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Extreme observations and risk assessment in the equity markets of MENA region: Tail measures and Value-at-Risk

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ABSTRACT

The standard "delta-normal" Value-at-Risk methodology requires that the underlying returns generating distribution for the security in question is normally distributed, with moments which can be estimated using historical data and are time-invariant. However, the stylized fact that returns are fat-tailed is likely to lead to under-prediction of both the size of extreme market movements and the frequency with which they occur. In this paper, we use the extreme value theory to analyze four emerging markets belonging to the MENA region (Egypt, Jordan, Morocco, and Turkey). We focus on the tails of the unconditional distribution of returns in each market and provide estimates of their *tail index* behavior. In the process, we find that the returns have significantly fatter tails than the normal distribution and therefore introduce the extreme value theory. We then estimate the maximum daily loss by computing the Value-at-Risk (VaR) in each market. Consistent with the results from other developing countries [see Gencay, R. and Selcuk, F., (2004). Extreme value theory and Value-at-Risk: relative performance in emerging markets. International Journal of Forecasting, 20, 287–303; Mendes, B., (2000). Computing robust risk measures in emerging equity markets using extreme value theory. Emerging Markets Quarterly, 4, 25–41; Silva, A. and Mendes, B., (2003). Value-at-Risk and extreme returns in Asian stock markets. International Journal of Business, 8, 17–40], generally, we find that the VaR estimates based on the *tail index* are higher than those based on a normal distribution for all markets, and therefore a proper risk assessment should not neglect the tail behavior in these markets, since that may lead to an improper evaluation of market risk. Our results should be useful to investors, bankers, and fund managers, whose success depends on the ability to forecast stock price movements in these markets and therefore build their portfolios based on these forecasts.

1. Introduction

The well documented high average stock returns and their low correlations with industrial markets seem to make emerging equity markets an attractive choice for diversifying portfolios (Bekaert & Harvey, 1997; De Santis & Imrohoroglu, 1997 and De Santis). For example, De Santis (1993) finds that adding assets from emerging markets to a benchmark portfolio consisting of US assets creates portfolios with a considerable improved reward-to-risk performance. Harvey (1995) finds that adding equity investments in emerging markets to a portfolio of industrial equity markets significantly shifts the mean-variance efficient frontier to the left. Harvey (1995) and Claessens Dasgupta, and Glen (1995) document that emerging market returns significantly depart from normality. This departure from normality is greatly influenced by the behavior of extreme returns. These observed extreme returns produce a fatter tail empirical distribution for emerging markets stock returns than for the industrial markets. Mandelbrot (1963) and Fama (1965) were the first to point out that the distribution of stock returns have fat tails relative to the normal distribution. Mandelbrot (1963) proposes a non-normal stable distribution for stock returns, in which case the variance of the distribution does not exist. Blattberg and Gonedes (1974) and, later, Bollerslev (1987), in an ARCH context, propose the Student-*t* distribution for stock returns, which has the appeal of a finite variance with fat tails. Jansen and De Vries (1991) and Loretan and Phillips (1994) use extreme value theory to analyze stock return in the US. Their results indicate the existence of second moments and possibly third and fourth moments, but not much more than the fourth moment.

In financial markets, extreme price movements may correspond to market correction during ordinary periods, to stock market crashes or to foreign exchange crises during extraordinary periods. Recently, emerging markets have experienced several extreme market events. Examples include the Mexican devaluation at the end of 1994, the Brady bond crisis at the end of 1995, the Asian series of devaluation during 1997 and the Russian crisis at the end of 1998, among others. The common lesson from these financial disasters is that billions of dollars can be lost because of poor supervision and management of financial risks. The Value-at-Risk was developed in response to these

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financial disasters. The VaR summarizes the worst loss over a target horizon with a given level of confidence, and summarizes the overall market risk faced by an institution (see Dowd, 1998; Jorion, 1997). In the context of VaR, precise prediction of the probability of an extreme movement and understanding the influence of extreme market events is of great importance for risk managers. Since all risk measurement methodologies used to estimate the Value-at-Risk (VaR) of a portfolio assume that the market behavior is stable, extreme market events demand a special approach from risk managers. Extreme movements are related to the tails of the distribution of the underlying data generating process. One approach that can be used to estimate the VaR focuses on modeling the tail of the distribution based on extreme value theory. The link between the extreme value theory and risk management is that EVT methods fit extreme quantiles better than the conventional approaches for heavy-tailed data. Also, the EVT allows for a separate treatment of the tails of a distribution which allows for asymmetry, considering the fact that most financial return series are asymmetric (see Longin, 2000; Danielson & De Vries, 1997; Diebold, Schuermann, & Stroughair, 2000; McNeil, 1998). Even though extreme value theory has previously found many applications in fields of climatology and hydrology, there have been a number of extreme value studies in the finance literature.

Return series are asymmetric (see Longin, 2000; Danielson & De Vries, 1997; Diebold et al., 2000; McNeil, 1998). Even though extreme value theory has previously found many applications in fields of climatology and hydrology, there have been a number of extreme value studies in the finance literature. Examples, include (Reiss & Thomas, 1997; Leadbetter et al., 1983; Embrechts, Klupperberg, & Mikosch, 1997) and other financial applications like Longin (1996, 2000), Longin and Solnik (1998), Danielson and De Vries (1997), Diebold et al. (2000), McNeil (1998) and McNeil and Frey (1998), among other studies. For example, McNeil (1998) study the estimation of the tails of loss severity distribution and the estimation of the quantile risk measures for financial time series using EVT. McNeil and Frey (1998) study the estimation of tail-related risk measures for heteroskedastic financial time series and Embrechts et al. (1997) is a comprehensive source of the extreme value theory to the finance and insurance literature.[1]

Despite the extensive research on the behavior of stock prices in the well-developed financial markets, less is known about it in other markets, specifically in the emerging markets of the Middle East and North African (MENA) region. Research on these markets has focused on the issue of efficiency as well as on their integration with international markets. Bulter and Malaikah (1992) examine individual stock returns in both the Kuwaiti and Saudi Arabian markets over the second half of the 1980s and conclude with market inefficiency in both markets. Darat and Hakim (1997) examine price linkages among three Arab stock markets (Amman, Cairo and Casablanca) and their integration with international markets, and find that these markets are integrated within the region but not at the international level. Darrat and Pennathur (2002) studied economic and financial integration among the countries in the Arab Maghreb region (Algerian, Morocco, and Tunisia) and found that they share a robust relation bringing their financial and economic policies. Abraham Seyyed, and Alsakran (2002) examine the random walk properties of three Gulf stock markets—Kuwait, Saudi Arabia, and Bahrain—after correcting for infrequent trading. They cannot reject the random walk hypothesis for the Saudi and Bahrain markets; however, the Kuwaiti market fails to follow a random walk even after the correction.[2]

Recently, more attention has been given to the MENA region in terms of studying its characteristics, behavior and volatility dynamics. The recent literature details the importance of these markets for risk management, portfolio analysis and market efficiency. For example, Hammoudeh and Li (2008) examined the sudden changes in volatility for five Gulf area Arab stock markets using the iterated cumulative sums of squares (ICSS) and analyzed their impacts on the estimated persistence of volatility. They found that most of the Gulf Arab stock markets are more sensitive to major global events than to local regional factors. For example, the 1997 Asian crisis, the collapse of oil prices in 1998 after the crisis, the adoption of the price band mechanism by OPEC in 2000, and the September 11th attack have been found to have consistently affected the Gulf markets.

Lagoarde-Segot and Lucey (2008) investigated the informational efficiency in a set of seven emerging MENA stock markets. They analyzed the impact of market development, corporate governance and economic liberalization on the latter using a multinomial ordered logistic regression. Their results concluded with heterogeneous levels of efficiency in the MENA stock markets, and their efficiency index seems to be affected mostly by market depth and corporate control, that is, factors directly related to the flow of information. By contrast, variables linked to the overall economic liberalization process do not seem to have explanatory power. Lagoarde-Segot and Lucey (2008) showed that Turkey and Israel showed the strongest evidence of weak-form efficiency. These markets were followed by Jordan, Tunisia and Egypt, with Lebanon and Morocco lagging behind. They associated that with the fact that Turkey and Israel are endowed with more liquid and capitalized stock markets and have well-developed financial systems. Strong capitalization in Jordan is counterbalanced by the fact that banks represent 50% of market capitalization and by the absence of a secondary market. Tunisia, Egypt, Lebanon and Morocco constitute smaller markets, although one limitation of these results is that they do not fully incorporate the recent developments in the Cairo Stock Exchange.

Brooks (2007) studied a set of emerging markets including those from the MENA region using the APARCH model and explored the applicability of the model to those markets. His findings were as follows. First, unlike developed markets where a power term of unity and a conditional standard deviation model appears to be appropriate, emerging markets demonstrate a considerably greater degree of power values. Second unlike developed markets where non-normal conditional error distributions appear to fit the data well, there are a set of emerging markets for which estimation problems arise with a conditional t distribution, and a conditional normal distribution appears to be the preferred option. Third, the degree of volatility asymmetry appears to vary across the set of emerging markets, with the Middle Eastern and African markets having very different volatility asymmetry characteristics to those of the Latin American markets.

Nikkinen et al. (2008) used data from 53 equity markets including the MENA markets to investigate the short term impact of the September 11 attacks on markets' returns and volatility. They found that the impact of the attacks resulted in significant increases in volatility across regions and over the study period. However, stock returns experienced significant negative returns in the short-run but recovered quickly afterwards. Nevertheless, they find that the impact of the attacks on financial markets varied across regions and implied that the less integrated regions (i.e., MENA) are with the international economy, the less exposed they are to shocks. They indicated that the MENA region provides investors with the highest returns and the

[1] The performance of EVT in VaR estimations in emerging markets has been studied by Mendes (2000), Gencay and Selcuk (2004), Silva and Mendes (2003), and Bao, Lee, and Saltoglu (2004). For example, Mendes found that EVT performed more precise risk estimates than the conventional estimation procedures in Latin American equity markets. Similarly, Gencay and Selcuk (2004) investigated the relative performance of VaR methods using daily stock market returns of nine different emerging markets and found that EVT based VaR estimates were more accurate than conventional methods in measuring risk in these markets. In contrast to the above findings, Silva and Mendes (2003) and Bao et al. (2004) found that the predictive performance of the EVT is less than satisfactory for Asian stock market indices.

[2] See El Erian and Kumar (1995), Lim (2009), Al-Loughani (1995) and Al-Loughani and Moosa (1997).