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# Value at Risk and expected shortfall of firms in the main European Union stock market indexes: A detailed analysis by economic sectors and geographical situation☆

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ABSTRACT

We have analyzed extreme movements of the main stocks traded in the Eurozone in the 2000–2012 period. Our results can help future very-risk-averse investors to choose their portfolios in the Eurozone for risk management purposes. We find two main results. First, we can clearly classify firms by economic sector according to their different estimated VaR values in five of the seven countries we analyze. Specially, we find sectors in general where companies have very high (telecommunications and banking) and very low (petroleum, utilities, energy and consumption) estimated VaR values. Second, we only find differences according to the geographical situation of where the stocks are traded in two countries: (1) all firms in the Irish stock market (the only financially rescued country we analyze) have very high estimated VaR values in all sectors; while (2) in Spain all firms have very low estimated VaR values included in the banking and the telecommunication sectors. All our results are supported when we also study the expected shortfall of the firms.

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## 1. Introduction

Although diversification in the portfolio is a well-known strategy to reduce risk, this is not a guarantee to avoid losses specially in crisis periods. All this motivates the need to have rigorous measures of risk, and specially, during extreme events. Both academics and practitioners have been trying to find determinants of extreme behaviors. For example, Cutler et al. (1989) in fact conclude that extreme values for returns happen during periods where there is no news with special relevance. The concept of financial risk is directly linked with one of the losses; however, there are different measures of risk. Value at Risk (VaR) has its origin in Riskmetrics, that was developed by JP Morgan. Moreover, VaR became a very important measure of risk specially since the Basel Committee on banking supervision declared that banks should be able to cover losses in their portfolios (see for example Dowd (1999), Linsmeier and Pearson (2000), Alexander and Baptista (2003), Bali et al. (2009), Rossignolo et al. (2012) and Kaplanski and Levy (2015) of the relevance of VaR in practice).

VaR has been applied in many different situations. This article analyzes the extreme movements of the main stocks traded in the Eurozone by sectors in the period 2000–2012. European stocks have been analyzed deeply in the literature (see e.g. Corhay et al. (1993), Osborn and Savva (2008), Ñguez (2008) and Laopodis (2009)), however, the main objective in this paper is to study their VaR behavior by economic sectors and if there are differences by countries. The main novelty of this paper focuses on providing some interesting insights into understanding the heterogeneity in extreme movements of the shares in different economic sectors in the Eurozone. Although knowledge of the past does not guarantee future events, we show the performance of VaR of the main firms traded in the main European stock market indexes from 2000 until nowadays and our results can help future very-risk averse investors to choose their portfolios in the Eurozone for risk management purposes. In the tables provided in this paper, the readers can find the estimated VaR measure for all firms traded in the main European stock markets. Iglesias and Lagoa-Varela (2012) have only studied the 2000 decade for the fifty companies traded in the Euro Stoxx 50, and they found that firms can be classified by economic sectors but not by geographical situation. In this paper, we extend this analysis to study over 300 firms that belong to the main European stock market indexes and to find out if the results change.

There are two distinct VaR measures, one dealing with the unconditional distribution and one with the conditional distribution. The former provides risk managers with information on different worst case scenarios dealing with market risk occurring over long periods. In contrast, the latter measure details the present risk facing investment managers conditional on the present risk and return environment of a futures contract (see e.g. Sheu and Chen (2012) for an example in analyzing conditional VaR). In this paper we are interested in providing measures of unconditional risk based on the 2000–2012 period (see Jansen and de Vries (1991), Kearns and Pagan (1997), Iglesias and Linton (2009),

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Iglesias (2012) and Iglesias and Lagoa-Varela (2012) as empirical examples where unconditional VaR estimates are provided) and that is why we focus our empirical analysis on the VaR estimates. Therefore our results provide risk managers with information on different worst case scenarios dealing with market risk occurring over long periods. Moreover, in order to check the robustness of our results, we also provide the expected shortfall (ES) estimates for each of the firms (see e.g. Christoffersen and Goncalves (2005), Inui and Kijima (2005), Bali et al. (2009), So and Wong (2012) and Ardia and Hoogerheide (2013)). We have carried out all the analysis in the paper also with the ES estimates, and the results from this second measure (we provide the historical estimates) confirm the same results we obtain from the estimated VaR.

In relation to time period, since we have a not very large sample size, we need a method that can provide reasonable VaR estimates. Many alternative estimators of unconditional Value at Risk can be found. The most traditional one was proposed by Hill (1975), where the existence of generalized autoregressive and conditional heteroskedastic (GARCH) effects (very important when modeling financial returns; see e.g. Engle (1982), Bollerslev (1986) and Taylor (1986) for more details) can be implicitly acknowledged. Hill (2010) has shown that the Hill (1975) estimator is robust to the existence of GARCH effects; however, there exists clear evidence in the literature of its poor finite sample properties (see e.g. Kearns and Pagan (1997) and Wagner and Marsh (2005)). In this paper, we also use an alternative estimator that is shown to have improved finite sample properties under some assumptions and it is based on the work of Stărică and Pictet (1997) and Berkes et al. (2003) and it has been generalized to the case of the GJR–GARCH model of Glosten et al. (1993) by Iglesias and Linton (2009). The reason for the improved finite sample properties of the Iglesias and Linton (2009) estimator of tail thickness is that it converges at rate $\sqrt{T}$ to a normal distribution (where $T$ is the sample size). In order to do that, it is necessary first to fit a GARCH-type volatility model to the time series. This is a very reasonable assumption since there are many papers such as Teresiene (2009), Aktan et al. (2010) and Christensen et al. (2012) showing that GARCH type models are suitable to model returns in the stock market. GARCH models can incorporate conditional heteroskedasticity which is an empirical stylized fact of financial returns. Another well-known advantage of GARCH models is that they are more parsimonious than ARCH models. Following Iglesias and Linton (2009), we also present Hausman type specification tests in the Empirical results section to choose the VaR estimated value (see for example Jadhav and Ramanathan (2009) for a review of parametric and nonparametric estimators of VaR).

The plan of the paper is as follows. In Section 2 we present the data. Section 3 shows the model and the estimators and tests that are used, while Section 4 provides the empirical results. Section 5 finally concludes. All tables are contained in Appendix A.

## 2. Data

We use daily data[1] of returns of all firms traded in the following seven main European countries from January 2000 until December 2012 (we use the adjusted value at the moment of the closing of each daily session following the literature such as Jansen and de Vries (1991), Kearns and Pagan (1997) and Iglesias and Lagoa-Varela (2012)):

- The DAX 30 (Deutscher Aktien Index) is a blue chip stock market index consisting of the 30 major German companies trading on the Frankfurt Stock Exchange.
- The IBEX 35 is the benchmark stock market index of the Bolsa de Madrid, Spain's principal stock exchange. Initiated in 1992, the index is administered and calculated by Sociedad de Bolsas, a subsidiary of Bolsas y Mercados Españoles (BME), the company which runs Spain's securities markets (including the Bolsa de Madrid). It is a market capitalization weighted index comprising the 35 most liquid Spanish stocks traded in the Madrid Stock Exchange General Index, which are reviewed twice annually.
- The CAC 40 is a benchmark French stock market index. The index represents a capitalization-weighted measure of the 40 most significant values among the 100 highest market caps on the Paris Bourse (now Euronext Paris).
- The AEX 25 index, derived from Amsterdam Exchange index, is a stock market index composed of Dutch companies that trade on Euronext Amsterdam, formerly known as the Amsterdam Stock Exchange. The index is composed of a maximum of 25 of the most actively traded securities on the exchange.
- The ISEQ is a benchmark stock market index composed of companies that trade on the Irish Stock Exchange.
- The FTSE MIB (Milano Italia Borsa) (the S&P/MIB prior to June 2009) is the benchmark stock market index for the Borsa Italiana, the Italian national stock exchange, which superseded the MIB-30 in September 2004. The index consists of the 40 most-traded stock classes on the exchange. The index was administered by Standard & Poor's from its inception until June 2009, when this responsibility was passed to FTSE Group, which is 100% owned by the Borsa Italiana's parent company London Stock Exchange Group.
- The FTSE 100 Index is a share index of the stocks of the 100 companies listed on the London Stock Exchange with the highest market capitalization. It is one of the most widely used stock indices and is seen as a gauge of business prosperity.

We analyze in total over 300 firms.[2]

If we denote $P_t$ the price of a stock at period $t$, then we construct the return as

$$r_t = \log(p_t/p_{t-1})$$

where $t = 1, \ldots, T$. We construct the stock returns for all companies and we test for the stationarity of the series by using standard Augmented Dickey–Fuller (1979) test and Phillips–Perron (1988) tests. We reject at all standard significant levels the null hypothesis of the unit root for all returns. We have computed some descriptive statistics for the returns of all analyzed firms.[3] It is possible to check in those statistics that the Irish stock market is the one that presents higher unconditional variance in most returns independently of the economic sector where they belong to.

## 3. Model and theory

The traditional Hill (1975, 2010) estimator $\left(\hat{\kappa}^+\right)$, allows to obtain an estimate for the tail index parameter $\kappa$. The Hill (1975, 2010) estimator

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[1] http://es.finance.yahoo.com/. The data has been obtained from the finance-yahoo database.

[2] The reason to analyze the previous seven stock markets is that they are the only European ones where we can have firm-level data from 2000 in the finance-yahoo-database. Moreover, in January 2013 there are very important changes in the European financial markets. For example, in Spain since January 2013 some very important firms such as Bankia are not part of the IBEX anymore. Also, the value added tax has increased, it is necessary to declare the accounts abroad to the government and the risk premium in Spain has changed significantly. The gross domestic product (GDP) in France contracted 0.20% in the first quarter of 2013 over the previous quarter. France is the fifth largest economy in the world and the second largest in the Euro Area. The German economy expanded less than forecast in the first quarter of 2013 while France slipped into recession. Netherlands is also on the edge of economic crisis in 2013 since unemployment surges as home prices collapse. That is why we have chosen December 2012 as the last data point in our analyzed period, to avoid important structural breaks since after 2012, an important increase in the volatility of the returns of firms has occurred, and we believe that alternative methodologies should be used in this case to the ones employed in this paper that can allow for the existence of structural breaks when modeling the extreme behavior of a time series.
We analyze those firms that belong to each of the stock market indexes with the date January 1, 2013. For most of these firms, we have data available only from 2000 onwards.

[3] The results are available in a supplementary appendix available from the author upon request.

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