Dynamic Interactions among Four European Market Regions
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Abstract
This paper examines the integration process of cross-listed equities in Europe. The primary focus of this study is to examine the volatility and error spillover effects for cross-listings across regional markets with different structures. More specifically, we analyse the magnitude of volatility and error spillovers and the volatility persistence among the home equity of cross-listed companies across four regional stock markets in Europe: the Scandinavian (Copenhagen, Stockholm, Helsinki and Oslo), the French (Brussels, Paris, Milan, Amsterdam and Madrid), the Germanic (Vienna, Zurich and German ones) and the UK (London and Dublin) stock markets. We examine the above regions in order to detect information spillover effects for investors when they construct portfolios of cross-listed equities, across markets with broadly different regional structures. Overall, we find that spillover effects are important across regional European markets for cross-listed companies.

Key words: Spillover effects, GARCH-BEKK model, volatility, cross-listings
JEL classification: G15, C3, C61

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INTRODUCTION
This paper examines the integration process of cross-listed equities in Europe across regional markets with different stock market equity structures. As a result, we examine the magnitude and persistence of information spillovers among the home equity of cross-listed companies across the Scandinavian (Copenhagen, Stockholm, Helsinki and Oslo), French (Brussels, Paris, Milan, Amsterdam, and Madrid), Germanic (Vienna, Zurich, and German ones) and UK (London and Dublin) stock markets. In order to investigate what degree of integration there is at the specific regional markets, we analyse the spillover effects among the above regions so that we detect information spillover effects across markets with broadly different regional equity structures.

In his seminal study Karolyi (1995) examined volatility spillover effects between the United States (S & P 500) and Canada (TSE 300) and demonstrated that such spillovers on the portfolios of ‘inter-listed’ versus ‘non-inter-listed’ stocks were distinctly different. Thus, the magnitude and persistence of S&P 500 shocks are greater for subsequent returns of ‘inter-listed’ stocks than ‘non-inter-listed’ stocks. Likewise, Eun and Jang (1997) found statistical evidence that there are dynamic interactions among the prices of those stocks that are ‘cross-listed’ on the three major stock markets of the world, i.e. New York, London, and Tokyo.

The objective of this study is to investigate volatility spillovers in relation to cross-listed companies in Europe for portfolio construction purposes. In particular, I look at the differences of the whole integration process (e.g. size and sign) among European regional equity markets and its risk exposure for portfolio investment purposes. In this study, we examine volatility and error spillovers and volatility persistence across and within four selected European regional markets in order to gain more insights in the way of constructing equity portfolios.

This paper is structured as follows: Section 2 cites the references, while 3 outlines the research design and discusses the data and the methodology. Section 4 presents and analyses the empirical results and, finally, Section 5 concludes the paper and offers some future research directions.

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LITERATURE REVIEW

There is an extensive empirical literature that examines information transfer or spillover effects in equity markets. Most of this literature has examined the interrelatedness of major exchanges in the U.S., Europe and Asia (Eun and Shim, 1989; Koch and Koch, 1991).

A number of studies bring to light empirical evidence on inter-temporal relationships between volatility and expected returns. The seminal works of Engle (1982) and these of Pindyck (1984) and Bollerslev et al. (1988) all provide evidence that volatility is ‘time-varying’ and that news tends to be clustered together with regard to the magnitude of its impact on stock prices. This is known as ‘volatility clustering’ and may be related to market dynamics. According to Bollerslev et al. (1992), ‘volatility clustering’ means that a market tends to be volatile for a week or two and then calms gradually during the following several weeks. Therefore, if traders have heterogeneous expectations, with some having insider information, news may disseminate after the first period. However, differences in investors’ expectations may take some time to be eradicated.

Volatility clustering also constitutes the transmission of news (e.g. daily and intraday) from one market to another. Among others, Bennett and Kelleher (1988), Von Furstenberg and Jeon (1989), Hamao et al. (1990), King and Wadhani (1990), Schwert (1990), Susmel and Engle (1990), Neumark et al. (1991), Becker et al. (1992), Granger and Machina (2006) and Demetrescu (2007) provide empirical evidence of this type of news transmission. In their various analyses, the above researchers suggest that the transmission of volatility between markets is also time-varying, that is, lagged spillovers of price changes and price volatility exist between major stock markets. Also, when volatility is high, price changes in major stock markets tend to become highly correlated. This type of correlation may be due to the fact that volatility spillovers that emanate from more efficient markets and are transmitted to less efficient markets are contagious.

For daily transmission of news, Saleem (2009) examined through a GARCH-BEKK approach whether the linkage of the Russian equity market (during the 1998 Russian financial crisis, before and after this period, as well as for a period from 1995 to 2007) to the world market (Russia-USA, Russia-European Union, Russia-Emerging Europe and Russia-Asia) is strong. The results suggest a weak linkage with partial integration between Russian equities and the world market. In particular, the above linkage is leading partially from the Russian market to the world market. Also, the Johansen cointegration test further establishes the interdependence among the markets during the crisis period, finding high correlations. Savva (2009) investigates the transmission of price and volatility spillovers across the US and the European stock markets in bivariate combinations. His findings suggest that the dynamic conditional correlation model captures the relationship between stock markets adequately, whereas a more general asymmetric model is required for the remaining cases. His results support the hypothesis that there is influence not only from the US to European markets, but also from European to the US markets. One reasonable explanation of the above results is that such patterns of spillovers lead regulators to impose rules on markets in a more pervasive way in order to remove inefficiencies. This, in turn, breaks down the regulatory restrictions that act as barriers to capital market integration.

There is some evidence that relates volatility spillovers to barriers on structural differences between markets. For instance, Kanas (1998) shows that spillovers across markets with diverse structures are different compared to those with similar structures. While Kanas (1998) focuses on London, Paris, and Frankfurt, other studies (e.g. Hamao et al., 1990; Theodossiou and Lee, 1993, Susmel and Engle, 1994, Koutmos and Booth, 1995) focus on the major stock markets such as the US, Canada, Japan, the UK, and Germany.

For different markets (e.g. bond and equity ones) the examination of volatility spillovers is also valid concerning the presence of asymmetry in the transmission mechanism. For instance, Dean et al. (2010) present return and volatility spillover effects between the equity and bond markets of Australia using a GARCH based model. They found that the dynamic of the above spillovers for both (returns and volatility) is asymmetric. In addition, they showed that bad news for return volatility from the bond market spills over into lower equity returns while good news for return volatility from the equity market spills over to lower bond returns. Therefore, transmission of news from one market to the other depends upon the respective signs of the return shocks in each market.
DATA AND METHODOLOGY
Sample Selection
This paper focuses on ‘cross-listed’ equities in 14 European countries. This means that data has been obtained for firms that have cross-listings. For that purpose, I collected information on daily home equity performance over the period 1/1/1987 to 1/1/2007.
To determine how much the above categories of equities contribute to the variations of stock price volatility transmission between equities, only the average return of these groups were added in the construction of equity portfolios. Furthermore, trading holidays as identified by Datastream were excluded in order to obtain continuous data series. The final sample consists of 210 firms having 504 foreign cross-listings across different European markets that met our selection criteria.

The GARCH-BEKK Model
According to Engle and Kroner (1995), the GARCH-BEKK parameterisation is specified in such a manner that no restrictions are required to ensure a positive definite \( H_t \) matrix.
Underlying these theoretical developments, the multivariate GARCH-BEKK (Berndt et al., 1974; Engle and Kroner, 1995) model is written as follows:

\[
    r_i = \alpha + \sum_{p=1}^{n} \Phi_p r_{t-p} + e_i | \Omega_{t-1} \sim N(0, H_t)
\]

where:
- \( r_i \) is the return series,
- \( e_i \) is the error term of return equation,
- \( \alpha \) is the constant term in the above return equation,
- \( \Phi_p \) is the matrix of coefficients with the \( p \) lagged values of \( r_i \),
- \( \Omega_{t-1} \) is the matrix of conditional past information that includes the \( p \) lagged values of \( r_i \).
To avoid the problems of dealing with normal distributions, the first moment of errors \( (e_i) \) is represented by a martingale process, as shown in Equation (2). It is assumed that \( e_i \) in Equation (1) follows a process of \( E(e_i) \),

where:
\[
    E(e_i) = E(r_i - \mu_i)
\]

\( \mu_i \) is the long-term drift coefficient and
\[
    H_{t+1} = CC' + BH_tB + A'e_i'e_i'A
\]

In the variance Equation (3) of the GARCH-BEKK model the squared innovation series are smoothed with an \( n \)-period moving average technique using the AKAIKE and SCHWARTZ criteria in order to account for the number of lags on the error term of equation (3). We used the same criteria as previously in order to specify the number of lag returns that should be imposed on the second term of equation (1) of the GARCH-BEKK model. This is written as:

\[
    \tilde{e}_i = \frac{1}{n}(e_{i} + e_{i-1} + ... + e_{i-n+1})
\]

Given a sample of \( T \) observations of the returns vector, \( r_i \), the parameters of the bivariate systems are estimated by computing the conditional log-likelihood function for each time period as follows:

\[
    L_i(\Theta) = -\log 2\pi - \frac{1}{2} \log |H_{t+1}| - \frac{1}{2} E(e_i')(\Theta)H_t^{-1}(\Theta)E(e_i)(\Theta)
\]

and
\[
    L(\Theta) = \sum_{t=1}^{T} L_i(\Theta)
\]
where \( \Theta \) is the vector of all parameters. Numerical maximization of the log-likelihood function following the Berndt et al. (1974) algorithm yields the maximum likelihood estimates and associated asymptotic standard errors.

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EMPIRICAL RESULTS
In this section I analyze and compare the magnitude and persistence of volatility and error spillovers for the sample of cross-listed firms across the four selected regional markets (Scandinavian, Germanic, French and UK). Table 1 shows that the magnitude of volatility spillovers varies, with the volatility spillover coefficient from the Germanic to French exchange markets being high in value and equal to (0.16). Specifically, the volatility spillover coefficient (0.04) from the Germanic to the Scandinavian markets is equal to the spillover coefficient from the Germanic to the UK markets, with the latter value being equal to the former one (0.04). However, the sign in the latter case is negative, indicating the existence of negative news coming from the Germanic stock market exchanges. The volatility spillover coefficient from the Scandinavian to Germanic markets is also negative and equal to (-0.09), which is the second largest spillover in magnitude after the one from the Germanic to French regional markets.

The results for the volatility persistence are reported at the bottom of Table 1. In terms of volatility persistence (previous period’s stock price volatility influences next period’s stock price volatility), the results indicate strong effects in the Scandinavian (0.94), the Germanic (0.98) and the UK (0.96) regions but not in the French region (0.70). In the French markets, volatility persistence is found to be below the standard value of 0.90 which indicates a moderate impact of the previous period’s volatility to the following period’s volatility.

Table 1: Spillover Effects for Cross-Listed Companies across Regional Markets

<table>
<thead>
<tr>
<th>All home equity portfolios-period: 7/1/87-1/1/2007</th>
<th>Scandinavian</th>
<th>Germanic</th>
<th>French style</th>
<th>UK</th>
</tr>
</thead>
<tbody>
<tr>
<td>Volatility Transmission from Germanic to Scandinavian</td>
<td>0.04</td>
<td>(0.02)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Volatility Transmission from Scandinavian to Germanic</td>
<td>-0.09</td>
<td>(0.03)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Volatility transmission from Germanic to French style</td>
<td>0.16</td>
<td>(0.03)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Volatility Transmission from Germanic to UK</td>
<td>-0.04</td>
<td>(0.01)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Error Transmission from Scandinavian to French style</td>
<td>0.07</td>
<td>(0.02)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Error Transmission from Scandinavian to Germanic</td>
<td>0.06</td>
<td>(0.02)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Error transmission from Germanic to French style</td>
<td>0.07</td>
<td>(0.03)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Error Transmission from UK to French style</td>
<td>0.06</td>
<td>(0.03)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Error Transmission from French style to UK</td>
<td>0.05</td>
<td>(0.02)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Error Transmission from Germanic to UK</td>
<td>0.14</td>
<td>(0.02)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Volatility persistence</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Scandinavian</td>
<td>0.94</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Germanic</td>
<td>0.98</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>French style</td>
<td>0.70</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>UK</td>
<td>0.96</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Log-Likelihood</td>
<td>47453.23</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Note: Numbers in parentheses are standard errors.

The second half of Table 1 shows the error spillover coefficients simultaneously for six equity pairs, namely, Scandinavian–French, Scandinavian-Germanic,
Scandinavian-UK, French-Germanic, French-UK, and Germanic-UK regions. At the 5 percent significance level, there are reciprocal error spillovers for the equity pairing of the UK and French markets and unidirectional error spillovers from the Scandinavian to French (Germanic) region and from Germanic to French (UK) region. A comparison of these results indicates that the magnitude of coefficients is generally similar in size ranging from 0.05 to 0.07, with the exception of the error spillover from Germanic to UK markets, which was found to be equal to (0.14).

Error and volatility spillovers indicate that the four European regions react quite differently to the information impact from the other three regions. In addition, this means that the integration process does differ somehow (e.g. in size, sign and below in persistence) for the four European regions, indicating a regional market difference on the way under which the portfolios of equities react to the impact of news from the other European regional equity portfolios. Within the same market, the transmitted mechanism is dedicated by the volatility persistence results. The volatility persistence is important as it enables one to decide on the most influential regional stock market within a regional area. If the news across regional markets lasts longer, it gives an advantage to investors regarding their strategy in selecting in which market region to invest. In the market region where the volatility persistence lasts longer, it gives investors plenty of time to evaluate their potential investments and reactions. However, in the French region the persistence of news is lower in comparison to the other three regions. This implies that, in the French region, when investors are about to choose their equity investments, they should make quick decisions, and they can not delay, as the market will punish them if they choose equities with low risk persistence in their portfolio.

MAIN FINDINGS AND IMPLICATIONS
The main results indicate that:
A multivariate GARCH-BEKK model provides a useful modelling framework to examine the process governing spillovers between markets with different regional equity structures. The cross-market spillover patterns for home equities across the selected regional markets were found to be significant indicating a well integrated market with small differences in the magnitude (e.g. size), sign and persistence of the whole process. Thus, it is crucial for investors to be aware of regional equity shocks, which may influence their strategies differently on these regional equity markets where the degree of stock price volatility is varied. Future research can be oriented towards examining the hypothesis of transmission of equities among developing markets or among developed and developing markets, where the degree of risk may be different than in this study in the transmission among regional stock markets.

REFERENCES


