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Separating the wheat from the chaff: Understanding portfolio returns in an emerging market ☆

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ABSTRACT

In this paper we apply Random Matrix Theory (RMT) to study daily return correlations of 83 companies that are part of the Chilean stock market during the period 2000 to 2011. We find that using RMT to identify statistically significant correlations within our sample of stocks significantly improves the efficiency of a family of Markowitz Portfolios. Moreover, by using Vector Autoregressive analysis we identify global risk aversion as the main driver of the Chilean equity market returns followed in importance by shocks to the monthly rate of inflation and the country's monetary policy rate. By studying the effects of macroeconomic variables on the constructed portfolio returns we reach a better understanding of the true risks involved in an emerging market portfolio.

1. Introduction

The Great Recession of 2008–2009 was a vivid reminder that financial correlations breakdown during periods of high volatility. It also highlighted the importance of identifying stable correlations in order to quantify the underlying risk of diversified portfolios. This paper contributes to current debates on portfolio optimization by examining the statistical significance of the correlations across the Chilean stock market.

Two questions frame our investigation. First, we ask if all the return correlations across the Chilean stock market are equally statistically significant. Second, we ask which are the main macroeconomic drivers affecting the Chilean stock market returns. To answer these questions, we use Random Matrix

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Theory (RMT) to study the daily returns of 83 Chilean stocks that are part of the IPSA and IGPA indices from January 2000 to January 2011. The RMT helps us to separate the wheat from the chaff in the correlation matrix. Using Markowitz's Portfolio Theory (MPT), we then compare the efficiency of portfolios constructed under RMT with others constructed under the standard approach which considers all covariances in the correlation matrix equally significant. Finally, we use Vector Autorregresion approach (VAR) to determine the impact of a set of macroeconomic and financial variables on the optimal portfolios derived from our significant eigenvalues.

We focus on the Chilean stock market as we think that it provides a good case study for other emerging markets due to a number of reasons. First, the Chilean equity market is one of the most developed within the emerging market world with a market capitalization of 120% of its GDP. Other markets such as the Brazilian one have much lower market capitalizations as percentage of their GDP (58%) while Mexico has a market capitalization of 39% of GDP. Second, Chile is a small open economy with almost no restrictions to the access of international investors. Therefore, both idiosyncratic and global factors are likely to be important determinants of the stock market returns. Assessing the relative importance of domestic versus international factors in explaining domestic market volatility is key for developing public policy and market regulation in other emerging economies that are following the path of financial liberalization.

Our main findings can be summarized as follows: First, applying Random Matrix Theory to a portfolio composed of Chilean equities improves its efficiency compared to a portfolio constructed using a standard MPT approach by at least 48%.[2] Second, using VAR analysis, we identify global risk aversion as the main macroeconomic determinant of the Chilean equity market returns followed in importance by shocks to the monthly rate of inflation and the country's monetary policy rate. Third, it is possible to diversify away some of the market portfolio risk by adding positions on the portfolios constructed by the second and third largest eigenvalues. Fourth, the three smallest eigenvalues produce portfolio returns that are mostly uncorrelated with macroeconomic shocks. These portfolios are also uncorrelated with the market portfolio. Finally, we show that the insights provided by the RMT approach can help us to improve some existing models of the MV-GARCH literature, with significant improvements in *realized* risk predictions.

In general, the stability and statistical significance of empirical correlations are crucial for risk and portfolio management, since the probability of large losses in a portfolio is mainly driven by the way the correlations between the assets in it behave. For example, a position which is simultaneously long in stocks and short in bonds is riskier than one holding any of those assets exclusively. This is because bonds and stocks usually move in opposite directions during periods of crisis (Laloux et al., 1999).

The use of correlation matrices has a long history in portfolio management and is one of the main ingredients of Markowitz's Portfolio Theory, which solves the following dual problem: given a set of financial assets characterized by their average return and risk; what is the optimal weight on each asset such that the overall portfolio provides the best return for a fixed level of risk, or equivalently, the lowest risk for a given return? The solution to this problem entails the resolution of a system of non-linear equations where the correlation matrix C has to be inverted. The final outcome of this exercise is a risk–return relation, the so-called "efficient frontier".

Despite the apparent success of this theory in explaining optimal portfolios, it has been widely criticized by its inability to provide good risk estimates. A possible explanation for this failure in the Markowitz's Portfolio Theory, has found room in the field of Statistical Physics, which states that the estimation of a correlation matrix may be difficult in case the length of the time series (henceforth, T) is not very large compared to the total number of assets (henceforth, N). In these cases we should expect the covariances to contain a lot of noise and therefore be, to a large extent, random. In particular, the smallest eigenvalues are precisely those that are the most sensitive to this noise and their associated eigenvectors the ones that determine the least risky portfolios (Laloux et al., 1999, 2000). With all these problems in mind, it becomes apparent the need to seek for new methods to separate out "signals", which contain economically relevant information, from "noise" which do not. From this perspective, it turns out interesting to compare the properties of an empirical correlation matrix C with respect to a "null hypothesis" purely random, that one could obtain from a time series of completely independent assets. In

[2] Throughout the paper, efficiency is measured by the Mean Percentage Error, which measures how close the risk of our portfolios is from the "true" realized risk. This is an average result over the sample analyzed in the most restrictive scenario, that is, without allowing for a "short-sale" strategy.