Risk portofolio management under Zipf analysis based strategies

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Summary. A so called Zipf analysis portofolio management technique is introduced in order to comprehend the risk and returns. Two portofolios are built each from a well known financial index. The portofolio management is based on two approaches: one called the "equally weighted portofolio", the other the "confidence parametrized portofolio". A discussion of the (yearly) expected return, variance, Sharpe ratio and $\beta$ follows. Optimization levels of high returns or low risks are found.

1 Introduction

Risk must be expected for any reasonable investment. A portofolio should be constructed such as to minimize the investment risk in presence of somewhat unknown fluctuation distributions of the various asset prices \cite{1,2} in view of obtaining the highest possible returns. The risk considered hereby is measured through the variances of returns, i.e. the $\beta$. Our previous approaches were based on the "time dependent" Hurst exponent \cite{3}. In contrast, the Zipf method which we previously developed as an investment strategy (on usual financial indices) \cite{4,5} can be adapted to portofolio management. This is shown here through portofolios based on the DJIA30 and the NASDAQ100. Two strategies are examined through different weights to the shares in the portofolio at buying or selling time. This is shown to have some interesting features. A key parameter is the coefficient of confidence. Yearly expected levels of returns are discussed through the Sharpe ratio and the risk through the $\beta$.

2 Data

Recall that a time series signal can be interpreted as a series of words of $m$ letters made of characters taken from an alphabet having $k$ letters. Here
below \( k = 2 \): \( u \) and \( d \), while the words have a systematic (constant) size ranging between 1 and 10 letters.

Prior to some strategy definition and implementation, let us introduce a few notations. Let the probability of finding a word of size \( m \) ending with a \( u \) in the \( i \) (asset) series be given by \( P_{m,i}(u) \equiv P_{i}([c_{t-m+2}, c_{t-m+1}, \ldots, c_{t+1}, c_{t}; u]) \) and correspondingly by \( P_{m,i}(d) \) when a \( d \) is the last letter of a word of size \( m \). The character \( c_{t} \) is that seen at the end of day \( t \).

In the following, we have downloaded the daily closing price data available from the web: (i) for the DJIA30, 3909 data points for the 30 available shares, i.e. for about 16 years; (ii) for the NASDAQ100, 3599 data points for the 39 shares which have been maintained in the index, i.e. for about 14.5 years. The first 2500 days are taken as the preliminary historical data necessary for calculating/setting the above probabilities at time \( t = 0 \). From these we have invented a strategy for the following 1408 and 1098 possible investment days, respectively, i.e. for ca. the latest 6 and 4.5 years respectively. The relevant probabilities are recalculated at the end of each day in order to implement a buy or sell action on the following day. The daily strategy consists in buying a share in any index if \( P_{m,i}(u) \geq P_{m,i}(d) \), and in selling it if \( P_{m,i}(u) \leq P_{m,i}(d) \).

However the weight of a given stock in the portfolio of \( n \) assets can be different according to the preferred strategy. In the equally weighted portfolio (EWP), each stock \( i \) has the same weight, i.e. we give \( w_{i \in B} = 2/n_{u} \) and \( w_{i \in S} = -1/n_{d} \), where \( n_{u} \) (\( n_{d} \)) is the number of shares in \( B \) (\( S \)) respectively such that \( \sum w_{i \in B} + w_{i \in S} = 1 \), with \( n_{u} + n_{d} = n \) of course. This portfolio management strategy is called ZEW P.

In the other strategy, called ZCPP, for the confidence parametrized portfolio (CPP), the weight of a share depends on a confidence parameter \( K_{m,i} \equiv P_{m,i}(u) - P_{m,i}(d) \). The shares \( i \) to be bought on a day belong to the set \( B \) when \( K_{m,i} > 0 \), and those to be sold belong to the set \( S \) when \( K_{m,i} < 0 \). The respective weights are then taken to be \( w_{B} = \frac{2K_{m,i} \in B}{\sum K_{m,i} \in B} \), and \( w_{S} = -\frac{K_{m,i} \in S}{\sum K_{m,i} \in S} \).

### 3 Results

The yearly return, variance, Sharpe ratio, and \( \beta \) are given in Table 1 and Table 2 for the so called DJIA30 and so called NASDAQ39 shares respectively as a function of the word length \( m \). The last line gives the corresponding results for the DJIA30 and the NASDAQ100 respectively. We have calculated the average (over 5 or 4 years for the DJIA30 and NASDAQ39 respectively) yearly returns, i.e. \( E(r_{P}) \) for the portfolio \( P \). The yearly variances \( \sigma_{P} \) result from the 5 or 4 years root mean square deviations from the mean. The Sharpe ratio \( SR \) is given by \( SR = E(r_{P}) / \sigma_{P} \) and is considered to measure the portfolio performance. The \( \beta \) is given by \( \text{cov}(r_{P}, r_{M}) / \sigma_{M}^{2} \) where the \( P \) covariance

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\[1\] From Jan. 01, 1989 till Oct. 04, 2004

\[2\] From June 27, 1990 till Oct. 04, 2004
$cov(r_P, r_M)$ is measured with respect to the relevant financial index, so called market ($M$), return. Of course, $\sigma^2_M$ measures the relevant market variance. The $\beta$ is considered to measure the portfolio risk. For lack of space the data in the tables are not graphically displayed.

It is remarkable that the $E(r_P)$ is rather low for the ZEW $P$, and so is the $\sigma_P$, but the $E(r_P)$ can be very large, but so is the $\sigma_P$ in the ZCPP case for both portfolios based on the DJIA30. The same observation can be made for the NASDAQ39. In the former case, the highest $E(r_P)$ is larger than 100% (on average) and occurs for $m = 4$, but it is the highest for $m = 3$ in the latter case. Yet the risk is large in such cases. The dependences of the Sharpe ratio and $\beta$ are not smooth functions of $m$, even indicating some systematic dip near $m = 6$, in 3 cases; a peak occurs otherwise.

The expected yearly returns $E(r_P)$ vs. $\sigma$ are shown for both portfolios and for both strategies in Figs.1-2, together with the equilibrium line, given by $E(r_M)(\sigma/\sigma_M)$, where it is understood that $\sigma$ is the appropriate value for the investigated case. Except for rare isolated points below the equilibrium line, data points fall above it. They are even very much above in the ZCPP’s cases.

| $m$ | $E(r_P)$ | $\sigma_P$ | SR | $\beta$ | $E(r_P)$ | $\sigma_P$ | SR | $\beta$ |
|-----|----------|------------|----|--------|----------|------------|----|--------|
| 1   | 20.00    | 16.98      | 1.18 | 0.97   | 20.16    | 17.95      | 1.12 | 1.02   |
| 2   | 18.10    | 16.21      | 1.12 | 0.92   | 20.36    | 17.66      | 1.15 | 1.00   |
| 3   | 22.00    | 14.05      | 1.57 | 0.79   | 65.24    | 39.52      | 1.65 | 0.98   |
| 4   | 24.93    | 11.90      | 2.09 | 0.57   | 104.85   | 47.02      | 2.23 | -1.11  |
| 5   | 22.60    | 9.16       | 2.47 | 0.38   | 95.96    | 56.54      | 1.70 | -1.58  |
| 6   | 18.37    | 11.68      | 1.57 | 0.47   | 67.97    | 40.55      | 1.68 | 0.09   |
| 7   | 17.33    | 8.93       | 2.94 | -0.06  | 65.27    | 30.18      | 2.16 | -0.50  |
| 8   | 9.84     | 7.73       | 1.27 | 0.11   | 53.83    | 37.52      | 1.43 | 0.32   |
| 9   | 11.23    | 4.91       | 2.29 | -0.01  | 44.23    | 38.12      | 1.16 | 0.58   |
| 10  | 6.46     | 7.11       | 0.91 | 0.15   | 37.40    | 61.05      | 0.61 | 1.92   |

Table 1. Statistical results for a portfolio based on the 30 shares in the DJIA30 index for two strategies, i.e. ZEW $P$ and ZCPP based on different word sizes $m$ for the time interval mentioned in the text. The last line gives the corresponding results for the DJIA30. All quantities are given in %

4 Conclusion

We have translated the time series of the closing price of stocks from two financial indices into letters taken from a two character alphabet, searched for
words of $m$ letters, and investigated the occurrence of such words. We have invented two portfolios and maintained them for a few years, buying or selling shares according to different strategies. We have calculated the corresponding yearly expected return, variance, Sharpe ratio and $\beta$. The best returns and weakest risks have been determined depending on the word length. Even though some risks can be large, returns are sometimes very high.
Fig. 2. Expected yearly return as a function of the corresponding variance for two investment strategies involving 39 shares taken from the NASDAQ100. The time of investigations concerns the latest 4 yrs.

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