	0.0000	-7.1504

Notes: Markets are BEL – Belgium, FIN – Finland, FRA – France, GER – Germany, IRE – Ireland, ITL – Italy. Sectors are CND – Consumer Discretionary, CNS – Consumer Staples, FNL – Financial, IND – Industrials, MTL – Materials. JB – Jarque-Bera test statistic (with *p*-value). Critical values for significance of skewness and kurtosis at the .05 level are 0.1639 and 0.3278, respectively. Augmented Dickey-Fuller (ADF) test hypotheses are H_0: unit root, H_1: no unit root (stationary). The lag orders in the ADF equations are determined by the significance of the coefficient for the lagged terms. Intercepts only in the series. The critical values for the ADF test statistic at the .10, .05 and .01 levels are -2.5670, -2.8618 and -3.4312, respectively.

Table 2. Estimated Coefficients for Conditional Mean Return Equations by Market and Sector

		BEL			FIN			FRA			GER			IRE			ITL		
		Coef.	Std.Err.	p-value	Coef.	Std.Err.	p-value	Coef.	Std.Err.	p-value	Coef.	Std.Err.	p-value	Coef.	Std.Err.	p-value	Coef.	Std.Err.	p-value
CND	GARCH	0.1458	0.1552	0.3474	0.2988	0.5550	0.5903	0.1799	0.1548	0.2452	0.3524	0.2298	0.1252	0.2436	0.2070	0.2394	0.1428	0.1479	0.3344
	CON.	-0.0038	0.0030	0.2113	-0.0049	0.0096	0.6140	-0.0022	0.0022	0.3100	-0.0058	0.0035	0.1003	-0.0035	0.0032	0.2668	-0.0018	0.0022	0.4087
	BEL	-0.0432	0.0477	0.3655	-0.0338	0.0267	0.2060	-0.0154	0.0252	0.5413	0.0184	0.0344	0.5924	-0.0065	0.0236	0.7828	-0.0197	0.0276	0.4763
	FIN	-0.0307	0.0365	0.4011	-0.1238	0.0380	0.0011	-0.0332	0.0281	0.2374	-0.0042	0.0318	0.8955	0.0368	0.0297	0.2159	0.0097	0.0349	0.7803
	FRA	0.1000	0.0734	0.1730	-0.0152	0.0494	0.7589	0.0151	0.0498	0.7625	-0.0138	0.0423	0.7442	0.0794	0.0576	0.1681	0.0562	0.0538	0.2965
	GER	0.1362	0.0668	0.0416	0.0460	0.0451	0.3081	0.0737	0.0395	0.0624	0.1001	0.0418	0.0166	-0.0298	0.0401	0.4568	0.0241	0.0397	0.5446
	IRE	0.0261	0.0460	0.5702	0.0551	0.0385	0.1521	-0.0233	0.0342	0.4966	-0.0207	0.0338	0.5395	0.0324	0.0408	0.4267	-0.0180	0.0356	0.6135
	ITA	-0.0060	0.0709	0.9329	0.0753	0.0439	0.0865	0.0788	0.0452	0.0816	-0.0428	0.0412	0.2991	0.1204	0.0578	0.0371	0.0804	0.0448	0.0726
CNS	GARCH	0.2638	0.2279	0.2471	-0.0479	0.4221	0.9097	0.1331	0.2220	0.5488	-0.1925	0.2053	0.3484	0.2535	0.1453	0.0810	0.3042	0.3171	0.3373
	CON.	-0.0044	0.0036	0.2287	0.0011	0.0081	0.8916	-0.0017	0.0031	0.5841	0.0048	0.0043	0.2608	-0.0022	0.0014	0.1198	-0.0045	0.0046	0.3214
	BEL	0.0558	0.0359	0.1202	-0.0309	0.0463	0.5041	0.0734	0.0333	0.0273	0.0340	0.0493	0.4894	0.0026	0.0246	0.9170	0.0299	0.0309	0.3329
	FIN	-0.0423	0.0383	0.2699	-0.0949	0.0352	0.0070	-0.0166	0.0325	0.6102	0.0108	0.0417	0.7955	-0.0289	0.0165	0.0803	-0.0550	0.0239	0.0214
	FRA	0.1052	0.0463	0.0230	0.0169	0.0540	0.7536	-0.0725	0.0373	0.0519	-0.0194	0.0553	0.7255	0.0348	0.0387	0.3683	0.0207	0.0382	0.5883
	GER	-0.0159	0.0213	0.4562	0.0078	0.0252	0.7576	0.0015	0.0242	0.9501	-0.1461	0.0357	0.0000	-0.0069	0.0167	0.6797	0.0027	0.0214	0.8984
	IRE	-0.0560	0.0446	0.2093	-0.0508	0.0538	0.3443	-0.0590	0.0503	0.2408	0.0154	0.0758	0.8388	-0.0554	0.0392	0.1574	-0.0140	0.0535	0.7933
	ITA	-0.0594	0.0521	0.2544	0.0921	0.0477	0.0534	-0.0201	0.0344	0.5603	0.0322	0.0502	0.5212	0.0181	0.0232	0.4349	0.0018	0.0382	0.9620
FNL	GARCH	0.2980	0.1544	0.0536	-0.1132	0.2016	0.5745	0.4756	0.3228	0.1406	0.3240	0.1944	0.0956	0.2736	0.2500	0.2738	0.2539	0.1335	0.0572
	CON.	-0.0039	0.0020	0.0509	0.0016	0.0040	0.6838	-0.0068	0.0049	0.1626	-0.0054	0.0034	0.1149	-0.0044	0.0040	0.2673	-0.0031	0.0017	0.0616
	BEL	0.1415	0.0434	0.0011	0.1731	0.0700	0.0134	0.0800	0.0535	0.1345	0.0635	0.0520	0.2217	0.0524	0.0587	0.3718	0.0553	0.0407	0.1741
	FIN	-0.0211	0.0234	0.3666	-0.1916	0.0501	0.0001	0.0430	0.0255	0.0918	0.0708	0.0523	0.1756	-0.0402	0.0278	0.1481	-0.0543	0.0215	0.0116
	FRA	0.0148	0.0400	0.7118	0.0951	0.0885	0.2826	0.0040	0.0503	0.9360	0.0290	0.0550	0.5980	0.0756	0.0499	0.1299	0.0276	0.0401	0.4919
	GER	0.0033	0.0336	0.9227	-0.0785	0.0927	0.3970	0.0166	0.0365	0.6494	-0.0498	0.0624	0.4251	0.0624	0.0425	0.1418	-0.0359	0.0357	0.3157
	IRE	-0.0034	0.0261	0.8974	0.0031	0.0426	0.9414	-0.0517	0.0357	0.1481	-0.0723	0.0399	0.0702	0.1386	0.0416	0.0009	-0.0010	0.0268	0.9714
	ITA	0.0237	0.0473	0.6164	0.0658	0.0661	0.3198	0.0743	0.0503	0.1396	0.0495	0.1092	0.6504	0.0369	0.0525	0.4820	0.0744	0.0453	0.1004
IND	GARCH	0.3522	0.2033	0.0832	-0.1522	0.3340	0.6486	0.1996	0.1871	0.2859	0.0163	0.1265	0.8973	0.0479	0.2076	0.8174	0.0130	0.1285	0.9193
	CON.	-0.0047	0.0030	0.1120	0.0027	0.0045	0.5514	-0.0019	0.0025	0.4315	0.0003	0.0024	0.8978	0.0003	0.0035	0.9393	-0.0004	0.0017	0.7973
	BEL	-0.0815	0.0464	0.0793	0.0339	0.0313	0.2788	0.0214	0.0315	0.4968	0.0468	0.0462	0.3110	0.0357	0.0406	0.3793	0.0537	0.0302	0.0750
	FIN	-0.0029	0.0396	0.9422	-0.0389	0.0371	0.2946	0.0421	0.0380	0.2673	0.0182	0.0492	0.7117	0.0353	0.0439	0.4215	0.0199	0.0393	0.6125
	FRA	0.0071	0.0410	0.8619	0.0074	0.0387	0.8475	-0.0325	0.0436	0.4552	0.0390	0.0589	0.5071	0.0536	0.0535	0.3167	0.0290	0.0421	0.4905
	GER	0.0488	0.0324	0.1321	0.0079	0.0227	0.7289	0.0594	0.0253	0.0190	0.0083	0.0392	0.8321	0.0597	0.0312	0.0560	-0.0009	0.0223	0.9696
	IRE	0.0015	0.0365	0.9673	0.0598	0.0274	0.0288	-0.0145	0.0287	0.6126	0.0214	0.0405	0.5964	0.0789	0.0387	0.0414	-0.0050	0.0262	0.8482
	ITA	0.0207	0.0379	0.5847	0.0327	0.0360	0.3629	0.0099	0.0363	0.7842	0.0038	0.0474	0.9364	0.0564	0.0444	0.2036	-0.0779	0.0458	0.0890

		BEL			FIN			FRA			GER			IRE			ITL		
		Coef.	Std.Err.	p-value	Coef.	Std.Err.	p-value	Coef.	Std.Err.	p-value	Coef.	Std.Err.	p-value	Coef.	Std.Err.	p-value	Coef.	Std.Err.	p-value
MTL	GARCH	0.0878	0.1506	0.5598	0.0414	0.2309	0.8577	-0.0814	0.1812	0.6532	0.5140	0.3538	0.1463	0.1800	0.3330	0.5888	0.3776	0.1711	0.0273
	CON.	-0.0006	0.0019	0.7535	-0.0002	0.0042	0.9613	0.0017	0.0025	0.4886	-0.0078	0.0057	0.1676	-0.0024	0.0053	0.6454	-0.0043	0.0023	0.0549
	BEL	-0.0378	0.0415	0.3617	-0.0533	0.0504	0.2906	-0.0207	0.0413	0.6166	-0.0656	0.0465	0.1588	-0.0210	0.0503	0.6766	-0.0261	0.0518	0.6137
	FIN	0.0294	0.0288	0.3080	0.0450	0.0396	0.2565	0.0374	0.0310	0.2264	0.0463	0.0321	0.1494	0.0629	0.0353	0.0744	-0.0296	0.0292	0.3119
	FRA	0.0394	0.0377	0.2950	0.0985	0.0522	0.0592	-0.0295	0.0486	0.5444	0.0846	0.0465	0.0690	0.0505	0.0580	0.3842	0.0752	0.0465	0.1063
	GER	0.0807	0.0317	0.0109	0.1384	0.0468	0.0031	0.0960	0.0364	0.0083	0.0324	0.0410	0.4291	0.1474	0.0412	0.0003	0.0564	0.0301	0.0613
	IRE	0.0064	0.0291	0.8269	0.0208	0.0434	0.6310	-0.0121	0.0315	0.7001	0.0155	0.0324	0.6334	0.0732	0.0394	0.0631	0.0014	0.0287	0.9602
	ITA	0.0099	0.0380	0.7951	-0.0605	0.0511	0.2365	-0.0136	0.0352	0.6985	-0.0170	0.0420	0.6852	-0.0747	0.0462	0.1053	0.0068	0.0398	0.8633

Notes: This table presents the estimated coefficients, standard errors and *p*-values for the conditional mean return equations. Markets are BEL – Belgium, FIN – Finland, FRA – France, GER – Germany, IRE – Ireland, ITL – Italy. Sectors are CND – Consumer Discretionary, CNS – Consumer Staples, FNL – Financial, IND – Industrials, MTL – Materials. CON – Constant.

Table 3. Estimated Coefficients for Conditional Variance Equations by Market and Sector

		BEL			FIN			FRA			GER			IRE			ITL		
		Coef.	Std.Err.	p-value	Coef.	Std.Err.	p-value	Coef.	Std.Err.	p-value	Coef.	Std.Err.	p-value	Coef.	Std.Err.	p-value			
CND	CON.	0.0000	0.0000	0.2563	0.0002	0.0001	0.1202	0.0000	0.0000	0.0733	0.0000	0.0000	0.0351	0.0001	0.0000	0.0167	0.0000	0.0000	0.0416
	ARCH	0.0728	0.0202	0.0003	0.0833	0.0465	0.0731	0.0789	0.0286	0.0058	0.0710	0.0279	0.0109	0.1590	0.0646	0.0138	0.1184	0.0375	0.0016
	GARCH	0.9092	0.0315	0.0000	0.3176	0.4002	0.4274	0.8987	0.0334	0.0000	0.8798	0.0401	0.0000	0.6309	0.1110	0.0000	0.8428	0.0468	0.0000
	Persist.	0.9820	–	–	0.4009	–	–	0.9776	–	–	0.9508	–	–	0.7899	–	–	0.9612	–	–
	R^2	0.0112	–	–	0.0329	–	–	0.0224	–	–	0.0047	–	–	0.0469	–	–	0.0256	–	–
	F-stat	0.9580	–	0.4789	2.8743	–	0.0016	1.9417	–	0.0367	0.3961	–	0.9487	4.1608	–	0.0000	2.2187	–	0.0151
CNS	CON.	0.0000	0.0000	0.0740	0.0004	0.0000	0.0000	0.0000	0.0000	0.1137	0.0000	0.0000	0.1726	0.0000	0.0000	0.0205	0.0000	0.0000	0.0375
	ARCH	0.0325	0.0152	0.0318	0.0870	0.0393	0.0268	0.0681	0.0236	0.0039	0.0536	0.0175	0.0022	0.1738	0.0609	0.0043	0.0683	0.0308	0.0264
	GARCH	0.9466	0.0168	0.0000	0.2190	0.0760	0.0040	0.8806	0.0476	0.0000	0.9177	0.0322	0.0000	0.7257	0.0781	0.0000	0.8240	0.0692	0.0000
	Persist.	0.9791	–	–	0.3060	–	–	0.9487	–	–	0.9713	–	–	0.8995	–	–	0.8923	–	–
	R^2	0.0217	–	–	0.0114	–	–	0.0146	–	–	0.0177	–	–	0.0149	–	–	0.0085	–	–
	F-stat	1.8786	–	0.0447	0.9718	–	0.4665	1.2539	–	0.2526	1.5240	–	0.1258	1.2807	–	0.2368	0.7282	–	0.6983
FNL	CON.	0.0000	0.0000	0.0016	0.0002	0.0000	0.0000	0.0000	0.0000	0.0949	0.0000	0.0000	0.1627	0.0000	0.0000	0.0838	0.0000	0.0000	0.0155
	ARCH	0.1833	0.0562	0.0011	0.4514	0.2686	0.0929	0.0642	0.0302	0.0333	0.1535	0.1013	0.1299	0.1089	0.0385	0.0047	0.1477	0.0425	0.0005
	GARCH	0.7348	0.0615	0.0000	0.1789	0.1553	0.2493	0.8611	0.0630	0.0000	0.7450	0.1463	0.0000	0.7424	0.1142	0.0000	0.8093	0.0483	0.0000
	Persist.	0.9181	–	–	0.6303	–	–	0.9253	–	–	0.8985	–	–	0.8513	–	–	0.9570	–	–
	R^2	0.0222	–	–	0.0055	–	–	0.0288	–	–	0.0013	–	–	0.0598	–	–	0.0166	–	–
	F-stat	1.9242	–	0.0388	0.4647	–	0.9129	2.5087	–	0.0057	0.1092	–	0.9997	5.3821	–	0.0000	1.4309	–	0.1616
IND	CON.	0.0001	0.0000	0.0057	0.0000	0.0000	0.0932	0.0000	0.0000	0.0381	0.0000	0.0000	0.0974	0.0000	0.0000	0.1539	0.0000	0.0000	0.0017
	ARCH	0.1992	0.0547	0.0003	0.0963	0.0515	0.0614	0.1069	0.0305	0.0005	0.0758	0.0176	0.0000	0.1018	0.0555	0.0669	0.2087	0.0595	0.0004
	GARCH	0.5483	0.1169	0.0000	0.6793	0.1679	0.0001	0.8392	0.0452	0.0000	0.9137	0.0193	0.0000	0.8215	0.0947	0.0000	0.6997	0.0672	0.0000
	Persist.	0.7475	–	–	0.7756	–	–	0.9461	–	–	0.9895	–	–	0.9233	–	–	0.9084	–	–
	R^2	0.0142	–	–	0.0157	–	–	0.0132	–	–	0.0023	–	–	0.0413	–	–	0.0087	–	–
	F-stat	1.2169	–	0.2759	1.3531	–	0.1977	1.1360	–	0.3319	0.1979	–	0.9964	3.6399	–	0.0001	0.7403	–	0.6867
MTL	CON.	0.0000	0.0000	0.0289	0.0000	0.0000	0.0675	0.0000	0.0000	0.0004	0.0000	0.0000	0.1408	0.0000	0.0000	0.2468	0.0000	0.0000	0.2363
	ARCH	0.1407	0.0370	0.0001	0.0792	0.0285	0.0055	0.2085	0.0526	0.0001	0.0534	0.0317	0.0918	0.0445	0.0245	0.0699	0.1061	0.0385	0.0059
	GARCH	0.7842	0.0576	0.0000	0.8355	0.0684	0.0000	0.6173	0.0775	0.0000	0.8841	0.0604	0.0000	0.8895	0.0753	0.0000	0.8436	0.0907	0.0000
	Persist.	0.9249	–	–	0.9147	–	–	0.8258	–	–	0.9375	–	–	0.934	–	–	0.9497	–	–
	R^2	0.0196	–	–	0.0288	–	–	0.0133	–	–	0.0202	–	–	0.0477	–	–	0.0063	–	–
	F-stat	1.6956	–	0.0774	2.5130	–	0.0056	1.1413	–	0.3279	1.7406	–	0.0678	4.2380	–	0.0000	0.5325	–	0.8679

Notes: This table presents the estimated coefficients, standard errors and *p*-values for the conditional variance equations. Markets are BEL – Belgium, FIN – Finland, FRA – France, GER – Germany, IRE – Ireland, ITL – Italy. Sectors are CND – Consumer Discretionary, CNS – Consumer Staples, FNL – Financial, IND – Industrials, MTL – Materials. CON – Constant. Persistence = ARCH + GARCH.