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Article

Multivariate GARCH models and risk minimizing portfolios: The importance of medium and small firms

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ABSTRACT

This paper re-examines the relationship among different firms using a combination of multivariate GARCH models (symmetric and asymmetric with structural changes) and the IBEX 35, IBEX MEDIUM CAP, and IBEX SMALL CAP indexes as the benchmarks to track the performance of large, medium and small firms, respectively. Our findings show the existence of a significant difference in the transmission of volatility when the asymmetric behavior and structural changes are considered. After calculating the risk minimizing portfolio weights, we show that the minimum-volatility portfolio is composed of medium and small indexes with a higher weight of medium firms for a set of different scenarios.

1. Introduction

The strong performance of medium and small firms has inspired huge interest among investors, analysts, financial intermediaries, communication media, and financial market participants in general during the last few years. Some interesting studies are those of Ewing and Malik (2005) and Hassan and Malik (2007), where the relationships between large and small firms in the US market are analyzed, or those of Aragó and Fernández (2007) and Pardo and Torró (2007) who analyzed that relationship for the Spanish stock markets.

The present paper re-examines the relationship among different firms using the IBEX 35, IBEX MEDIUM CAP, and IBEX SMALL CAP indexes as the benchmarks to track the performance of large, medium and small firms, respectively.[1] This study emphasizes to the role that sudden changes in variance may play not only in the transmission process but also in the calculation of risk minimizing portfolios.

We improve the previous literature in various ways. Firstly, to our knowledge this paper is the first one to focus on all three IBEX indexes. Pardo and Torró (2007) and Chuliá and Torró (2007) used the Ibex Complementario and the Ibex Medium Cap taking them as the reference for the small firms. Secondly, in order to check the robustness of our results, we employ a symmetric and an asymmetric multivariate GARCH model with structural changes. Thirdly, since different assets are traded based on these indexes, we use the estimated volatilities to calculate the risk minimizing portfolio weights considering the methodology of Kroner and Ng (1998) and a set of different scenarios. Finally, we shed some light on the behavior of the Spanish stock market by providing some clues to better understand portfolio allocations.

Our study focuses on the Spanish stock market because in recent years it has become a reference for the main European stock markets due to improvements in the technical, operational and organizational systems supporting the market which have enabled it to channel large volumes of investment and have made it more transparent, liquid, and effective.

Our findings show the existence of a significant difference in the transmission of volatility when asymmetric behavior and structural changes are considered. However, the most interesting results are related to the risk minimizing portfolio composition. For all the different scenarios analyzed, we show that the minimum-volatility

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[1] In the Spanish market large, medium and small firms are represented by the IBEX 35, IBEX MEDIUM CAP, and IBEX SMALL CAP indexes respectively. The IBEX 35 is composed of the 35 largest companies in terms of capitalization and liquidity which are traded on the Spanish stock market. Additionally, the IBEX MEDIUM CAP and the IBEX SMALL CAP indexes were created to provide better insight into the evolution of medium and small capitalization companies. Nowadays, they are a national and international reference. It is also important to note that these indexes are replicable and investable, that is, their calculation allows for the issuance of financial products such as Exchange Traded Funds (ETFs), index funds or derivatives.

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Table 1
Descriptive statistics.

	IBEX 35	IBEX MEDIUM CAP	IBEX SMALL CAP	Equality tests
Mean	0.00023	0.00024	0.00012	0.1609 (0.85)
Std. Dev.	0.01441	0.01038	0.01159	150.92 (0.00)
Skewness	−0.01527	−0.43262	−0.32531	
Kurtosis	8.28053	7.14654	8.02533	
Jarque-Bera	5851.2 (0.00)	3764.9 (0.00)	5387.9 (0.00)	
Q (20)	62.336 (0.00)	102.90 (0.00)	223.81 (0.00)	
Q^2 (20)	3032.9 (0.00)	2406.6 (0.00)	1580.9 (0.00)	
ARCH (20)	754.77 (0.00)	690.96 (0.00)	600.28 (0.00)	
ADF (4)	−33.303 (0.00)	−30.107 (0.00)	−28.092 (0.00)	
PP (6)	−68.601 (0.00)	−65.762 (0.00)	−62.666 (0.00)	

This table presents descriptive statistics for the daily return series of the Ibex 35, the Ibex Medium Cap and the Ibex Small Cap indexes. Last column reports the mean and variance equality tests using the ANOVA and Levene statistics, respectively. Skewness and Kurtosis refer to the series skewness and kurtosis coefficients. The Jarque-Bera statistic tests the normality of the series. This statistic has an asymptotic χ^2 (2) distribution under the normal distribution hypothesis. Q (20) and Q^2 (20) are Ljung–Box tests for 20th-order serial correlation in the returns and squared returns. ARCH (20) is the Engle (1982) test for the 20th-order ARCH. These three tests are distributed as χ^2 (20). The ADF (4) and PP (6) refer to the Augmented Dickey and Fuller (1981) and Phillips and Perron (1988) unit root tests corresponding to the process with intercept but without trend. The p-values of these tests are reported in parenthesis.

portfolio is composed of medium and small indexes with a higher weight of medium firms. These results have important implications for building accurate asset pricing models, forecasting volatility, and understanding the Spanish stock market.

The remainder of the paper is organized as follows: Section 2 presents a review of related literature. Section 3 describes the data and methodology. In Section 4 we show the principal results and, finally, in Section 5 we provide the main conclusions.

2. Literature review

One of the most important issues in finance in recent years has been the analysis of price and volatility spillovers among stock markets, sector indexes, or small and large firm portfolios. Initial studies such as those by Hamao et al. (1990), King and Wadhwani (1990) and Lin et al. (1994), among others, were followed by others such as Fleming et al. (1998), who demonstrated how cross market hedging and sharing of common information could lead to transmission of volatility across markets over time, or those of Chelley-Steeley and Steeley (1996) and Grieb and Reyes (2002), who examine data for the UK using different methodologies and show the existence of a bi-directional feedback of conditional variances between UK firms of different sizes.

More recently, Malik and Hammoudeh (2007) analyze the volatility and shock transmission mechanism among equity and global crude oil markets of US and Gulf countries. Ewing and Malik (2005) examine the asymmetry in the predictability of volatility allowing for sudden changes in variance by using the Bivariate GARCH model. Finally, Hassan and Malik (2007) and Li and Majerowska (2008) use multivariate GARCH models (including more than two variables) to analyze the transmission of shocks and volatility among different US sector indexes and links between emerging stock markets in Poland and Hungary and established markets in Germany and the US, respectively.

Volatility behavior in the Spanish stock market has also been studied in recent years. Cuñado et al. (2004) analyze the behavior of volatility in the Spanish stock market by detecting if volatility has changed its behavior significantly over a period and by identifying the causes. The results show that the Spanish stock market is subject to higher, but less persistent, volatility and that trading volume significantly impacts on volatility.

Aragó and Fernández (2007) analyze the European transmission of information through volatilities with structural changes in variance for the main stock indexes following the ICSS algorithm to detect sudden changes. Their findings suggest that markets react not only to local news, but also to news originating in other markets, especially adverse news. Soriano and Climent (2006a) use a multivariate GARCH approach to analyze the importance of regional versus industrial effects and volatility transmission patterns in a particular industry across different regions. Chuliá and Torró (2007) analyze volatility spillovers between large and small firms in the Spanish stock market by using a conditional CAPM with an asymmetric multivariate GARCH-M model.

Finally, Pardo and Torró (2007) study volatility spillovers between large and small firms by analyzing the impulse-response function for conditional volatility computed following the Lin (1997), and Meneu and Torró (2003) procedure. They show that volatility spillovers exist in both directions between those portfolios after bad news.

This paper adds a new point of view to the analysis of volatility in the Spanish stock market. As opposed to the previous empirical evidence, we focus on large, medium and small firms and propose a risk minimizing portfolio strategy based on a multivariate GARCH methodology. Additionally, in order to obtain more conclusive economic implications, we analyze the optimal portfolio responses to good and bad news.

3. Data and methodology

3.1. Data

The data consists of daily close returns (calculated as logarithmic differences) for the IBEX 35, IBEX MEDIUM CAP, and IBEX SMALL CAP indexes for the period from January 14, 1992 to December 30, 2011.[2]

Table 1 presents the summary statistics for these return series. An initial conclusion might suggest that the performance of the IBEX MEDIUM CAP as measured by mean return is better (0.024%) than the IBEX 35 (0.023%) and the IBEX SMALL CAP (0.012%). However, on the basis of the Anova test we cannot reject the null hypothesis that all series in the group have the same mean since those differences are not statistically significant. On the other hand, due to the rejection of the null hypothesis of equality of variances among the return series, we can conclude that the IBEX MEDIUM CAP index is less volatile (standard deviation of 1.03%) than the other two indexes (1.15% and 1.44% for IBEX SMALL CAP and IBEX 35, respectively). These preliminary results are consistent with

[2] The data was extracted from Sociedad de Bolsas, which is the owner of the indexes and is in charge of their management, calculation, dissemination as well as of the review of their composition.