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CONTENTS

Portfolio selection during the crises

Francesca Pavanati, Sergio Ortobelli Lozza[1]

Abstract

In this paper, we propose a Mean-Variance analysis, with the aim of analyzing the different investment choices in the European Stock Market and the ambitious goal of comparing the effects on the Stock Market during periods of crises. To do this, five countries with the largest capitalization in Europe were chosen: Italy, Germany, France, Spain and United Kingdom. For each of the five Stock Markets, we propose an ex-post analysis based on the mean-variance optimal choices during the last two decades. Therefore, for each stock market, we examine the *ex-post* optimal mean-variance investments evaluating which sectors were suffering during the subprime crisis, the sovereign credit risk crisis and the covid 19 crisis.

Key words:

Portfolio choice, market crises, mean-variance analysis, European stock market.

JEL Classification: G11, G01

1. Introduction

On January 30, 2020, following the reporting by China of a cluster of cases of pneumonia of unknown etiology in the city of Wuhan, the World Health Organization declared a public health emergency of international interest following the outbreak of Coronavirus (Covid-19) in China. The following day, considering the particularly widespread nature of the epidemic, several European governments declared a state of emergency and implemented the first measures to contain the contagion throughout their country (see Casagrande et al. (2020), Agnoletti et al. (2020)). The strongly uncertainty regarding the global economic outlook triggered strong turbolence on the stock markets which, on a global level, was reflected in large falls in prices and an increase in volatily (see Ruzzi and Rubi (2020)). The impact differed across geographical areas and sectors, depending on exposure to the pandemic and the effects of lockdown measures. Share price trends in the Eurozone, in particular, fell below the level recorded at the beginning of 2007 and price volatilty also increased significantly. Portfolio choices have changed radically in 2020 even if this crisis presents several differences respect to the previous ones (see, among others, Bertocchi et al. (2013), Biglova et al. (2014)). For this reason, in this paper, we want to examine the differences on optimal choices during some crises of the last decades. In particular, we propose a Mean-Variance analysis of the five European Stock Markets with the largest capitalization in Europe: Italy, Germany, France, Spain and the United Kingdom. It's considered appropriate to point out that the timeframe of our analysis is characterized by several financial crises: the Argentina crisis of 2001, the dot-com crisis of 2001, the subprime crisis of 2007-2009, the European sovereign debt crisis of 2010-2011, the Chinese currency crisis of 2014-2015 and, finally, the recent Covid-19 crisis. Specifically, this paper considers three crises: the 2007-2009 subpime crisis, the 2010-2011 European sovereign debt crisis and the beginning of Covid-19 crisis.

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In Section 2 we propose the mean-variance empirical analysis and we discuss the observed differences of the optimal choices. In the final section we summarize the results.

2. The empirical analysis

In this paper, we deal the portfolio selection problem in a mean-variance framework for five European stock markets. We consider the portfolio of returns $x'R$, where $x' = [x_1, \dots, x_n]$ is the vector of percentages of wealth, and $R = [R_1, \dots, R_n]'$ is the vector of returns. We generally assume that no short sales are allowed (i.e., $x_i \geq 0$ for any $i=1,\dots n$). In particular, at the time t, the return of i-th asset obtained over the period $(t-1, t)$ is given by $R_{i,t}=\frac{P_{i,t}-P_{i,t-1}+A_{i,t}}{P_{i,t-1}}$ where $P_{i,t}$ is the price of the i-th security at time t and $A_{i,t}$ denotes the cash movement from owning the i-th security over the period $(t-1, t)$.

According to the mean variance portfolio selection model in the empirical analysis we fit the efficient frontier solving the following problem for different values of the mean *m*:

$$\begin{gathered} min_x\ x'Qx \\ E(x'R) = m \\ \sum_{i=1}^{n} x_i = 1; \quad x_i \geq 0; i = 1, \dots, n \end{gathered} \quad , \tag{1}$$

where Q is the variance covariance matrix and *m* is a fixed mean belonging to the interval $[\underline{m}, \overline{m}]$ ($\underline{m}$ is the mean of the global minimum variance portfolio and $\overline{m}$ is the mean of the asset with the greates mean).

2.1 The Dataset

The dataset used in this analysis has been extracted from *Datastream*. The analysis is placed temporally over a period of about 21 years: from November 1999 till November 2020. We use a window of four years (1000 trading days) to fit every month the mean-variance efficient frontier for each of the five European stock markets we consider: United Kingdoom, Germany, France, Italy and Spain. In particular, for each country the assets are shared respect to their sector (Datastream Classification) as it follows:

1) 425 stocks for the the UK stock market that are shared in 12 sectors (automotive, construction, electronic, financial, food, industrial, insurance, consumer goods, pharmaceutical, technology, support services and mining)
2) 520 stocks for the German stock market, shared in 10 sectors (automotive, chemical, healthcare, industrial, pharmaceutical, technology, consumer goods, electronic, energy and telecommunications)
3) 397 stocks for the France stock market, shared in 10 sectors (automotive, healthcare, industrial, insurance, mining, consumer goods, pharmaceutical, construction, electronic and food)
4) 113 stocks for the Italian stock market, shared in 12 sectors (banking, technology, electronic, financial, industrial, insurance, tourism, construction, telecommunications, media and manufacturing)
5) 69 stocks for the Spain stock market, shared in 9 sectors (construction, energy, food, industrial, mining, real estate, financial, pharmaceutical and consumer goods)

2.2 The optimal choice procedure and discussion

For each efficient frontier we compute forty mean-variance optimal portfolios: starting from the global minimum variance portfolio till the maximum mean asset. According to Papp et al. (2005) and Kondor et al. (2007), we use a Principal Component Analysis (PCA) to reduce the dimensionality of the problem, since the number of assets is large for each stock market. In practice, for each stock market, at the k-th recalibration (that applies every month, i.e., every 21 trading days), we evaluate the following steps:

Step 1: We apply the PCA to the correlation matrix of the returns. Doing so, we identify the factors that explain at least the 60% of the variability. Then, we approximate the returns regressing them on these few principal components (with an OLS estimator).
Step 2: We solve problem (1) for 40 fixed mean *m*, fitting the efficient frontier.
Step 3: For the s-th optimal portfolio (s=1,…,40 corresponding to the s-th position of the efficient frontier), we compute the ex-post wealth as it follows:

$$\boldsymbol{W_{t_{k+1},s} = (W_{t_k,s}) z^{(ex-post)}_{t_{k+1},s}}$$

where $\mathbf{W_{t_k,s}}$ is the ex-post wealth obtained at time t_k from the s-th optimal portfolio of the efficient frontier and $z^{(ex-post)}_{t_{k+1},s}$ is the s-th portfolio ex-post gross return obtained during the period $[t_k, t_{k+1}]$.
Step 4: For each optimal portfolio of the efficient frontier, we evaluate the sectors in which we invest (according to the analysis proposed by Kouaissah and Ortobelli (2020)).
Step 5: We repeat the previous steps for all observations and for each stock market.

From this analysis we can report the results in several tables and graphs. Of course, we cannot report all of them in this paper and thus we summarize the results reporting only the case of the German stock market that is the best performing one.

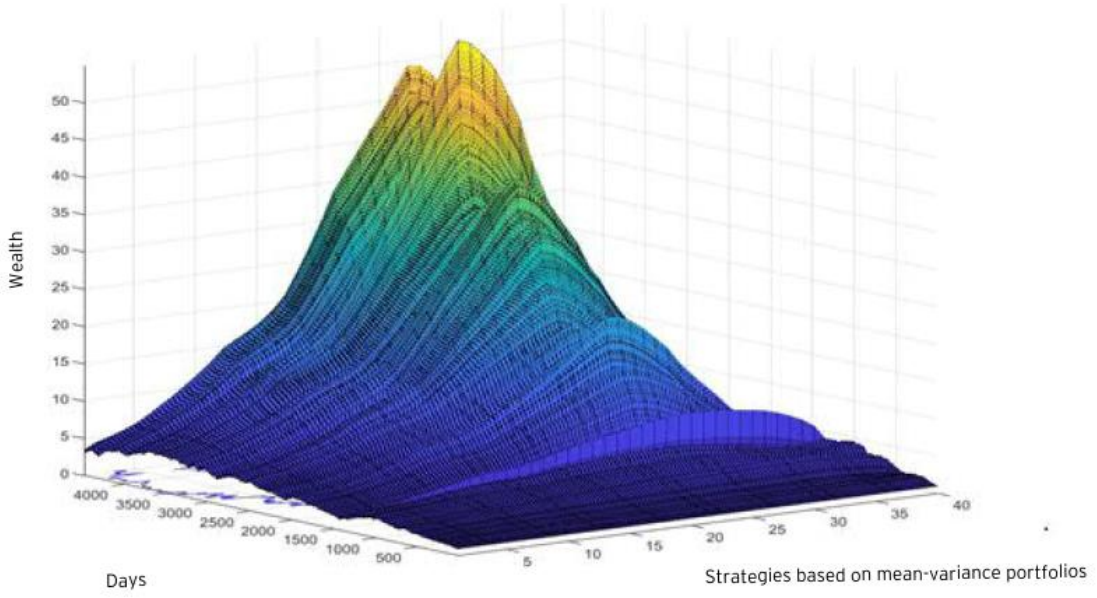

Figure 1: *Ex-post wealth for optimal mean-variance portfolios of Germany*

In particular, Figure 1 represents the ex-post wealth obtained for forty strategies deriving by optimal mean-variance portfolios. The first strategy corresponds to the most conservative choice of the global minimum variance portfolio, that is the lest risky choice of the efficient frontier, and often less profitable. In the case of the German stock market, the 33rd strategy presents the maximum ex-post final wealth and, finally, the 40th strategy corresponds to the choice of mean maximizer, that is also the most risky choice in the mean-variance framework.

Next, graphs represent which sectors were profitable or distressed during the period of crises. Referring to the example of Germany, the following graphs show investments in the various sectors during the subprime crisis (see Figure 2), the European sovereign credit risk crisis (see Figure 3) and the Covid-19 crisis (see Figure 4).

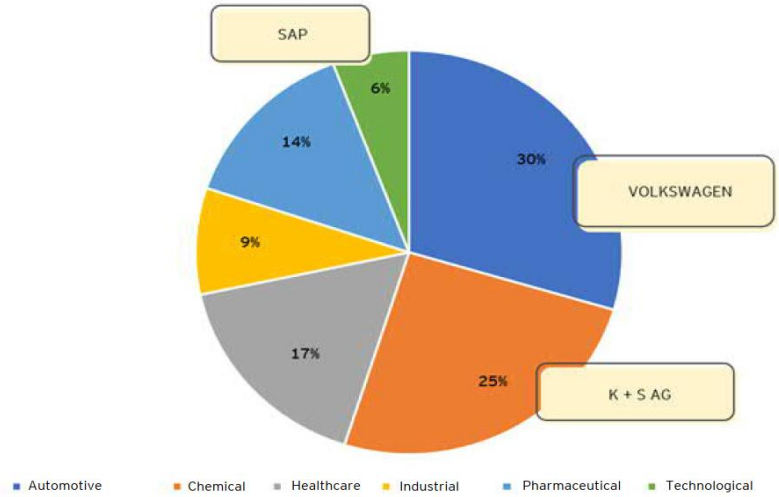

Figure 2: *Investments, in %, made in various sectors in Germany during the subprime crisis*

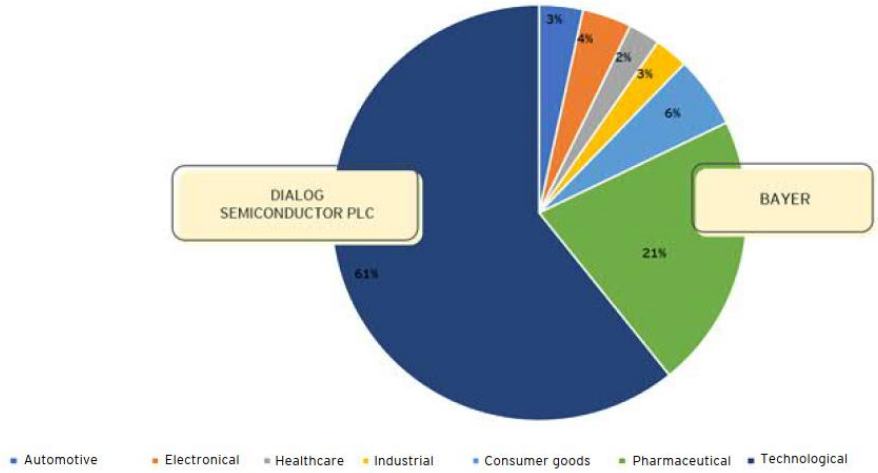

Figure 3: *Investments, in %, made in various sectors in Germany during the European sovereign credit risk crisis*

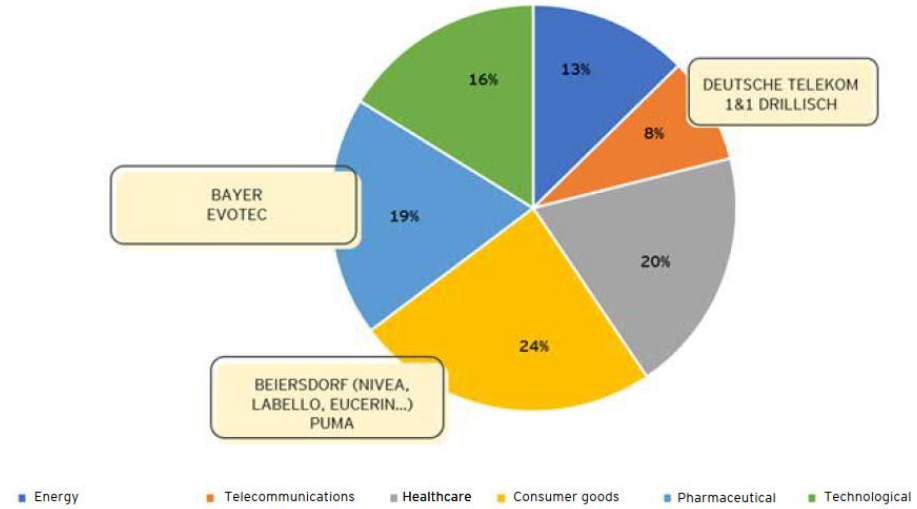

Figure 4: *Investments, in %, made in various sectors in Germany during the Covid-19 crisis*

From Figure 2 we deduce that the chemical, automotive and only in minor part (6%) the technology sectors are the "mean-variance optimal" sectors during the subprime crises in the German stock market. Figure 3 suggests that the technology sector (61%) chemical sector (21%) and only in minor part automotive (3%), electronic (4%), healthcare (2%), industrial (3%) sectors are the principal "optimal" sectors for the German stock market during the European sovereign credit risk crisis. Figure 4 reports the percentage of optimal choices during the Covid 19 market crisis for the German market. In particular, we observe that the optimal mean variance choices were distributed as it follows: the 24% in Consumer goods, 19% in Pharmaceutical, 20% in Healthcare, 16% in Technological, 13% in Energy and 8% in Telecommunication sectors.

2.3 The results

We focus our attention on the optimal choices during three systemic crises. Each crisis has different timing, methods and consequences and on the basis of the analysis carried out, commonalities and differences have emerged, depending on the analyzed country. Specifically, the banking sector was particularly weakened following the subprime crisis in all five countries. On the other hand, the sectors in which the greatest investment was made are different. Specifically, in Italy there was greater investment in the tourism sector, while in Germany, France, Spain and the United Kingdom the automotive sector enjoyed greater investment during the subprime crisis. Regarding the European sovereign debt crisis, the sector most affected were different depending on the country under consideration: Italy weakened in tourism; France suffered reductions in investment in the construction sector, together with the United Kingdom; Spain suffered losses in the food sector and Germany saw reductions in investment in the healthcare, industrial and automotive sectors. However, during the Eruopean sovereign debt crisis, investment increased in certain sectors: technology in Italy and Germany, pharmaceuticals in France and Germany, and industry in Spain and the United Kingdom. Overall, therefore, during the European sovereign debt crisis, taking into consideration only the five countries analyzed in this study, the pharmaceutical and industrial sectors suffered the least. Finally, regarding the Covid-19 crisis, the sectors that have inevitably been characterized by greater investment are healthcare and pharmaceuticals (especially in Germany, France, Spain and the United Kingdom). The sectors that, on the other hand, have particularly suffered are consumer goods, telecommunications and finance. These results are briefly summarized in the following Table 1. In particular, we evidence with X the sectors where we observe a large reduction of investments, while we denote with V the sectors where are substantially maintained the investments.

Table 1: *Brief summary of the main investments during the crises (for sectors in five stock markets).*

SUBPRIME	**Italy**	**Germany**	**France**	**Spain**	**UK**
Automotive sector	X	V	V	V	V
Tourism sector	V	X	X	X	X
Banking sector	X	X	X	X	X
CREDIT RISK	**Italy**	**Germany**	**France**	**Spain**	**UK**
Technology sector	V	V	X	X	X
Pharmaceutical sector	X	V	V	X	X
Industrial sector	X	X	X	V	V
Construction sector	X	X	V	X	V
Food sector	X	X	X	V	X
COVID 19	**Italy**	**Germany**	**France**	**Spain**	**UK**
Healthcare sector	V	V	V	V	V

Pharmaceutical sector	V	V	V	V	V
Consumer goods sector	X	V	X	X	X

3. Concluding remarks

The paper examines the optimal portfolio choices in five European stock markets during three crises of the last two decades. In particular, we evaluate optimal mean-variance choices during the subprime crisis, the sovereign credit risk crisis and the recent (not finished) Covid 19 crises. Even if each country reacts differently to a crisis and each crisis is characterized by different timescales, methos and effects, we observe a major common behavior during the subprime cirsis and Covid 19 crisis while there are greater differeces during the sovereign credit risk crisis. This difference is not very surpricing taking into account that some European countries were involved directly in the credit risk crisis.

Aknowledgments

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