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Clustering in emerging equity markets ☆

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Abstract

We consider pairwise tail behavior of return series for identifying the most important emerging markets clusters. Pairs of markets belonging to the same group present similar type and strength of interdependence during stressful times, represented by a common copula and a statistically equivalent measure of tail dependence. By collapsing data from *d* markets in to a group we overcome the difficult problem of finding their (higher dimensional) *d*-variate distribution. Results may help portfolio managers to deal with risk due to co-movements within clusters. We provide examples on how this can be done. Our study contributes to the discussion about the international association among stock markets during turbulent periods, and *does not confirm* the intuition that the observed association between extremes should be credited to linkages to leading markets. The study also confirms the importance of stock selection, particularly among the non-dominant stocks, instead of holding market-value weighed portfolios of stocks from countries within the same region.

JEL classification: C51; G15; F36

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1. Introduction

Recent financial crisis in emerging market economies have evidenced an increase in the frequency and magnitude of joint extreme movements among stock indexes, risky assets, and

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economic indicators (Longin and Solnik, 2001; Hartmann et al., 2003). Portfolio managers and the insurance industry in general have great interest in the accurate computation of probabilities of simultaneous extreme events. Understanding the multivariate behavior among stock markets is important for portfolio selection and crucial for risk management decisions.

Statistical approaches for modeling and measuring *bivariate* interdependence are well known and easy to implement. However, the usual measures of association do not naturally extend to dimensions higher than 2. Even the simplest extension to the trivariate case is usually not available. For example, the widely used correlation matrix provides pairwise measures. Moreover, the correlation coefficient measures linear association on the entire range of the data. To assess risks during extreme events one should rather use just return distribution tail data, representing the most extreme returns. We address the issue of *identification and measurement of multivariate dependence* using copulas. Modeling with copulas allows for the computation of the coefficient of tail dependence, which measures the amount of dependence at extreme joint quantiles. To assess the strength of the interdependence for joint gains (losses) we compute the non-linear measure of upper (lower) tail dependence coefficient $\lambda_U(\lambda_L)$.

The copula of a multivariate distribution is the distribution function of the same variables standardized using the probability integral transform. By transforming each margin into a standard Uniform distribution we do not change the dependence structure linking the variables. In other words, the pertaining copula contains all the information about the original variables' dependence structure. The tail dependence coefficient, is a number between zero and one, and it is zero when the variables are asymptotically (at the extremes) independent. However, tail independence does not mean independence. For example, two assets may possess the Pearson correlation coefficient ρ equal to zero (or even negative) and $\lambda_L = 0.14$. Thus, $\rho = 0.00$ does not guarantee no co-movements during high volatility periods. On the other hand, two portfolio components may possess $\rho = 0.90$ and λ_L equal to zero, therefore exhibiting strong correlation during the usual days, but being dissociated during extreme events. Copula based measures of dependence may be defined to reveal each specific aspect of the dependence and overcome limitations of the traditional linear bivariate measure. See Ané and Kharoubi (2003) for an introduction to this topic. See the Appendix for a brief and more formal presentation of copulas and tail dependence.

Recently, copulas have been rediscovered as useful for modeling in finance. For example, see applications in Cherubini et al. (2004). Schmidt (2002) investigated the concept of tail dependence and showed its usefulness for modeling credit risk. Ané and Kharoubi (2003) modeled the dependence structure among stock index returns using copulas. Breymann et al. (2003) used copulas to assess tail behavior on high frequency data, discussing the problem of the clustering of extremes in bivariate data. Other references include Li (2000), Embrechts, Lindskog, and McNeil (2003), among others.

Mendes and Kolev (in press) empirically investigated the type and degree of interdependence among the most important emerging markets during crises. One of the results of that paper is that high conditional volatility strengths tail dependence. When the data is filtered for conditional volatility they show a weaker degree of dependence when compared to the *raw* log-returns. The filtered data also presented a well known phenomenon, the so called *information asymmetry*: tail dependence between pairs of emerging markets in the lower left corner (losses) is typically stronger than that in the upper right corner (gains).

A natural follow-up investigation is the search for global models built up from similar asset pairs. In this paper we investigate whether or not we could find a common structure among several emerging stock markets. In other words, it is possible to find subsets of these pairs