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USING TECHNICAL ANALYSIS FOR PORTFOLIO SELECTION AND POST-INVESTMENT ANALYSIS

Abstract. *Modern Portfolio Theory selects financial assets based on return-risk analysis. The parameters are the average of daily rate of return, the dispersion of returns and the correlation between the financial assets. This paper subscribes to the many critiques, which highlighted the weaknesses of this approach; some of these critiques are detailed here, while the approach proposed in this paper overcomes them. The substantiation based on technical analysis will allow us the selection of different types of financial assets, determining their weight and effective monitoring the portfolio, depending on the investment intent.*

Keywords: *Shares, Technical Analysis, Portfolio, Modern Portfolio Theory.*

JEL Classification: G11

Introduction

Overview

A portfolio is a linear combination of securities in which each of them has a certain weight, which correspond to the coefficient in the linear combination.
Portfolio selection is based on the idea that if the yield of return on a portfolio is high, then the risk of not achieving this yield in the future is higher, too. By diversifying a portfolio, it is possible to reduce its total risk.

Based on an analysis that takes into consideration both the expected gains as well as the possible variations of these gains, H. Markovitz proposed a procedure for constructing optimal portfolios.
The yield or the (relative) rate of return of a share in a period t, is expressed as the ratio of the amount the dividends brought by in period t, $D_t^{(i)}$ plus the increase in price of the share in the same period, $V_t^{(i)}-V_{t-1}^{(i)}$, divided by the value of the share at time t-1:

$$R_t^{(i)} = \frac{D_t^{(i)} + \left(V_t^{(i)} - V_{t-1}^{(i)}\right)}{V_{t-1}^{(i)}} \tag{1}$$

From any future moment perspective, the yield of a security may take, randomly, any value from a given set of values, meaning that it can be regarded as a random variable. From this point of view, there is an expected yield of the security i, which is defined as the random variable average $R_t^{(i)}$, i.e. the constant size $E(R_t^{(i)})$ expressed as:

$$\mu_{R_t^{(i)}} = E\left(R_t^{(i)}\right) = \begin{cases} \sum\limits_{r \in \Re_{R^{(i)}}} r \cdot f_i(r) & \text{discrete case} \\ \int\limits_{\Re_{R^{(i)}}} r \cdot f_i(r) \cdot dr & \text{continuous case} \end{cases} \tag{2}$$

where f_i is the probability density of title i, in a given moment t.
Similarly, we define the future value of individual performance variance, $Var(R_t^{(i)})$, as:

$$\sigma^2_{R_t^{(i)}} = Var\left(R_t^{(i)}\right) = \begin{cases} \sum\limits_{r \in \Re_{R^{(i)}}} \left[r - R_t^{(i)}\right]^2 \cdot p(r) & \text{discrete case} \\ \int\limits_{\Re_{R^{(i)}}} \left[r - R_t^{(i)}\right]^2 \cdot f(r) \cdot dr & \text{continuous case} \end{cases} \tag{3}$$

The expected value of the security i at the moment (t-1,t), may be more or less different from the yields' average from previous times, yields that are known.
Assuming that the yield probability distribution will maintain in the future, the expected future value can be estimated using the achieved yields in previous periods, i.e.:

$$\hat{\mu}_{R^{(i)}} = \frac{1}{T} \cdot \sum_{j=1}^{T} r_{t-j}^{(i)} \tag{4}$$

where $r_{t-1}^{(i)}$, $r_{t-2}^{(i)}$,…, $r_{t-T}^{(i)}$ are the yields recorded in previous periods, and are of known size.
Also yield variation $R_t^{(i)}$, can be estimated by using the following equation:

$$\hat{\sigma}^2_{R^{(i)}} = \frac{1}{T} \cdot \sum_{j=1}^{T} \left(r_{t-j}^{(i)} - \hat{\mu}_{R^{(i)}} \right)^2 \tag{5}$$

The two values associated with an individual yield, average and expected value, are fundamental quantities to any financial phenomena modeling process.
The portfolio is considered to be a linear combination of n securities, whose yields are $R_t^{(i)}$.
If we note with n_i the number of units from asset i and with V_i the price of the asset i, then the value of the portfolio will be:

$$V_P = \sum_{i=1}^{n} n_i \cdot V_i \tag{6}$$

and the yield of the portfolio in the period (t,t+1) is:

$$R_{tP} = \frac{V_{t+1,n}}{V_{tP}} = \frac{n_1 \cdot V_{t+1,1} + n_2 \cdot V_{t+1,2} + \ldots + n_n \cdot V_{t+1,n}}{n_1 \cdot V_{t1} + n_2 \cdot V_{t2} + \ldots + n_n \cdot V_{tn}} = \frac{n_1 \cdot R_{t1} \cdot V_{t1} + \ldots + n_n \cdot R_{tn} \cdot V_{tn}}{n_1 \cdot V_{t1} + \ldots + n_n \cdot V_{tn}} \tag{7}$$

Considering: $\alpha_1 = \frac{n_1 \cdot V_{t1}}{n_1 \cdot V_{t1} + n_2 \cdot V_{t2} + \ldots + n_n \cdot V_{tn}}$, the portfolio yield can be written as the following combination of individual yields:

$$R_{tP} = \alpha_1 \cdot R_{t1} + \alpha_2 \cdot R_{t2} + \ldots + \alpha_n \cdot R_{tn} \tag{8}$$

This means that the yield of the portfolio is also a linear combination of the individual yields $R_t^{(i)}$

$$R_t^{(P)} = x_1 \cdot R_t^{(1)} + x_2 \cdot R_t^{(2)} + \ldots + x_n \cdot R_t^{(n)}$$

where x_i represents the weight of the n shares in portfolio $\wp$, which must respect the following condition:

$$x_1 + x_2 + \ldots + x_n = 1 \tag{9}$$

Hence, the following relation define the yield or rate of return on a portfolio $\wp$, which includes a number of n financial assets:

$$\wp_n : \begin{cases} R_t^{(P)} = x_1 \cdot R_t^{(1)} + x_2 \cdot R_t^{(2)} + ... + x_n \cdot R_t^{(n)} \\ x_1 + x_2 + ... + x_n = 1 \end{cases} \quad (10)$$

Given that individual yields $R_t^{(i)}$ are regarded as random variables, and portfolio yield $R_t^{(P)}$ is a linear combination of these random variables, it is noted that $R_t^{(P)}$ also has the nature of a random variable, hence, we can speak of its average and variance.

Plotted, the result is called the efficient frontier [1], [2] and is a curve, on which the most profitable portfolio for a given risk, respectively the least risky combination of assets that generate an expected return, is found. The statistical approach is mathematically precise [3], but starts from uncertain and irreproducible data (estimates of statistical parameters).

In response, technical analysis [4] [5] [6] of financial assets is based on the graphical representation of the evolution of the asset, on the repeatability of data templates, and on the visual signals of both indicators and oscillators. It lacks precision and mathematical rigor, but is extremely intuitive, popular among investors, traders, brokers, and financial press. Essentially, technical analysis states that prices move in trends: uptrend (bullish), downtrend (bearish), or sideways (trading). This fact suggests the idea of portfolio selection, taking into account that the trend leads, eventually, all financial assets after it.

Methodology

Attempts to establish a universal recipe for choosing financial assets in a portfolio, dates from the early twentieth century [7]. Nowadays, Modern Portfolio Theory (MPT) is recognized as a standard method for portfolio selection. MPT uses the average daily rate of return to estimate the profitability of a financial asset and the dispersion (the volatility of the financial asset), as a measure of risk.

Technical analysis allows tracking both parameters directly on the evolutionary chart of the financial asset, the behavior being clearly highlighted, both on its growth period as well as on the decline period. In addition, comparative graphical analysis allows both, direct visualization of differences in yield, and the correlation between financial assets.

To this end, this paper seeks to apply the results of technical analysis in the selection and monitoring of portfolio of financial assets. Technical analysis specialized literature proposes various techniques and strategies [8], [9] to select favorable input/output timing for a financial title [10], whether it consists of shares, commodities [11], forex, or indexes. Furthermore, technical analysis provides the

necessary tools for financial assets monitoring, empirical, but confirmed in practice and used by most market participants.
The proposed approach will allow the selection of financial assets based on their graphs, as well as setting the weight in a portfolio based on the graph's scale. The novelty lies in the direct monitoring of the portfolio. Technical analysis programs view the option of monitoring solely based upon analyzing each single title. This paper proposes effective portfolio construction, similar to a new financial asset, like an index, while the weight of the assets will be determined based on judgment and technical analysis, not on random criteria.

MPT Criticism

Weaknesses of MPT

Many critiques aim in the direction of MPT, the most popular being:

- Daily rates of return and the correlations between these vary historical, so exactly the protection in case of crisis is questionable.
  In Figure 1 the dynamic evolution of the mean of the logarithmic rate of return **r** and its dispersion **σ** was plotted, calculated for the issuer SIF5 listed on BSE, from launch to date. It is noticeably that precisely in times of crisis and enthusiasm, values fluctuate greatly, so there is no rational basis for a prediction of their future values.
- The distribution of the rate of return is not Gaussian, therefore, it is impossible to rely the reasoning solely on media and dispersion.
- Default premises, from which the model starts (informational efficiency of the market, investor rationality, risk adversity, etc.), are often violated by the behavior of speculators.
- Concluding, MPT does not properly model the market. In fact, complex mathematics are used [12], but starting from brittle based data: mean and variance estimates, based on historical data.
- For a portfolio of two financial assets, any combination is found on the efficient frontier. Therefore, it does not help in selecting the portfolio, but only helps selecting the average and its dispersion (positioning on the chart). Selecting a position depends on the investor, without any recommendation from MPT.

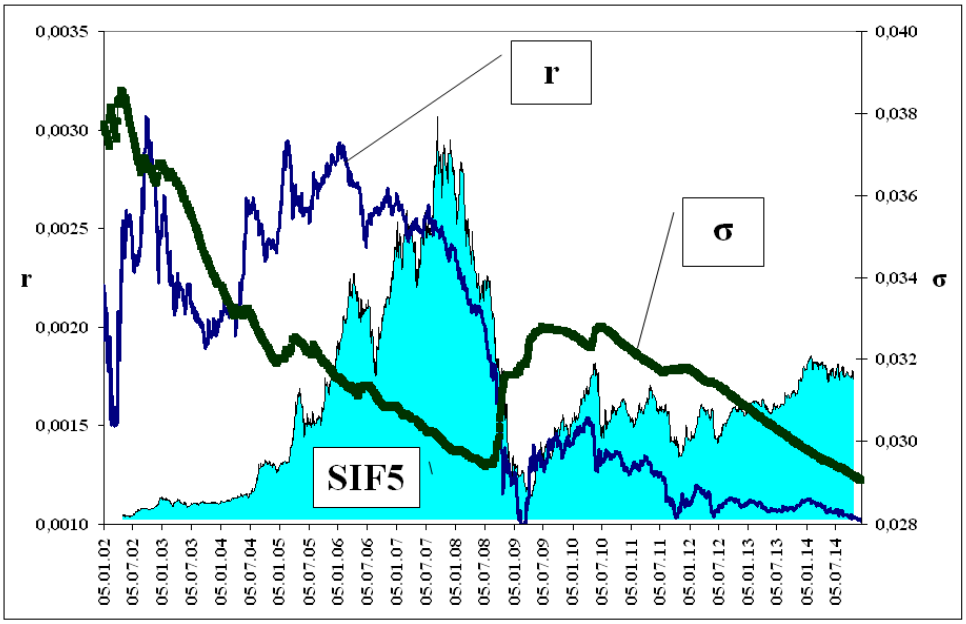

Figure 1. The evolution of the mean and of variance over time

It is noticeable that historical data are not a credible benchmark for predicting future results. Data was taken from the BSE website [13] and processed by the authors in Microsoft Excel

In the following section, the paper seeks to detail and exemplify the weak points that can be overcome by the methodology proposed in this paper.

Dispersion as a measure of risk

MPT proposes dispersion (standard deviation) to be seen as the risk of the financial asset [14]. From the ordinary investor point of view, this risk measure is not adequate: as an investment advisor, I cannot ask the customer „ which is the expected variance for which you want your daily rate of return to be optimized?" Perhaps the only common reference is linked to the Bollinger bands (drawn at **±1σ** of the moving average). Technical analyst knows that the proximity of the bands means trend consolidation, whereas their remoteness is a clear sign of reverse. (Figure 2).

Therefore, a technical analyst would conclude that both, the mean and variance of their rate of returns vary over time, depending on market development, so there is no guarantee that, past data will be replicated in the future, and the predictability of future average rate of return, and especially of future variance, is irrational (also see Figure 4).

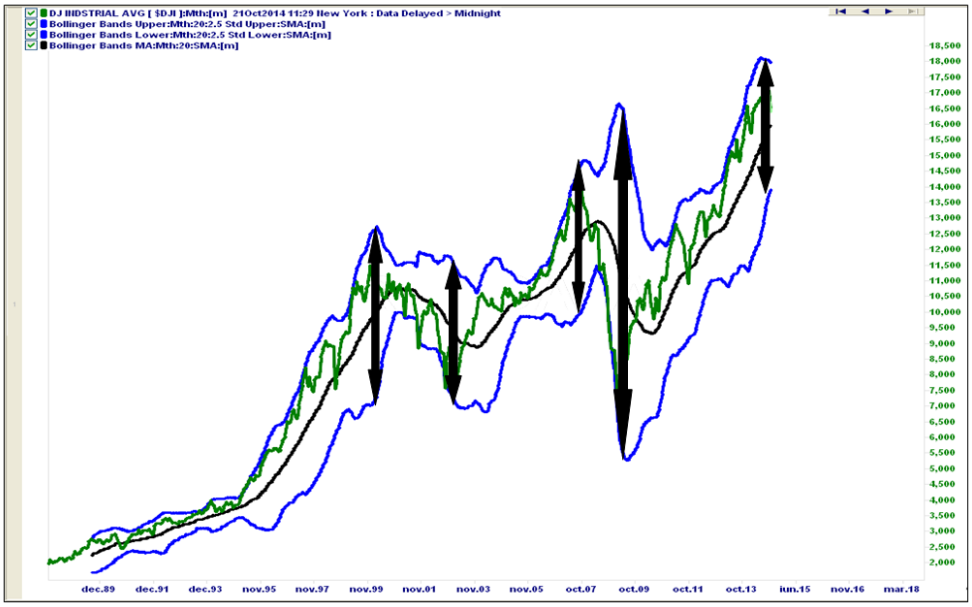

Figure 2. Bollinger bands

All major trend changes occur when the width of Bollinger bands increases (when the strips are removed). Graph program conducted by authors in IncredibleCharts.

Correlation between financial assets

More important than the deviation of the rate of return from the mean (dispersion) is the financial asset's behavior in relation to market trends. Inevitably, the market moves in trends, fact, which actually relies on technical analysis. Statistical characteristics of distributions cover the entire analyzed period, do not express the movement in relation to the trend, and do not provide any information about the sequence of values that determine the overall average and dispersion.

Protection offered by the diversification of portfolio refers to two types of risks:

- Systemic risks (which affect the entire market – crisis or bubble type), which can be avoided by selecting a portfolio of assets from various negatively correlated types of markets: commodities vs. bonds, stocks vs. bonds, commodities vs. USD index [15].
- Non-systemic risks (unwanted and unexpected life events of the company, initially unpredictable), which can be avoided by including financial assets in the portfolio, that have similar trends (positively correlated).

Correlation related issues are not properly captured by probabilistic analysis, mainly due to the factor of covariance. Consider the Asian market, which opens the day after the US market closes; any informed observer knows that the Asian markets follow America's trends, although the values are not the same. Analyzing

a logarithmic graph of the two market indices (DJIA and HSI in our example), it is intuitively noticeable that they are strongly positively correlated (Figure 3).
If we consider that there is a one day difference between quotations, the correlation between the two indices doubles its value. Even so, the value of the correlation between the daily returns of 0.25 is not statistically significant; this means a relative indifference between the two indices. Any investor, may, however contradict this conclusion: if the market development in the US would be known in advance, most likely substantial profits could be realized on the Asian market. Although statistically they are not strongly correlated, their developments (trends) are similar, fact, which is essential for any speculator. Probabilistic, HSI intraday trading, based solely upon the DJIA quotations the night before, does not provide spectacular results (meaning of CORREL=0.25), but because even sub-side trends are similar (in terms of directions, even if not of amplitude), if we know in advance how the DJIA will evolve, taking similar long and short HSI positions, would be extremely profitable.

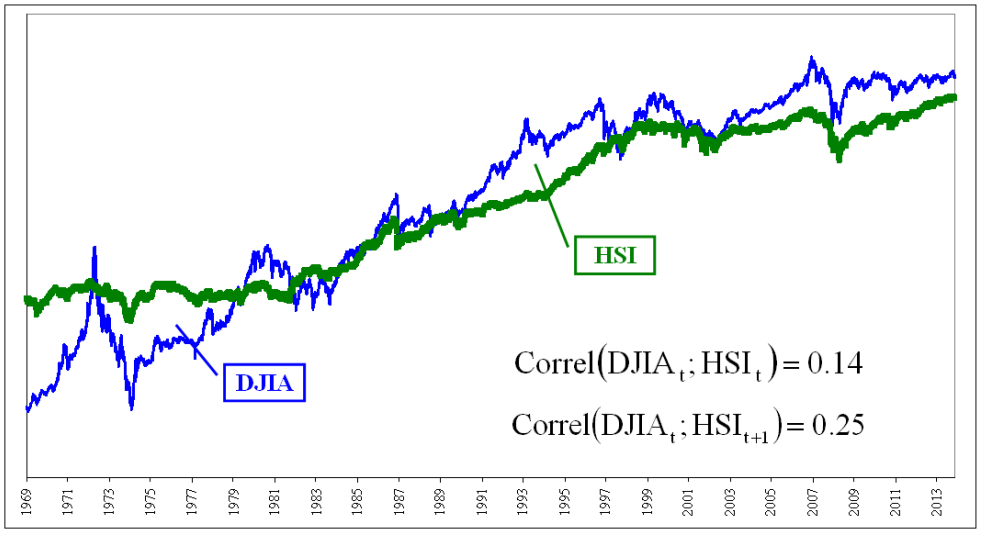

Figure 3. The correlation between DIJA and HIS

Intuitively, the two financial assets are correlated, but statistically there is a gap, because the Asian markets start the next day after the US markets. Data taken [16] and processed by the authors in Microsoft Excel.

Sub-trends similarity is an important aspect of the market that statistics do not capture adequately. The explanation lies in the fact that its profitability and daily fluctuations are directly dependent on market trends, as shown in Figure 4. It is noted that the average daily return is slightly above 0 (the general market trend is rising), but the variations are symmetric even in times of crisis or exuberant momentum. This conclusion contradicts one of the basic principles of technical

analysis, which states that charts are fractal [16], [17], in other words, laws of technical analysis apply similar regardless of scale: from monthly to those under a minute [18].

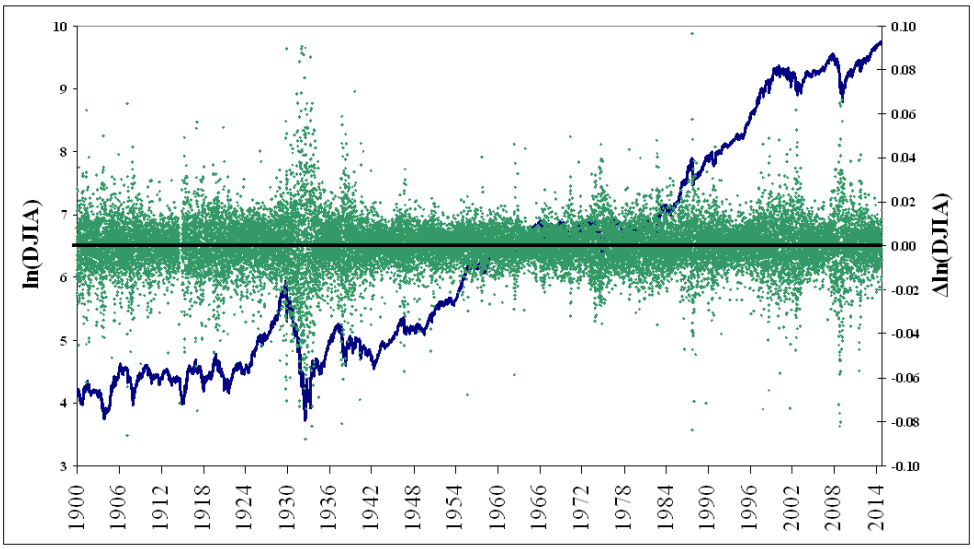

Figure 4. Daily fluctuations of the rate of return

There is no correlation between the fluctuations of the rate of return (logarithmically calculated) and the trend of the financial asset. Graphic conducted by the authors in Microsoft Excel.

Portfolio Monitoring

MPT does not state anything about portfolio tracking or the required feed-back: The problem needs to be treated from at least two points of view:

- Estimates (or expectations) of the results do not fall within the predetermined parameters. This phenomenon can occur frequently, but the theory does not have any reference about the moment the portfolio needs to be abandoned or restructured.
- Initially calculated parameters are not confirmed. For example, some financial assets in the portfolio modify their **r**, **σ** or **ρ**. MPT has no answer prepared, which would warn us, when, and up to which extent, the removal of the portfolio from its original predictions is based on normal statistical variations or if a basic problem appeared.

Portfolio selection based on technical analysis allows the pursuit of the same technique, thus having a clear and immediate feedback.

Portfolio selection with the graphic method

In this section, the following assumptions will be considered:

- Financial assets having similar variation (positively correlated) will be used for protection against non-symmetric risk. Selection will be based solely on

performance, because the technical analysis of the portfolio will enable us to discern exit signals in case of bearish trends.
- Financial assets with opposite variations (negatively correlated) will be used for systemic protection.
- Uncorrelated financial assets (which appear to be unrelated in-between or with other markets) will be treated comparatively with passive bank interests or other risk-free assets (government bonds).
- Proportion of financial assets in the portfolio will be determined based on graph's scale – the most intuitive way.

Protection against systemic risks

The main systemic risk is that the entire market would enter in bearish trend. Regardless of the premises and grounds, since financial assets are generally highly positively correlated with the overall market, major trends will eventually lead all the financial assets after it. It is a natural phenomenon, reflecting the general view of market investors, which subsequently reflects on individual securities.

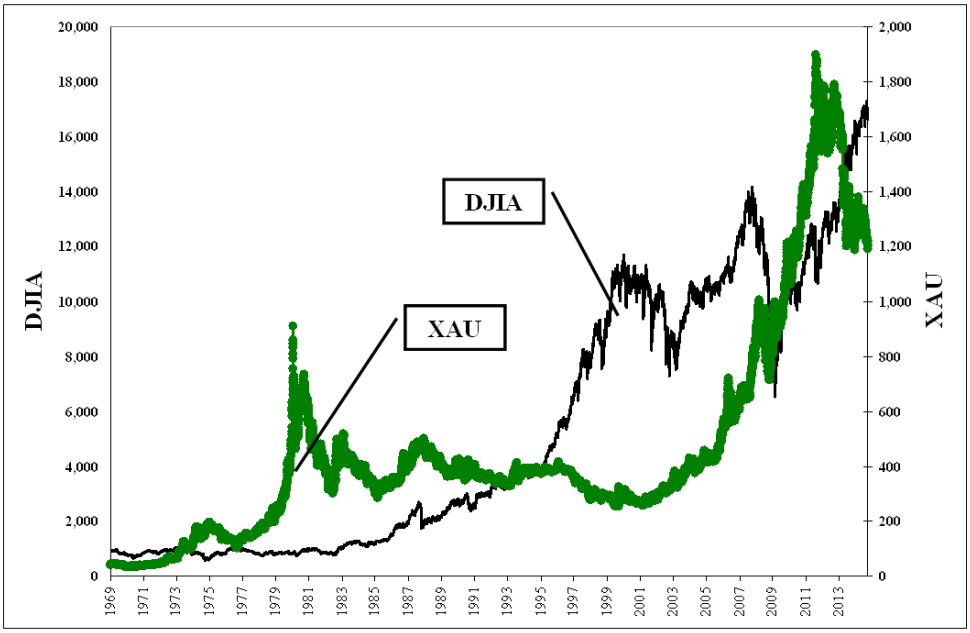

Figure 5. Graphical representation of two financial assets on two axes

The scale of representation of each of the financial asset will be established in such a manner that the two graphs will fill the available space. Chart performed in Microsoft Excel.

The only real possibility of protection (apart from exiting the market or adopting short positions) is to select simultaneously in the portfolio financial assets from other markets, which are preferably negatively correlated (have inverse variation).

The problem is finding these markets (assets) and determining their proportion in the portfolio.
Let us consider two financial assets, which have the natural tendency to be inversely correlated: stock market index vs. gold. Gold is seen as a defensive asset (financial protection in case of breakdown or shortage of liquidity) but its hoarding does not bring any income [19]. Therefore, in times of crisis gold will be sought determining an increase in the price. In bullish periods of the stock market and/or the economy, investors will not hoard gold, because they have no profit from its possession, which will lead to a decrease in price. The evolution of the US market index DJIA and the XAU gold prices are represented in Figure 5.

Graphics scale and the proportion of financial assets in a portfolio

In order to be significant the graphics of the two financial assets must be represented at different scales. The scales are chosen so as the graphs to fill the available space, each financial asset having a different axis, depending on its size. Based on the amplitude and the starting point of each graph, by multiplying each quotations of a title with a determined factor by a specific scale, we can represent both financial assets on the same axis (the same scale). The calculations are shown in Table 1, and the resulting graphical representation in Figure 6.
In general, values have similar orders of magnitude; otherwise, these values would have had to be leveled to zero, by adding a constant size to each point on one of the graphs. On the logarithmic chart, the physical significance of this adjustment would express the values in another unit, multiple different of 10^N of prices. Considering such an operation has no economic sense, we gave up to zero level adjustment.

Table 1. Scale of the graphic representation

	DJIA	GOLD
max	17.280	1.898
min	578	35
difference	16.702	1.863
ratio		**9**

The table shows the scale at which the financial asset with lower variance should be increased in order to be represented on the same axis.

The purpose of this representation is the graphical selection of financial assets in the portfolio. For the chosen example, it is noted that, except from a brief period after the crisis (2009÷2011), gold XAU and DIJA fluctuated in opposite directions, creating „islands" between the graphs. This is useful for hedging systemic risks, because financial assets have inverse variation.

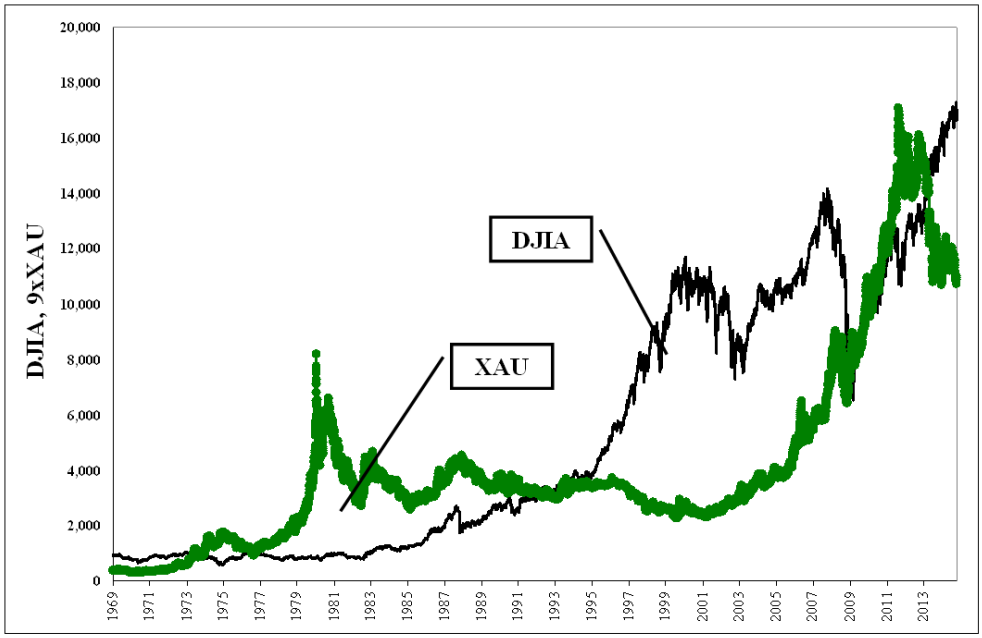

Figure 6. Graphical representation of both financial assets on a single axis
The idea of axis unification indicates the way the portfolio is constructed.

This representation confirms that the two financial assets have opposite variation and provide a relatively permanent protection against systemic risks. Also, the fact that the representation in on one scale suggests the proportion of the two financial assets – in our case, DJIA/XAU = 1:9. The graphic verification is immediate, if we consider a portfolio port = (DJIA+9*XAU)/2 (Figure 7).
A series of important observation are required:

- Through this approach, we can immediately check if the portfolio is effective.
- It immediately checks if the portfolio offers protection in case one of the financial assets runs out. Unfortunately exactly during the financial crisis of 2007÷2009 the portfolio suffered a downturn (was no longer profitable), but the decrease was less than the DJIA's one. The conclusion is that the protection is not absolute (the chosen portfolio is not an arbitrage), but for overall profitability the risk is relatively small.
- Portfolio selection necessitated simple operations in Excel; there was no require for advanced knowledge of profitability theory. The fact that the method is intuitive, constituted an advantage, because investor would understand much more easier
- Monitoring is simple and effective, as will be shown later.

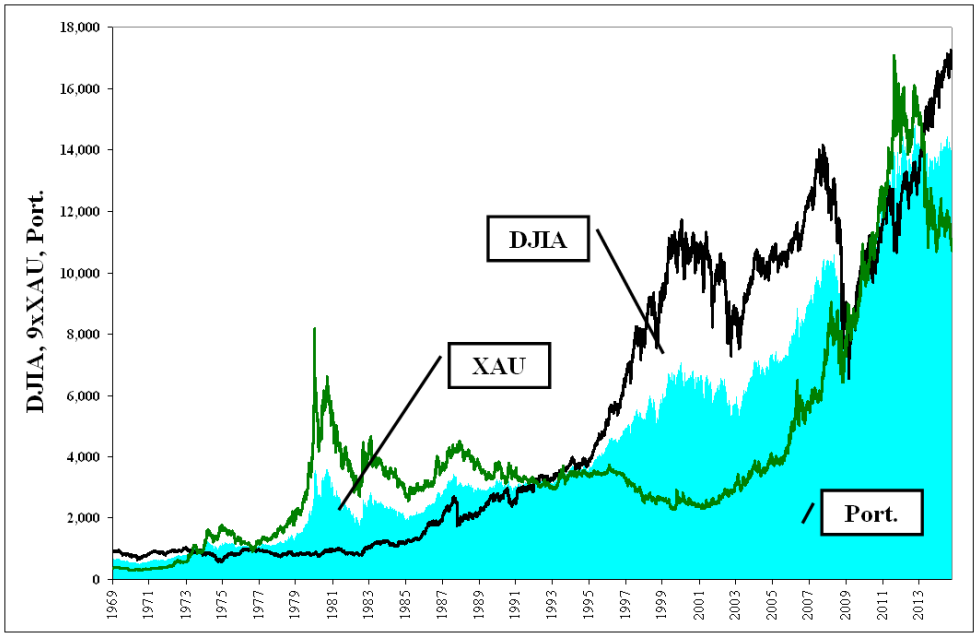

Figure 7. DJIA and XAU consisting portfolio

It is noted that the portfolio has a bullish trend on the majority of the interval and that it is relatively protected from dramatic decrease of each of the financial assets. Data was processed by the authors in Microsoft Excel.

Portfolio Monitoring

In general, technical analysis programs allow the monitoring of portfolio by selecting the component financial assets and their separate analysis. In Figure 8, portfolio analysis was performed using a specialized program, by taking data from a .csv file type analyzed in Microsoft Excel. Immediate advantages can be observed in overall portfolio analysis on individual financial assets:

- There are chart portions where the portfolio does not follow the evolution of any individual financial assets. In fact, it is the purpose of the portfolio: to diminish individual oscillations and to "smooth roughness".
- Signals occur at different times from the individual financial assets:
  - The right upward of the trend of XAU does not cross the graph at all, so there is no long-term exit signal.
  - DJIA trend is violated earlier (2008). Considering the portfolio is one of fall protection, it is not an output signal (unless we have invested only in DJIA).
  - The exit signal of the portfolio is important. The signal tells us it is no longer able to pursue its mission (protection and positive return) and therefore it must be completely out of the portfolio (to close both positions). The signal appears in 2009, after the exit signal on DJIA.

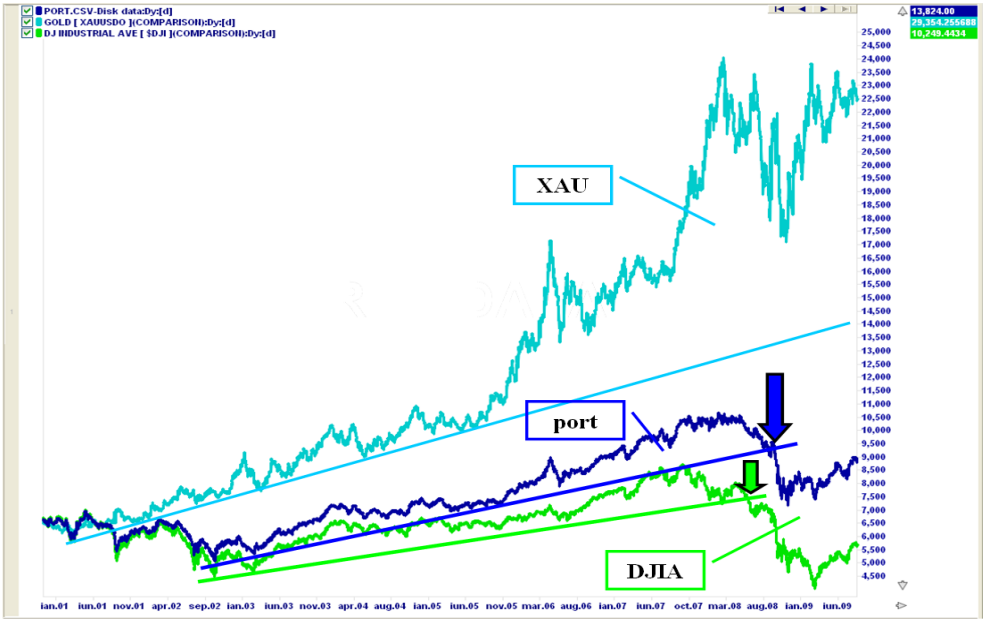

Figure 8. Technical analysis of the portfolio

The portfolio was exported in .csv format, then imported and interpreted in IncredibleChart program [20].

By monitoring the portfolio and not the individual components, this article's proposed approach is consistent. The choice of the portfolio was made on graphic grounds; hence, its monitoring is based on the same principles.
Please note that portfolio protection is not absolute (the proposed method is not similar to arbitrage), due to the fact that there is a chance of a decline of the portfolio (Figure 9). During the financial crisis, just when the protection offered by portfolio diversification should have been consistent, both bonds and shares fell. The motivation is clear: the investors preferred to protect themselves by hiding "money under the mattress", thus leaving all positions held.

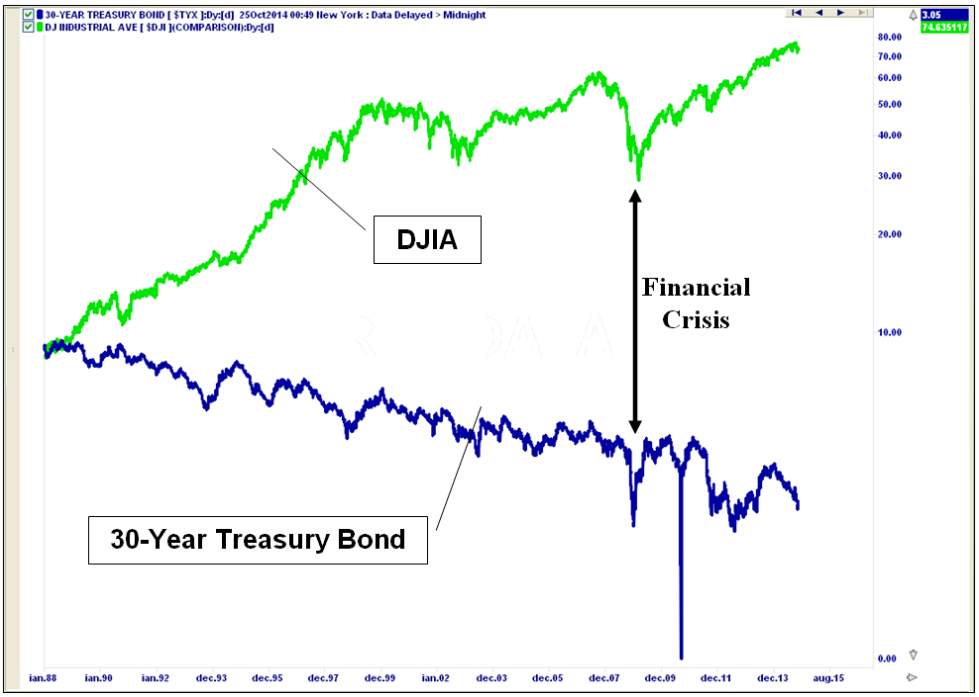

Figure 9 Portfolio protection cannot be absolute

Although the stock market vs. natural bond naturally vary inversely, in times of crisis both suffered setbacks, hence, letting the portfolio unprotected. Graph achieved in IncredibleChart.

Non-systemic risks

We plotted in Figure 10 (made under [21]) several financial assets listed in the US market that are part of the DJIA index. As expected, they are strongly positively correlated. Obviously, a portfolio formed entirely of similar assets is not protected from systemic risks (the risk that the entire market goes downwards), but provides protection against non-systemic risks (which depend only on the issuer itself).

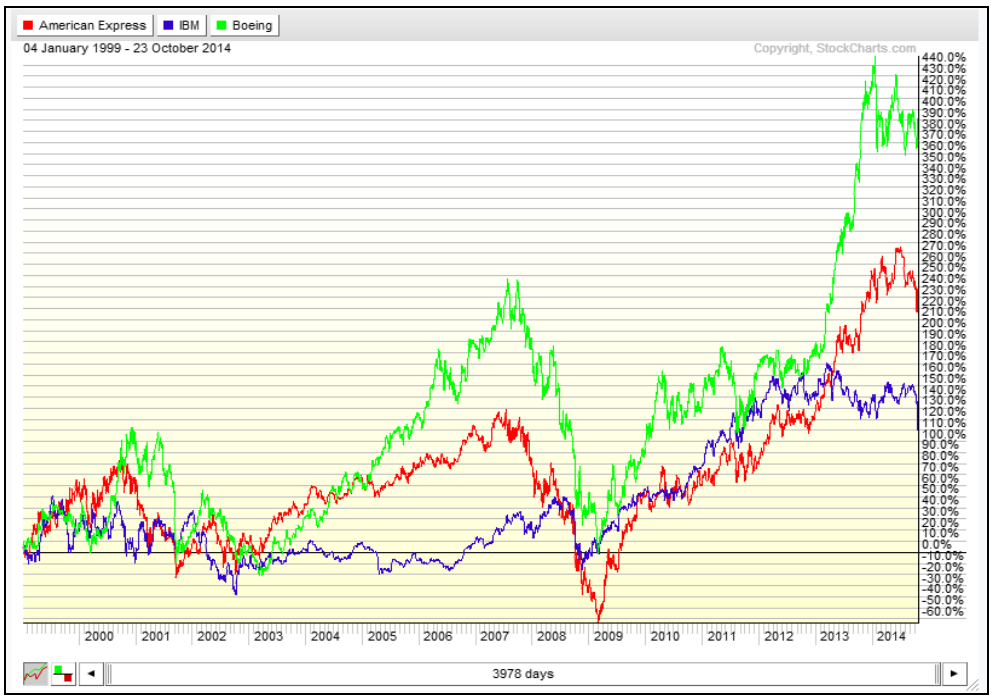

Figure 10. Positively correlated financial assets

As expected, such financial assets are on the same market and even in the same index (DJIA). Graphic made by the authors on the Stockcharts.com website.

Any company can go through difficult times. Wrong internal decisions, loss of key managers, a failed business, a disaster or misfortune can affect any company, and these situations are difficult (if not impossible) to predict. Protection against these risks can be achieved through arbitrage – which, however, severely limits the profitability – or by selecting in the portfolio several similar financial assets – by definition, non-systemic risks apply only to a particular issuer, not the entire market.

Graphic check of positive correlation is a fast, efficient, intuitive, and simple method to decide over which financial assets the investor should focus. The graphical representation in **Figure 10** gives an indication on the proportion of the financial assets in the portfolio. If Boeing (BA) provides a return of 440%, and IBM (IBM) a return of approx. 150%, it only makes sense to state that a protected portfolio for non-systemic risks must be structured in such a manner that it should contain three times more shares of IBM than BA.

Data accuracy is sufficient, because the market is not perfect:

- The financial assets cannot be bought in any quantity, at any time, at the same price;
- The current yield does not even remotely guarantee the same future results;

- The portfolio can be easily monitored, hence, fine adjustments can be made at any time;
- Financial asset's variation may depend on their inclusion in certain indices (when the relative weight changes, all issuers of structured products will restructure their protection portfolio); hence, the exact evolution would be unpredictable.

Conclusions

This paper proposes the selection of financial assets in the portfolio based on the following criteria:

- The relationship between trends, in comparison with the statistical notion of covariance (correlation) of daily rate of return.
- The share of financial assets is determined according to the scale of the graphs in order to obtain the desired protection effect, instead of minimizing the risk for a desired rate of return.
- The selection of positively correlated financial assets (meaning similar trend variations, not statistical correlation) is made by nominating at the same value of the desired yield – for protection against non-systemic risks.
- Portfolio monitoring, including through technical analysis, similar with any other asset (the portfolio represents a compound (index-type) asset).

After selecting the portfolio and after its processing (in any spreadsheet or database type software), it is clear that any analysis is possible, including statistics, if desired. Using graphs is just a tool, an aid in making investment decisions, not a mark of absolute fairness.

The proposed selection of financial assets is simple, accurate enough for current practices, easy to understand and implement. The suggestion to analyze the portfolio as a compound (index-type) asset helps investors and speculators who have an adversity towards mathematics and attraction towards technical analysis to build a rational investment policy.

Considering the fact that an index and a portfolio are build the same way, it is relatively easy to retrieve data and to implement in the portfolio any program of technical analysis.

Future research directions aim in particular towards the adaptation of statistical mathematics to the analysis of dynamic data in relation to market trends, but also automatic selection of financial assets based on stock exchange data and the choice of adopted criteria.

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