# A METHODOLOGY FOR TREND ANALYSIS OF STOCK EXCHANGE ACTIVITIES, BASED ON INDICATOR SIGNALS AND FREQUENCY VOLATILITY

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*Abstract: Different technical and statistical methods and indicators which are usually applied separately are used in market trend analysis. Some of the fundamental principles in technical analysis, as well as a great part of the quantitative indicators are not popular enough. There are unsettled issues regarding the change in the information indicators during the market trend and one can find unexploited potential in the analytical methods, which sets up a necessity for a more thorough and comprehensive study of the primary exchange indicators. Therefore, we propose a comprehensive methodology of market trend analysis, which integrates the signal functions of exchange indicators, statistical variation and frequency volatility by specifying their change throughout the market phases.*

*Keywords: stock exchange trend analysis, market trend phases, investment activities, stock exchange indicators, signal functions, frequency volatility, coefficient of dynamics.*

*JEL: G12; G14; G17.*

### Introduction

The study of market trends has permanent significance in the scientific-methodological and practical aspects of investment analysis, and the presence of uncertainty or problems in investment activity periodically makes this issue topical. Market analysis focuses primarily on price trends expressed in exchange indices, but the dimensions of stock markets and their other characteristics are rarely considered. Investment activity has some other indicators which are assessed by different stock exchange indicators, such as exchange turnover, number of transactions, bid-ask spread, etc. At the same time, different analysts of stock exchange trends apply specific technical analysis methods (wave theory or selected oscillators). On the other hand,

analysts usually ignore the wide range of quantitative technical indicators and popular statistical indicators, leaving the unilaterally applied methods. There is an unrealized potential in the different analysis methods in terms of both information significance of individual indicators and their applicability in market trend analysis. Besides, the academic world is still sceptical of the soundness and practical relevance of technical analysis. It should be emphasized that popular criticism of the theoretical validity and practicality of technical analysis can be accepted as reasonable grounds only for its early forms in which technical analysis is fully applied as graphic and based only on the Elliott wave theory (EWT). The prevalence of technical analysis in the professional environment of market analysts and stock traders is a sufficient argument for its practical relevance and efficiency, if only within the EWT. This study focuses on more advanced analytical instruments based on quantitative indicators where the distinction between technical and fundamental analysis is somewhat blurred. The reason for this is the use of a wider range of primary indicators of stock exchange activity, some of which are common to both analytical approaches, as well as the integration of the analytical methods themselves.

Taking into account the above stated, this article presents a comprehensive methodology for stock exchange trend analysis through an integrated study of different aspects of investment activity. The following are essential in the comprehensive methodology: the signal functions of primary exchange indicators; the different pace in the change of indicators; including frequency volatility in the trend analysis; integrating statistical variation and frequency volatility in the market trend phases.

On this basis, the *object of study* here is the methodology for stock exchange trend analysis, and its *subject* is the different technical, statistical, etc. approaches and the respective indicators. The study is based on the *thesis* that a successful market trend analysis requires a complex analytical approach that not only does not oppose technical and fundamental analysis, but unites their indicators and models. The prevalence of fundamental or technical analysis in the final assessment should be determined by the investment motives, which directly determine the time horizon. The *purpose* is to present a more in-depth, comprehensive and reliable methodology for market trend analysis. In order to achieve the stated goal, the following *tasks* are performed: the principles in the technical analysis for exchange trend analysis are used as a basis; the signal functions of primary exchange indicators are outlined; a more in-depth view is sought regarding the information significance of the direction in which indicators are jointly changed; the importance of frequency volatility is highlighted; statistical variation and frequency volatility are integrated in the market trend phases[1].

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[1] This article synthesizes methodological ideas and concepts, most of which are presented and some are practically applied in the author's monograph" Measures of stock exchange activity – a study on indicators and market trend analysis". // Economic World Library, issue 131, Tsenov Academic Publishing House, 2016.

# 1.   Defining a market trend

Regarding statistics, the term 'trend' means 'tendency in development' and is one of the four components (along with random fluctuations, seasonal fluctuations and cyclical fluctuations) comprised in the classical view of time series. A trend is assumed to be a main component of a time series, which involves "the total operation of all permanently operating systematic causes" (Ivanov, 2008, pp. 16-17). Besides, L. Ivanov points that a trend has a period of operation larger than that of cyclical, seasonal and random fluctuations. We should note that by the *prevailing tendency coefficient*[2] we differentiate between the terms tendency and trend and allow for a mismatch in their direction within a certain period.

In terms of investment analysis, the market trend is viewed as "a directed movement of prices, which is preserved long enough to be defined and still tradable" (Kirkpatrick& Dahlquist, p.12). In this study, we view the trend not only regarding the market exchange rate (the exchange price of investment instruments), but also regarding the change in the other market indicators, which are neither an asset nor an investment instrument and their value is not a price. This excludes the addition of tradability from the above definition, but refers to market activity, and hence it can be associated with investment decisions.

## 1.1.   Direction of the trend

In terms of the direction of dynamics of the indicator concerned, the trend may have three definitions: uptrend, downtrend and sideways trend. The methodology of technical analysis characterizes the trend in terms of its direction based on the peaks and troughs (bottoms) in the value and their consequent positioning[3].

A substantial analytical tool of the market trend forecast analysis is **the levels of support and resistance**, which are viewed at a certain time or a for certain period. The level of support is a price level, at which the interest for a purchase is considerably stronger than that for sale. Respectively, the levels of resistance are the price levels where the motive for sale dominates over that for purchase.

## 1.2.   Market trend classification

In Dow's theory, underlying technical analysis, a market trend is classified by three categories: major, secondary and near-term.

The length of the *major trend* is determined by Ch. Dow as lasting over a year. This is understandable given the fact that he observed and analysed the capital market back in the 1870s. Modern scholars, such as J. Murphy, define the major trend as lasting from six months to several years, which reflects the shortened investment horizon of financial derivatives strategies (Murphy, 1999, pp. 52-53).

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[2] Introduced in prior publications and discussed below.
[3] For further characterization of the direction of the trend see the above cited source.

The movement in the opposite direction of the major trend, Dow defines as a *secondary trend* (Stevens, 2002). Price fluctuations in the opposite direction of the major trend are also called reactions or corrections. The secondary or *intermediate* trend is defined as lasting from two or three weeks to several months, which also depends on the investment instrument.

A *near-term trend* is any trend lasting less than two weeks. The trade strategies based on fluctuations within the trading day (so called scalping) are practices independent of the trend.

We can summarize that trend categorization is in fact ranking according to the direction of movement compared to that of the major trend and the length of time for maintaining the respective direction. The trade approach and preferences about investment strategies are essential for viewing the trend. In terms of the near-term, daily strategies a common drop within the exchange session is enough to close long and open short positions, while for positional traders and portfolio investors this means a minor correction within the uptrend.

### 1.3. Market trend phases

Charles Dow examines the behaviour of the main market players during the bullish trend and the bearish trend and divides these trends into three phases, characterizing each of them with the changes in the investment environment and stock exchange activity.

*The first phase of the bullish trend* is defined as **an accumulation phase** and is characterized by the beginning of the accumulation of shares in the investors who rely on the reviving business and begin to actively buy shares from the still dominant pessimistic investors. The group of 'in the know' buyers begin to gradually pay a higher price than that expected by pessimists. The business environment still remains predominantly negative. Therefore, the broad investment community is not interested in the acquisition of shares and remains out of the market. A large part of mainstream investors is disappointed by the market – given its latest bearish trend. Separate instruments try an upward trend[4].

*The second bullish phase* is **a steady climb**. During it there appear encouraging economic reports and resurgent business announces expectations for increased corporate profits. This is the phase in which investments still require caution – until technical indicators turn positive. The stock exchange rates have little volatility.

*Charles Dow calls the third phase of the bullish trend 'Main Street Adopts Wall Street'* and this is characterized by broad market interest, high yield and high risk. The economic pages have articles heralding the new bull market. There is an appetite for new companies and the stock issue market gets going. At the same time market volumes go up and the exchange rates increase. Speculative companies report record levels of demand and rise, while blue chips lag behind the overall euphoric trend. There

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[4] The definition of market phases is based on Stevens, L. Essential Technical Analysis, Tools and techniques to spot market trends. *John Wiley & Sons, Inc.* 2002.

is an increase in the activity of buying stock on margin, futures and option transactions. The end of the third phase is always the same– a varying decrease.

The first phase of the bearish trend is defined as *distribution phase* and can be viewed as the final sub-phase of the bull market. It can be characterized as the 'freezing' of shares in investors and slowdown in investment activity. At this stage, the view that corporate profits have probably reached their peak is gradually spread among the investment community. The more active traders begin to sell their shares to the more optimistic and inert players, but this is accompanied by decreasing trade volumes. Investors gradually begin to withdraw from the market. This is the phase when belated traders usually enter the market – those who have been gathering courage till that moment – conservative investors, preferring safety.

*Panic selling phase* is the main feature of the bear market. Bid priced fall sharply, investors become sellers desperately trying to get out of the market. The drop in the exchange rates is accelerated and leads to the Black Friday (1987), Black Monday (2000) and the NASDAQ crash, well-known in the stock exchange history.

*Discouragement phase* – this third phase is a consequence of the worst part in the previous one. It is characterized by low stock exchange activity, limited movements in the exchange rates. There is usually a serious period of stabilization of the economy till the appearance of trust in shares and more perceptible initiatives of demand. In this phase, the decrease in rates reaches 80 to 90% (from the beginning of the bearish trend) for fast-growing speculative companies. Decapitalization in the blue chips is significantly smaller. A bear market ends when all the possible bad news has been discounted by the market. Even after the decline stops there is more bad news that keeps coming. Dow points that in terms of the whole market the 'discounting mechanism' (reduced price) of shares is a kind of an attempt to look ahead.

It should also be considered that there cannot be complete similarity between any two bear markets. The degree of 'cooling' of the investment activity and the duration of investment distrust expressed in low stock turnover and a small number of transactions as well as the degree of index devaluation and the length of time till the beginning of their recovery are individual for each market and period.

## 2. Analytical focus of the methods and models for studying a market trend

Statistical science offers various measures for characterizing the trend, from basic (growth, average growth, rate of change and average rate of change) to stationarity, random fluctuations, cyclic recurrence, etc. In simultaneous analysis of more than one time series for studying regularity, statistics provides specific measures, such as *factors of advance* (Ivanov, 2008, pp. 30-40), etc.

The characteristics of the trend, summarized in Table 1 show a different aspect of the dynamics of the time series, reflecting the behaviour of the studied investment instrument or stock exchange indicator. At the same time the synthesized analytical methods and measures are specialized on a different aspect of characterizing the trend.

*Table 1*
*Characteristics of the trend and analytical and predictive methods*

| Indicator | | Trend direction | Rate of change | Trend stability/volatility | Seasonal fluctuations, cyclic recurrence, etc. |
|---|---|---|---|---|---|
| **Characteristics** | | - Uptrend;<br>- Downtrend;<br>- Sideways trend. | - Growth;<br>- Rate of change. | - Stable/ volatile;<br>- Stationarity. | - Cyclic recurrence;<br>- Seasonal fluctuations;<br>- Market anomalies. |
| **Analytical methods** | *Stat.* | *Predictive models: Arena, etc.* | *Development rate* | *Measures variation* | *Spectral analysis* |
| | *Ec-s* | *Smoothing, chain averages* | *Dynamic analysis* | *Regression models* | *Dynamic analysis* |
| | *FAVT* | *Shows the presence of a tendency* | *Through the coefficient of prevailing tendency* | *Coefficient of dynamics and CAFDC* | *Are not object of special study* |
| **Methods of investment analysis** | **EWT** | Object of study | Used without being a central instrument | Is not an object of special study | Cyclic recurrence is a fundamental presumption |
| | **Tech. indic.** | Smoothing, chain averages | Show | In some of them it is used for signalling a change | Are not object of special study |
| **Modern non-quantitative predictive methods** | | | | | |
| Methods of artificial intelligence | | Chaos Theory | | | |
| | | Fuzzy logic | | | |
| | | Neural networks | | | |
| | | Genetic algorithms | | | |

Abbreviations in the table used:

*Stat.* is statistics;
*Ec-s* - econometrics;
*FAVT* - Frequency analysis of volatility and trend;
*C. dynamics* - Coefficient of dynamics;
*AFCCD* - Average frequency coefficient of change of direction;
Tech. indic. - Technical indicators (technical analysis measures);
EWT - Elliott wave theory.

As we know from practice, information and the result of the different analytical methods remain more detached and even often contradicted. The following points of this study set the task to search for a model that brings together the results of different methods in order to obtain a more complete and reliable characterization of the trend of investment indicators.

## 2.1. Common analytical methods and measures

Traditional statistical measures for variation and dispersion are popular enough per se, yet no particular studies of the market trend based on these are available. Because of their fundamental importance and popularity, they will not be dealt with here. The frequency analysis of volatility and trend (FAVT)[5] comprises three complementary indicators: coefficient of dynamics, average frequency coefficient of change of direction and coefficient of prevailing tendency, which characterize the frequency in the direction of dynamics and give an answer to the questions about the existence of a trend and an expressed tendency and the degree of trend sustainability[6]. In this article (point four) we discuss the feasibility of frequency volatility in market trend analysis.

## 2.2. Significance of technical indicators

As the current article focuses on quantitative indicators and models, we will not discuss Elliott Wave Theory and its modern application in investment analysis. However, technical indicators[7] that have been developing significantly over the last three decades should not be missed when discussing technical analysis tools. Technical indicators are sufficiently widespread in the practice of market analysts, although universities show certain scepticism and lag behind in their knowledge of them. The significance and scope of technical indicators form a separate section in investment analysis. Depending on the information-analytical aspect of the market trend there are three main groups of technical indicators formed:
- Trend indicators;
- Momentum indicators;
- Sentiment indicators[8].
P. Colby presents a wide range of over 120 technical indicators (Colby, 2003),

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[5] In the first presentations the three coefficients were designated by the general name 'Three-component analysis of volatility Tsenov-Simeonov' in memory of the founding benefactor of the Academy of Economics – Dimitar Apostolov Tsenov. See"Investitsionna aktivnost na balgarskata fondova borsa – analiz na promelivostta na pazarnata kapitalizatsiya", International scientific conference 25 years of Department of General Theory of Economics, "The development of Bulgarian economy – 25 years between expectations and realities", D. A. Tsenov Academy of Economics, November 2015 and Simeonov, S. „Analiz na promenlivostta na investitsionnite indikatori na Balgarskata fondova borsa (BG40 I borsovi oboroti)", International scientific conference "Investment in the Future", Varna, September 2015.

[6] On detailed contents of coefficients, their values and applicability in volatility analysis see Simeonov, S.monograph" Measures of stock exchange activity – a study on indicators and market trend analysis". // Economic World Library, issue 131, Tsenov Academic Publishing House, 2016, pp.101-107.

[7] The popular term 'technical indicators' corresponds to their indicative function regarding the changes in the market trend, but they are essentially relative measures.

[8] Technical indicators are discussed in detail in our monograph "Measures of stock exchange activity – a study on indicators and market trend analysis". // Economic World Library, issue 131, Tsenov Academic Publishing House, 2016, pp. 49-88.

which cannot be used simultaneously. Practically, the choice depends on the individual analytical approach and time investment horizon. These are some of the basic and most widely spread technical indicators in the work of practical analysts: the 'degree of price change' index, the market width index, the Arms index, etc.

## 2.3. Non-quantitative modern predictive methods

Non-quantitative predictive methods based on Chaos Theory, Fuzzy logic, Neural networks and Genetic algorithms, applicable in various areas (management, economics, science, etc.),have been developed since the 1980s. Over the last more than two decades R. Magenroiter[9]has developed a hybrid model for predicting financial markets, combining the above stated methods (Magenreuter, 2016).

## 3. Predictive signals of stock exchange indicators

The signal indicators presented here synthesize the value in the change of primary indicators. The theory of technical analysis deals with the interrelations between some stock exchange indicators[10] and the market trend, which are set as common–basic rules for market analysis. In the practice of speculators these established relationships are used as trading signals. For other indicators, such as stock turnover, for example, individual markets or assets are examined, but there are no representatively confirmed universal dependencies, or at least such are not made known.

### A) Indicators of Bid-Ask spread
Dealing with the two market prices 'buy' and 'sell' the Bid-Ask spread immediately reflects all market factors affecting supply and demand, risks and transaction costs. The earliest comments on the relationship of the Bid-Ask spread to market cycles were made by Charles Dow. The opening of the bid-ask spread is an indisputable indicator of market uncertainty growth. Charles Dow states that when the increase in the spread is a result of a decrease in the bid price, this is an indicator of exhaustion of the bullish trend and the beginning of a bearish trend (Stevens, 2002).In the context of practical application of the Bid-Ask spread, when analysing the trend the following characteristics should be considered:
1) In order for this indicator to be present, the trading platform of the stock and/or options market should be organized on a market-maker or mixed basis.
2) The Bid-Ask spread gives early signals within the intraday, but in general confirmation is also needed by another indicator or technical indicator.

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[9] The basic stages of the development of R. Magenroiter's hybrid model can be traced in a number of articles in 'Matematika i informatika' magazine, 2016.
[10] On indicators of investment activity, detailed classification and information significance see Simeonov, S.'s monograph 'Measures of stock exchange activity – a study on indicators and market trend analysis'. // Economic World Library, issue 131, Tsenov Academic Publishing House, 2016, pp. 17-48.

3) The Bid-Ask spread is the only stock exchange indicator which, being a market indicator, is subject to control (subjective limitation) by stock exchange managers (for more details see (Simeonov, 2015)).

### B) Basic rules for trading volume

One of the basic dependencies reflects the importance of aggregate trade (stock exchange) volume, in which *the larger trading volume is associated with a greater likelihood of continuing the trend than of its reversal* (Technical indicators, n.d.). This underlies one of the basic (general) assumptions in technical analysis, namely that *the change in volume precedes the change in price*. In particular, this rule has the following practical interpretation: there is a decrease in volume in an upward trend before the reversal of the trend into bearish, and a decrease in volume in a bearish trend is a signal of its reversal into bullish.

### C) Basic rules for open positions

Open positions reflect the value of the traded contracts on options and futures exchanges and the trading volume reflects the number of traded units of the respective basic asset at stock exchanges or contracts at commodities exchanges. As a result, most logically open positions give indicators similar to those of the trading volume. The 'general rules' defined in technical analysis involve the following dependencies treated as signals to initiate or change the trend (Table 2).

*Table 2*
*Trend signals based on the open positions*

| Market | Open positions | Signal |
|:------:|:--------------:|:------:|
| Growth | Increase | Bullish |
| Growth | Decrease | Bearish |
| Drop | Increase | Bearish |
| Drop | Decrease | Bullish |

*Investopedia* (Article, Technical indicators)

The dependence of trend signals presented in Table 2, which are of key importance for investors' decisions is, in our opinion, subject to discussion and needs to be specified in several aspects:

*First*, it is not clear what the term 'market' means, as it could reflect both market volumes and the trend of the overall market rates level. In both cases, there are certain contradictions. If the meaning of the defined 'market' is volume, then the overall concept needs further clarification. We consider it would be more correct to assume the term 'market' here as a market rate.

*Second*, we consider it more appropriate and necessary to view the bull and bear signals more precisely set in the respective phases of the two cycles based on the indicators concerned[11].

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[11] These issues are subject of the author's studies in the following points.

The decrease in the open positions in derivatives has to be interpreted as an indicator of trend exhaustion, whereby investors receive incomes from their speculatively open positions. The cited source also notes the possibility of exceptions to this rule. The increase in speculative potential along with hedge needs in enhancing market uncertainty, i.e. expectations for reversal of the trend, can support this ambiguous interpretation. In fact, the time between the decrease and increase in open positions in derivatives is commensurate with information timing – the short period between the exhaustion of the market trend and the beginning of its reversal. A more precise insight into the change of open positions in derivatives should reflect the following dependences:

- a decrease in open positions in trend exhaustion;
- an increase in open positions with expressed domination of call options and an increase in the price of futures contracts (term exchange rate) – when a bullish trend is expected or manifested;
- an increase in open positions with expressed domination of put and a decrease in the price of futures contracts – when a bearish trend is expected or manifested;
- a balanced increase of call and put positions – market uncertainty.

The combination of data for the two indicators – trading volume and open positions in derivatives is used as a confirmation of autonomous trade signals (the signals of a separate individual indicator).

### D) Combining trading volume, open positions and exchange rate when confirming the trade signal

Market exchange rate is the direct indicator of a market trend, but the filtration and fluctuations of factual reversals requires the confirmation by more indicators. The rise in prices, accompanied by a rise in trading volumes and open positions, is interpreted as 'an entry of new cash to market', reflecting the new buyers – an indicator of a bullish trend. We must emphasize that such behaviour of indicators is characteristic of the first two phases of the bullish trend. If, however, prices rise and at the same time volumes and open positions fall and short sales are activated[12], the situation is characterized by 'the money leaving its position on the market', which is a sign of exhaustion of the bullish trend and a beginning of a bearish trend (Table 3).

A situation in which the common (of the whole market and not of a separate instrument) open positions decrease and the exchange rates also fall is defined as a stable bearish trend. Long position holders are forced to close them in order to limit their losses. Technical analysts assume that the bearish trend continues until it is exhausted – closing of all long positions, which were opened during the preceding bullish trend.

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[12] We do not share the opinion in the source cited here that the end of the bullish trend and the beginning of the bearish trend is accompanied by "mass closing of short positions". On the contrary, we think that the transition between these phases is characterized by activation in the opening of non-covered short positions, which enables the exploitation of the expected decrease. At the same time, at the end of the third phase of the bullish trend there begins a closing of the positionally held long positions for receiving the formed income.

The exhaustion of the bearish trend is characterized by consolidated undertaking of reverse purchases by speculators that are left with uncovered short positions for receiving the incomes of the latest drop.

*Table 3*
*Common rules for market stability depending on the trading volume and open positions*

| Rate | Trading volume of basic assets | Open positions | Market trend |
|---|---|---|---|
| *Increase* | *Growth* | *Growth* | Stable |
| *Increase* | *Drop* | *Drop* | Unstable |
| *Decrease* | *Drop* | *Drop* | Stable |
| *Decrease* | *Growth* | *Growth* | Unstable |

*Investopedia* (Article, Technical indicators)

**The open positions growth** in options and futures contracts is also discussed by Ph. Jorion as an indicator of increasing the risk (Risk and Turnover in the Foreign Exchange Market, January 1996). Undoubtedly, the increasing risk both gives rise to the need for hedging and opens speculative potential, which initially leads to a growth in open positions and stock exchange turnovers with derivatives.

Continuing this logic, we can consider the **increase in the price of both call and put options** as an expression of a higher risk. If the exchange rate of shares or another market instrument has a downtrend, then the premium on the put options will grow and the premium on the call will grow with the growth of the basic asset. The exhaustion of the trend, regardless of its direction, is a risk and then, ceteris paribus both call and put premiums will grow.

### E) Signals of stock exchange turnover

Stock exchange turnover is a function of the trading volume and the market rate. Therefore, the stock exchange turnover as a whole has to function analogous to the trading volume. At the same time the stock exchange turnover should record a certain delay given the presumption of the forestalling reaction of the volume before the market rate.

An analogous relationship between the primary indicators discussed here is presented by Philippe Jorion in his paper 'Risk and Turnover in the Foreign Exchange Market'[13], in which he highlights the presence of a relationship between the volatility and turnover of the foreign exchange market and "the low exchange turnover is associated with the low volatility of the Canadian dollar or of a cross-rate" (Jorion, January 1996, p. 20). In addition, he argues the correlation with the new information and risk expressed by models known as *'Mixture of distribution hypothesis' (MDH)*, where "unexpected risk and unexpected volume are positively correlated through their dependence on an information-flow variable".

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[13] Again there, p. 19-40 the findings refer to foreign exchange rates between the Canadian dollar and the German mark, Dutch guilder in 1979-1980. The whole study covers other currencies as well with different time observations over 1079-1992.

In earlier studies (in 1983) Tauchen and Pitts showed that "the expected turnover can be changed over time and rise with the increase of active traders, with the intensity of the information flow and with the amount of the trade non-agreement" (Tauchen & Pitts, 1983, p. 4). There Tauchen and Pitts add that "this is in compliance with the idea that while stock exchange trade reflects the capital transactions, the turnover has to be defined by heterogeneous expectations combined with volatility". In that study referring to Clark (Clark, 1973, pp. 135-155), they point out the leptokurtic[14] probable distribution of day prices emphasizing the randomness of the number of transactions within the day trading. It must be borne in mind that their findings are the result of studying the foreign exchange markets. However, there is no principal reason that they are not valid for the stock exchange, too.

## 4. A comprehensive method for analysing the stock exchange trend

The present method of stock exchange trend analysis integrates four autonomous analytical approaches: the joint change of indicators, which develops the classical rules of the basic indicators' signal functions; indicators' volatility, studying in parallel value variation and frequency volatility; the dynamics of indicators and measures of volatility is studied in depth in the market trend phases. In order to achieve objective comparability between the different indicators, the rates of change are ranked and indicators are grouped and equalized through indexing of measures with different periods of reporting. These studies are integrated in the comprehensive approach in the given logical sequence.

### 4.1. Hypothesis of the forestalling change significance of some stock exchange indicators

This point of the study is based on the hypothesis of the forecasted value of stock exchange indicators when deciphering signals for changes occurring in the investment behaviour of financial markets. At the same time, we think that there is potential and insufficient clarity of the interrelations between primary stock exchange indicators. The above stated presupposes the application of statistical analytical indicators, different from those popular in investment, including in portfolio management as well. In methodological terms the goal for finding dependencies is pursued first, in particular one-way or opposite to the joint movement of the indicators.

It is well-known that stock exchange indicators are the most sensitive indicators of investment activity and as such react first in anticipating changes in the economic and investment environment. It is also a fact that in periods of recession, most of them register a decline on the whole, and in periods of upsurge they register a rise on the whole[15]. In studying their movement in shorter periods, however, one or two indicators

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[14] Leptokurtic – frequency distribution with over-normal excess (excess larger than that of the normal distribution).
[15] See exchange statistics of the BSE, and other world stock exchanges.

can be outlined, which register a movement opposite to the rest – those that are first to change their direction before changes in the total price trend are taken into account, or those that preserve their behaviour against the total exchange rate changes.

The above discussed characteristics of the signal function of open positions and trading volume are based on sufficient practical observations, so that they can be adopted as rules in the technical analysis. The hypothesis posed here expands the range of indicators used, which lets us set a goal to find an analogous dependence in the change of other primary indicators that will additionally confirm or independently signal the change or the preservation of the price trend.

The one-way movement of most indicators accompanied or preceded by an opposite change in the value of one or two of the leading exchange indicators can register changes in the risk expectations. The information significance of such an *opposite in the direction of change of indicators* largely exceeds the two main definitions of investment activity – positive (bullish market) or negative (bearish market). Outlining the dependencies sought could give a timely answer (an early signal) of the issues vital to investors – for entering the market, preserving the position, or closing the position.

This is the logical formulation of the model for a joint change of exchange indicators:

*1) Selecting the primary exchange indicators* for a comprehensive analysis. Based on the above discussed analyses, we place the following indicators as the most essential carriers of market trend signals: leading (and/or broad) market index; stock exchange turnover; number of transactions; open positions and bid-ask spread. Due to the dynamic variability of the bid-ask spread within the intraday and the correct comparability with other indicators, its inclusion in such a model should be carefully judged. We think it is more appropriate to examine the bid-ask spread independently and as an additional indicator.

2) *Deciding on a period for reporting*. We adopt the daily data of indicators as an information basis for studying the trend and the significance of indicators. The periods of averaging and measuring volatility are subject to an analytical and investor's judgement and they should reflect correctly the dynamics of exchange indicators and the significance of indicators measured. Thus, the periods may vary between 14 and 60 trading days. Similar is the logic in choosing periods in technical indicators, too. Defining and combining the signal and confirming indicators must be correctly concerted with their volatility within the chosen period of reporting. GDP is usually examined on an annual basis, the shortest-time application being on a three-month basis, and for its analytical application a certain delay is principally adopted. This characteristic of the GDP determines its applicability in long-term studies, mainly for macroeconomic purposes.

### 4.2. Coordinating the studied periods and rates of indicators' change

The change in the direction of dynamics of a certain indicator may not have occurred but reporting the volatility in the next step requires knowing the usual and normal rates of change in the separate indicators for a certain market and period. In

order to make a comparison in reporting the state and change of stock exchange indicators, we recommend the introduction of grouping with generalized characteristics and the application of suitable measures (such as percentage change, coefficient of variation, FAVT, etc.). Grouping according to the rate of change should be properly complied with the individual specifics of the indicator simultaneously in three aspects:

- First, with the dimensions of change in the respective primary indicator (stock exchange index, exchange turnover, market capitalization, etc.);
- Second, with the studied indicator (coefficient of variation, coefficient of dynamics, etc.);
- Third, with the period of reporting.

If a very short-term change in the index within the intraday is examined, the percentage changes indicated as slight in a ten-day period, will be viewed as strong. If deviations of that extent are expressed as declining, this will cause the precautionary exchange mechanisms to act and to discontinue the stock exchange trade. For the purposes of market analysis, the aggregated market data is studied, as we set in the beginning, but if a separate investment instrument is studied (shares of a particular company), a deviation of 5 or 10% compared to the previous (reference) rate will trigger a break in the 'continuous method of trade' and announce an auction[16].

Besides the above-mentioned consideration regarding the reporting period, we should take into account that *each of the exchange indicators has a principally different rate of change*. The stock exchange turnover and the number of transactions are the most dynamic and have the most expressed spread, deviation and variation. Stock exchange indexes have much weaker variation and here the range of the respective index (narrow or broad, sectoral, or general) is of significance. Market capitalization[17] has explicably the weakest variation.

Including indicators for the real sector development and mostly a generalizing indicator – such as GDP, requires that they be specified mainly with the much longer period in which their change is reported due to the significantly smaller number of observations possible and respectively slower change. Besides, the GDP cannot be applied with a change variation commensurable with that of the changes in the stock exchange indicators.

When finding a consistent common difference in the behaviour of individual stock indicators, an additional specifying sign could be introduced for determining the value of the percentage change for the grouping. The volatility of the respective indicator can be assumed as the most appropriate sign for this purpose.

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[16] On the preventive/cautionary stock exchange mechanisms – price ranges see Regulations of BSE-Sofia, Part IV, Section Seven. http://download.bse-sofia.bg/BSE-Rules/Part_IV-Trading_Rules.pdf

[17] Specific details regarding the established dependencies are given in Simeonov, St. "Sravnitelen analiz na promenlivostta na indikatorite za investitsionna aktivnost na Balgarska fondova borsa" *International scientific conference "Economic welfare through knowledge sharing", 80 years of D. A. Tsenov Academy of Economics,* 9–10 November 2016.

### 4.3. Implementing variation and frequency volatility in market trend analysis

It is known that volatility is a key indicator of risk, which accompanies investment instruments. We find proof of established positive correlation between volatility and some of the stock exchange indicators, specifically – trading volume, in Ph. Jorion, who refers to publications prior to his research for foreign exchange markets (Jorion, January 1996, p. 21).Here we look at volatility as a key indicator of changes in investment activity, especially when there is uncertainty in the dynamics of the rates of stock exchange instruments. To this end, in this approach for studying the trend we propose a more in-depth view on volatility in the following three aspects:

*First*, we suggest studying volatility and its change in each of the market phases.

*Second*, we suggest studying volatility for each of the chosen information indicators, not only for investment instruments.

*Third,* studying completely information indicators other than investment instruments, as was noted in the beginning, makes it necessary to search for additional measures – measures that characterize volatility in an aspect other than the expected yield and the indicators of descriptive statistics. The frequency analysis of volatility (FAV) provides such an additional view. The three coefficients included in the frequency analysis of volatility involve:

- Coefficient of dynamics $D = \frac{D_{Ch}}{D_{n-1}}$, expressing the days by a change in the direction of indicator change on the total number of observations (days);

- Coefficient of average frequency of changing the direction of change: $AF_{DC} = \frac{D_{n-1}}{D_{Ch}}$, reciprocal to the coefficient of dynamics;

- Coefficient of prevailing tendency: $PT = \frac{D_{Increase}}{D_{Decrease}}$, the days with an increase in the value towards the days with a decrease[18].

We expect that the established frequency feature of volatility shows additional signals in the market trend analysis. Regarding the latter, applied to the market trend indicators (stock exchange indexes or rate of a chosen instrument) we assume the following concepts:

- The indicators of variation of **descriptive statistics** record higher values in the middle of the market phases when the trend is clearly expressed, while frequency volatility is stronger in the intermediate periods when the market trend changes. That is, in trend exhaustion the rate of change, the rank and the coefficient of variation decrease and frequency volatility increases.
- In terms of **frequency volatility**, an increase in the value of the *coefficient of dynamics* and a decrease in the *average length of change of the direction*,

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[18] For more details regarding the three coefficients of frequency analysis of volatility and their application see Simeonov, S. Analysis of the measures of stock exchange activity – a study on indicators and market trend analysis. // Economic World Library 131, Tsenov Academic Publishing House, 2016. Chapter three, 2.3. Frequency analysis of volatility.

accompanied by a *coefficient of prevailing tendency* tending to unity (neutral value) are interpreted as a signal for reversal of the trend.

We make these assumptions regarding the trend in stock exchange activity but we expect that similar dependencies are recorded regarding other phenomena as well.

### 4.4. Integrating the direction of change and indicators' volatility in the market cycle phases

Our idea here develops volatility analysis and the joint behaviour of stock exchange indicators by putting them in a parallel analysis through the market trend phases in its entire cycle[19].The sequence in which indicators are examined reflects the order of their reaction when the market trend changes. Thus, we view indicators placed before the stock index (open positions, bid-ask spread, trading volume, number of transactions and stock exchange turnover) as signalling. We define those put after the market capitalization index and new listings as filtering the shorter-time fluctuations and confirming the trend. The changes in the value of some of the indicators confirm the above discussed principal formulations of technical analysis. The change in the other indicators specified in the trend phases (placed in Table 4), as well as their volatility are drawn based on a detailed empirical study[20].

The descriptive characteristics of indicators in the value of their measures (tendency, dynamics and variation) can be presented in a working format by rank designations as recommended above. This facilitates the parallel tracing of the change in the studied indicators and their measures, keeping the necessary precision for ranking their change.

When proving a permanent dependence in the joint change of stock exchange indicators, the result can be assumed as a model of a complex oscillator. Although it is more complicated than the chain averages and MACD applied broadly in technical analysis, here we expect the following advantages:

- avoiding the signal delay, typical and inevitable for chain averages;
- greater safety than the autonomous application of a separate indicator.

**Expected outcomes of the method integrating the parallel analysis of change in stock exchange indicators, variation and frequency volatility in market trend phases:**

1) The outcome of the model application to a specific capital market generally has to give certain investment characteristics, which include: the risk or crisis reaction of the market; an indication for a recession beginning; as well as its ability for a post-crisis recovery;

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[19] Regarding the market cycle phases we refer to Charles Dow's principles summarized and published by Stevens, L. Essential Technical Analysis, Tools and techniques to spot market trends. *John Wiley & Sons, Inc.* 2002.

[20] The empirical application of the comprehensive method is presented in Simeonov, S.'s monograph "Measures of stock exchange activity – a study on indicators and market trend analysis". // Economic World Library, issue 131, Tsenov Academic Publishing House, 2016.

Table 4.
*Summarized matrix of the joint change of stock exchange indicators and volatility over the market trend phases*

| Market trend phases / indicators | | Bullish market | | | Bearish market | | |
|---|---|---|---|---|---|---|---|
| | | I | II | III | I | II | III |
| | | Accumulation | Stable rise | Popularization | Distribution | Panic selling | Distrust and discouragement |
| Stock exchange turnover | Value | Small | Big | Biggest | Very big | Big | Very small |
| | Tendency | Growth | Big growth | Growth | Bigdrop | Huge drop | Drop |
| | Variation | Relatively low | Relatively low | Very high | Highest | Low | Very low |
| | Dynamics | Low | Very high | Moderate | Huge | Very high | Moderate |
| Number of transactions | Value | Very small | Moderate | Big | Biggest | Moderate | Very small |
| | Tendency | Changed stagnation | Growth | Big growth | Drop | Big decline | Big decline |
| | Variation | Low | Low | Relatively high | Very high | Relatively low | Very low |
| | Dynamics | Very high | Significant | Relatively low | High | Very high | Significant |
| Stock index | Value | Low | Moderate | High | Highest | Average | Low |
| Narrow index | Tendency | Moderate growth | Moderate growth | Moderate growth | Rapid decline | Crash | Stagnation at the bottom |
| | Variation | Relatively low | Moderate | Very high | High | Very high | Low |
| | Dynamics | Very high | High | Low | Moderate | Very high | Highest |
| Wide index | Tendency | Moderate growth | Large growth | Huge growth | Rapid decline | Crash | Stagnation at the bottom |
| | Variation | Relatively low | Moderate | Very high | High | Very high | Low |
| | Dynamics | Very high | High | Low | Moderate | Very high | Highest |
| Market capitalization | Value | Very small | Moderate | Very large | Largest | Average | Very small |
| | Tendency | Poor growth | Moderate growth | Large growth | Rapid decline | Crash | Stagnation at the bottom |
| | Variation | Very low | Relatively low | Relatively high | Low | Relatively low | Very low |
| | Dynamics | Moderate | Low | Lowest | Highest | Moderate | High |
| IPO and SPO | Number for the period | Emergence of interest | Strengthening of interest | Rapid growth | Are discontinued | Very small | Very small |

2) Prompt signalling for the passing (ending) of one and entering another investment (market) phase;
3) The observation of a larger number of periods allows for and suggests seeking dependencies of the indicators' movement in groups or in pairs;

4) The introduction of volatility and studying it in its two dimensions – variation and FAVT, suggests additional safety of the outcomes obtained;

5) Finding similar and different models of behaviour for the individual national markets (exchanges) enables the typifying of capital markets not only according to the generally visible size and degree of development, but also to the more specific investment characteristics, such as liquidity and 'vitality'.

The non-quantifiable characteristics 'vitality' is used to designate the ability of a particular exchange to quickly overcome the recessions that occur, to preserve and restore investment activity even in bearish trend phases. The characteristic 'vitality' is formed by the comprehensive reporting of exchange indicators and has a generalizing importance, with number of transactions and trading volume being the most essential for the investment activity.

The hypothesis thus defined suggests that it can be tested and different stock markets can be specified.

## 4.5.  Coordination of periods and adaptation of indicators

Having in mind the above discussed inconsistency of indicators of descriptive statistics in periods of different duration such as the market trend phases, we propose the introduction of weight for equalling the reporting period. A convenient option is to consider the duration of the shortest period as a unity and for each of the other periods to calculate a coefficient of its relative duration. The calculated statistical indicators for each period longer than the basic one are divided by the equalization coefficient. The rank, standard deviation and coefficient of variation are definitely dependent on the chosen period, and the longer it is, the greater the possible change. It should be borne in mind that the change of indicators is time-dependent but not straightforward in largely increasing the period. We believe that the dependence of the values of statistical indicators of the period under review is straight in relatively short periods, and increasing the period gradually decreases its significance.

In **conclusion,** the following main findings and results can be summarized:

1) The interpretation of stock exchange indicators is deepened in terms of their trend signal functions. Emphasis is placed on the parallel study of more than one stock exchange indicator so as to obtain a more reliable early signal and confirmation.

2) The rates of change for the individual stock exchange indicators should be ranked, depending on their varying volatility, established for a certain period, which should precede the subsequent reporting of changes occurring in statistical variation and frequency volatility.

3) Studying frequency volatility is introduced in market trend analysis, which adds different information significance of variation and dispersion indicators known in descriptive statistics. Coefficients of dynamics, average frequency of change of direction and prevailing tendency answer the questions about the presence of a trend and an expressed tendency and the degree of trend stability.

4) The statistical measures of variation (rank, standard deviation, coefficient of variation, excess and asymmetry) do not give a comparable estimate for periods of

different duration. In contrast, the FAVTindicators allow their application for a comparative analysis of phenomena with different reporting periods, which is essential in trend analysis, where the duration of individual phases differs greatly.

5) Frequency analysis of volatility and trend provides an appropriate methodology for comparative analysis of volatility and dynamics between different categories of indicators of investment activity – between investment instruments and entirely information indicators. This is important for the analysis of investment activity, where stock indexes or a specific investment instrument can be explored in parallel with indicators that do not reflect capitalization or return, such as: stock exchange turnover, number of transactions, market capitalization, bid-ask spread, number of public offers, etc.

6) The proposed integration of variation (dispersion) and frequency volatility, together with the trade signals of stock exchange indicators and their study by bullish and bearish phases, enriches and refines market trend analysis. This comprehensive methodology is suitable for a comparative analysis of investment activity between markets of different dimensions, different degree of development and activity.

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## CONTENTS

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- ☐ Commitment as a constraint
  to the pursuit of self-interest

- ☐ A methodology for trend analysis
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