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Choosing an optimal investment strategy: The role of robust pair-copulas based portfolios

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ABSTRACT

This paper is concerned with the efficient allocation of a set of financial assets and its successful management. Efficient diversification of investments is achieved by inputing robust pair-copulas based estimates of the expected return and covariances in the mean-variance analysis of Markowitz. Although the whole point of diversifying a portfolio is to avoid rebalancing, very often one needs to rebalance to restore the portfolio to its original balance or target. But when and why to rebalance is a critical issue, and this paper investigates several managers' strategies to keep the allocations optimal. Findings for an emerging market target return and minimum risk investments are highly significant and convincing. Although the best strategy depends on the investor risk profile, it is empirically shown that the proposed robust portfolios always outperform the classical versions based on the sample estimates, yielding higher gains in the long run and requiring a smaller number of updates. We found that the pair-copulas based robust minimum risk portfolio monitored by a manager which checks its composition twice a year provides the best long run investment.

1. Introduction

Financial institutions and portfolio managers are primarily concerned with the efficient allocation and monitoring of sets of financial assets. Periodic portfolio rebalancing, aiming to restore the investment back to its desired target risk and return, is a crucial step in the process of controlling risk. Commonly asked questions are how often a portfolio should be rebalanced, and which would be the best indicators of changes in the global economy or in the balance among the component assets.

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Efficient diversification of investments based on the mean–variance analysis of Markowitz (1952) is widely used by institutional investors. Statistically, the resulting efficient frontier just relies on the estimates of the expected return and covariance matrix, and the sample estimates are the usual inputs. However, the statistical good properties of the sample estimates are attached to the highly improbable assumption of multivariate normality.

A better characterization of the data underlying multivariate distribution will provide more reliable estimation of the efficient frontier. This means we must know not just the marginal univariate series behavior and their correlations, but their whole *d*-dimensional probability distribution. This may be accomplished by modeling the data through pair-copulas (Berg and Aas, 2009; Fischer et al., 2008; Aas et al., 2007; Min and Czado, 2008).

A pair-copula construction is just a hierarchical decomposition of a multivariate copula into a cascade of bivariate copulas. Since an appropriate copula function can be found for any type of association – linear, nonlinear, ranging from perfect negative to perfect positive dependence – one can expect the model to truthfully represent the data at hand. Estimation takes place at the level of the two-dimensional data, therefore avoiding the famous *curse of dimensionality*.

The analysis of financial data from emerging markets poses some specific challenges. Atypical points in transaction prices (from non-confirmed unexpected news, market manipulation, and so on) distort classical statistical inference, corrupting the inputs to the mean–variance algorithm. A distorted correlation matrix and inflated risk estimates will provide misleading allocations. To handle deviations from the true underlying distribution, robust methodologies are called for. We suggest to apply the robust estimates for pair-copulas models, initially proposed in Mendes et al. (2007). For each parametric copula family there exist a robust *weighted minimum distance* or a *weighted maximum likelihood* estimator providing accurate estimates under contaminations. The robust portfolios are obtained by inserting the robust pair-copulas based mean and covariance estimates in the mean–variance Markowitz procedure.

Robust methods typically detect the pattern implied by the vast majority of the data, providing more stable estimates. Robust allocations are resistant to unjustified sudden fluctuations of the market, which are identified by the robust estimates as point contaminations. Therefore, robust portfolios are primarily designed for long run investments. We note that the notion of "long run" may vary across markets and to account for changes in the economy, some periodic rebalancing of the portfolio may still be needed. It is expected from a robust investment to yield higher gains in the long run and to require a smaller number of updates.

There is no universally accepted best strategy for portfolio management. Best strategy will change with investor risk aversion, portfolio target return or standard deviation. Among many others, we consider the popular strategy followed by institutional investors that monitors a portfolios at an annual (or monthly) frequency and then rebalances only if the allocation to an asset shifts more than some threshold (5%, 1%). We do not consider additional factors when implementing the rebalancing strategies, such as trading costs or cost of time spent which would reduce the return of the portfolio. However we keep track of the rebalancing frequency of each manager and are able to draw some conclusions based on their number of rebalancings.

Summarizing, in this paper we address both problems of composing and managing portfolios, given a set of financial instruments. We do not address the issue of choosing the component assets. We robustly estimate the data multivariate distribution using pair-copulas obtaining the inputs which will define the robust efficient frontier. The trajectory of a target return and the minimum risk portfolios will be managed by twelve managers during a 2-year period of out-of-sample investigation. We use data from emerging markets because of the higher volatility of these stock markets and their greater potential for interdependence with the major markets. More specifically, we use six-dimensional contemporaneous daily log-returns from the most traded Brazilian stocks, due to Brazil's important position among emerging equity markets. The robust portfolios are compared to their classical version based on the sample empirical estimates.

The contributions of this paper are three fold: (*i*) we introduce and investigate the performance of pair-copulas based robust portfolios; (*ii*) we investigate 12 managing strategies aiming to keep (or restore) the portfolio target, to guarantee the same risk aversion level; (*iii*) we illustrate the ideas using Brazilian data.

Findings in the paper are striking and convincing. We found that despite the investment type, the robust methodology always outperform the classical version. We are able to determine the best rule for restoring the portfolio to its original balance and keep the allocations optimal. We show that the best