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**Diploma Thesis Title:**

**IMPROVING THE SUSTAINABILITY OF THE MOSCOW  
STOCK EXCHANGE DURING THE ECONOMIC CRISIS**

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**IMPROVING THE SUSTAINABILITY OF THE MOSCOW STOCK EX-  
CHANGE DURING THE ECONOMIC CRISIS**


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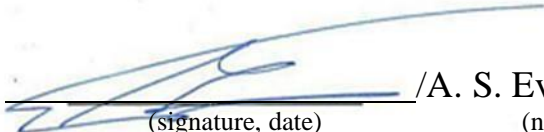
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## ANNOTATION

There is a strong direct link between the stock markets and the economic condition of the country, expressed through the stock exchanges. Thus, the economic condition is one of the factors affecting the stability of the stock exchange. Currently, the stock exchange is one of the most important sectors of the financial economy, which in turn affects the development of the entire economy. That is why, it is very important to find out and analyze the presence of factors influencing the stability of exchange activity during periods of crisis.

Modern stock exchanges are an important institution of the country's economy. This is explained by the fact that the society has formed a need for their presence in the national economic complex at present. The essence of economic needs expresses the need realized by society, and its satisfaction is possible with the help of the functioning and development of material production. Through the products produced or the services provided, which form the basis of the consumption process, occurs within the framework of certain socio-economic relations.

In this paper, key indicators are identified that affect the stability of the exchange through a correlation matrix, and based on the selected parameters, stock exchange trends are analyzed, and a forecast for the next 5 years is modeled.

In the work, the author emphasizes that to influence the activities of the stock exchange, an integrated approach is required aimed at increasing economic stability, since only these measures will favorably affect the selected parameters.

## CONTENTS

INTRODTION .....	4
1 Theoretical aspect of increasing the sustainability of the stock exchange .....	7
1.1 The essence of stock exchange activities, sustainability and economic crisis .....	7
1.2 Methods of sustainability of the stock exchange during the crisis .....	15
1.3 Methodology of building the econometric model and forecast of stock exchange .....	19
2 Analysis of the Stock Exchange trends .....	25
2.1 Analysis of Stock Exchange macroeconomic statement .....	25
2.2 The Microeconomic Assessment of Moscow Exchange Group's.....	29
2.3 The parameters of the Stock Exchange.....	38
3 Econometric Modeling and Forecasting of the Stock Exchange trends .....	42
3.1 Panel Data Set of Moscow Stock Indexes and processing market price .....	42
3.2 Algorithms of the Econometric Modeling Process of Stock Exchange .....	49
3.3 Forecasting of the future Stock Exchange trends .....	54
CONCLUSION .....	58
LIST OF USED LITERATURE.....	60
APPENDIX B - Variation for the dependent variable and recreation .....	67

## INTRODUCTION

Relevance. There is a strong direct relationship between the stock markets represented by the economic condition of the stock exchanges. Thus, the economic condition is one of the factors affecting the sustainability of the stock exchange. Currently, the Stock Exchange is one of the most important sectors of the financial economy, which in turn affects the development of the entire economy as a whole. That is why it is very important to find out and analyze the presence of factors affecting the sustainability of stock exchange activities during crises.

The purpose of this work is identification of factors affecting the sustainability of the Moscow Stock Exchange.

The object is the sustainability of the Moscow Stock Exchange.

Subject is the economic relationship arising between the stock market and economic systems.

To achieve the goal there are the following tasks that define the logic and structure of the work:

- to identify the fundamental factors that determine the main characteristics of the stock exchange;
- to study the process of pricing of stock assets and the influence of instruments, participants and infrastructure of the stock exchange on the performance of the function of attracting investments into the economy of the Russian Federation;
- to study the key features of the emerging stock markets and analyze the degree of development of the Russian stock market;
- construction of time series for the analysis of indicators of the Moscow Exchange Index;
- conducting correlation analysis to identify the relationship between the variables;
- to determine the priorities for the development of the Moscow Stock Exchange, associated with increasing its role as a mechanism for redistributing investments in the real sector;

– building a forecast for the next 5 years using the least squares method. Base hypothesis means that such factors as average world oil price, average DXY index, average TED spread, the dynamics of oil production in the world, average MSCI EM can improve the sustainability of the Moscow Stock Exchange.

Alternative hypothesis means that such factors as Moscow Stock Exchange index, the dynamics of oil production in the world, average MSCI EM can improve the sustainability of the Moscow Stock Exchange.

This work presents three parts. In the first there is theoretical aspects of increasing the sustainability of the stock exchange.

The first chapter explores: the essence of stock exchange activities, sustainability, and economic crisis. Additionally, methods of sustainability of the stock exchange during the crisis and methodology of building the econometric model and forecast of stock exchange.

Second chapter is about analysis of the Stock Exchange trends, exchange macroeconomic and microeconomic statement. In this chapter described and chosen parameters for creating econometric model.

The third chapter explores: the parameters effecting sustainability of Moscow Stock Exchange. What is more, author uses the economic regression in order to analyze and predict the sustainability of Moscow Stock Exchange for the next 5 years.

The added value of the research lies in the identification and formulation of 3 types of stock exchanges and their features. Also, the added value is expressed in the study and formulation of factors affecting the sustainability of the Stock Exchange. Using the methodology and methods from this mater thesis it is possible to investigate factors influencing sustainability of Stock Exchange and predict it behavior in the future.

The heist value of the master thesis is the way using the econometric regression and least square method for predicting the trend of stock exchange during the economic crises.

The master thesis consists of:

- 1 picture;

- 12 figures;
- 10 formulas;
- 19 tables.

Most of the graphical figures and tables were compiled by the author based on articles or author's calculations.

# **1 Theoretical Aspects of Increasing the Sustainability of the Stock Exchange**

## **1.1 The Essence of Stock Exchange Activities, Sustainability and Economic Crisis**

Financial markets play an increasingly important role in the global economy, they determine its health and sustainability. Firstly, this is approving the fact that there is a strong positive relationship between the development of the financial market and the economic growth of a country. Financial market helps to turn savings flows from investment to the economy, by contributing to the accumulation of capital and the production of goods and services. There are the combination of well-developed financial markets and institutions, as well as a variety of financial products and instruments, meet the needs of borrowers and lenders [46].

Stock markets, both as separate entities and in their aggregate, are an important part of financial markets. According to M.M. Lubochkin, the financial system is the circulatory system of the whole organism, performing a redistributive function, and the stock market is its heart, thereby making the movement of financial resources [25]. According to this definition Stock market is a central system of financial market. The stock market cannot exist without stock exchange, as if stock exchange provides all operations throw stock market.

A stock exchange, securities exchange, or bourse is an exchange where stock-brokers and traders can buy and sell securities, such as shares of stock, bonds, and other financial instruments. Stock exchanges may also provide facilities for the issue and redemption of such securities and instruments and capital events including the payment of income and dividends [18].

In an article Y.I. Bulatov distinguishes stock exchanges as the largest and most important segment of the financial sector. Considering the theoretical aspects of the stock exchange and the stock market, the author concludes that these concepts are not synonymous, but in practice the border between them is blurred. The difference lies in the fact that these two concepts express a different level and a different degree



of economic relations. The stock exchange itself is a participant in the processes taking place in the securities market [4].

While both terms – stock market and stock exchange – are used interchangeably, the latter term is generally a subset of the former. If one says that she trades in the stock market, it means that she buys and sells shares/equities on one (or more) of the stock exchange(s) that are part of the overall stock market.

The main aim of the stock market is to ensure the efficient operation of the stock exchange. In turn, the role of the stock exchange is to serve the movement of money capital, which mediates the distribution and redistribution of national income both in the national economy as a whole and between social groups, sectors, and spheres of the economy [14].

Stock exchanges play a vital role in economic development as one of the primary tools for the allocation of capital in both emerging economies and developed ones. Exchanges indices are used by the financial services industry and politicians alike as a barometer of economic health and a predictor of financial well-being [55].

The role of stock exchanges in the market economy is emphasized by Ryabov A.M., he examines in detail the impact of various stock exchanges not only on the economy, but also on the activities of enterprises. The author concludes that stock exchanges are the main mechanism for the redistribution of capital between various sectors of the economy [41].

Considering stock exchanges from the point of view of legal status, in world practice, there are three types of stock exchanges: private, state, and mixed in figure 1.

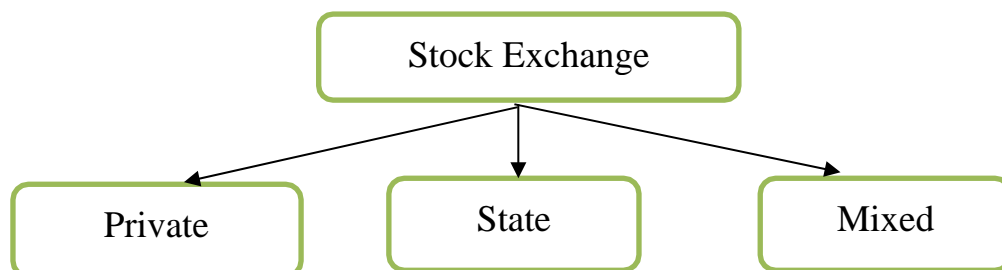


Figure 1 – Types of stock exchanges (compiled by the author)

The stock exchange, as a public law organization, is under the constant control of the state. In this case, it is the state that is engaged in the development of trade rules and provides a supervisory function. This type of exchanges can be found in France [39].

Stock exchanges as private companies are created in the form of joint stock companies. They are independent in organizing trade and are not regulated by the state. This type of stock exchange operates in the United Kingdom and the United States.

Stock exchanges are classified as mixed, if they are created as joint stock companies, and more than 50% of the capital belongs to the state like in Sweden, Switzerland, and Austria.

It is customary to distinguish two more types of stock exchanges, each of which has its own niche and specialization: global and regional.

The essence of the stock exchange is reflected through its functions. At the moment, the following are the main functions of stock exchanges [23]:

- preparation and implementation of exchange contracts;
- organization of exchange trading;
- quotation of exchange prices;
- guaranteed execution of exchange transactions.

In addition to functions, important elements for ensuring the functioning of the exchange have its tasks, designed to ensure the fulfillment of the main goal of the exchange, which is to ensure the smooth interaction of its subjects and objects. These tasks include the following:

- creation of a permanently operating securities market;
- determination of the exchange price for securities, conditions of their circulation and dissemination of information about financial instruments;
- mobilization of temporarily free financial resources and funds and facilitating the transfer of property rights;
- providing liquidity and guarantees for the implementation of agreements concluded on the exchange;

- analysis of the economic situation in the internal and external capital markets, determination of the prospects for their development;
- ensuring publicity, openness of exchange trading.

Financial markets can play a role in sustainability development. They can support sustainability by making ESG disclosure, launching sustainability related indices or offering sustainability guidance for listing companies. All these activities help in developing sustainability.

Sustainability Indices based on ratings using voluntary public disclosure appear to be one of the preferred instruments used by the exchanges to encourage transparency of corporate sustainability indicators without mandatory rules. Such indices highlight top performers, facilitating investor pressure and competition between companies to drive disclosure, and ultimately better performance, in the long term. Tough but flexible regulations are conduit to improving a country's competitiveness through innovation [67]. Lower the environmental and social local standards, higher would be the costs of adopting better sustainability practices for individual firms.

Sustainability indices are stock market indices that evaluate the sustainability performance of companies. They look to synthesize – often with one piece of data, position, or seal – complex concepts related with general company sustainability. The objective is to show the public which companies are acting responsibly when it comes to the environment.

Given that clients and end users are increasingly concerned with companies' environmental policies, these indices look to summarize – with regards to investors searching for ethical projects – which companies are a Socially Responsible Investment (SRI). Not all indices are the same, nor do they measure the same factors. There are dozens of indices.

They are sometimes presented as an open list, limited to a specific number of companies, as is the case with the Dow Jones Sustainability Index (DJSI). On other indices, the companies are revealed one by one, as is the case with FTSE4Good. What they all share is an objective and rigorous work methodology that looks at many factors in the work environment.

Some factors appear as a synthesis of questionnaires filled out by the committees of the companies being evaluated. Others evaluate levels of CO emissions, recycling performance, water use reduction, internal sustainability training policies, sustainability in R&D, and a long list of items with measurable parameters.

The sustainability of the stock exchange is influenced by many factors, both external and internal. Nowadays, crisis is one of the most influencing external factors. Arjen Boin the Professor of Public Institutions and Governance defines an economic crisis as a sharp decline in the economic indicators of the state, the result of which is a decrease in the welfare and standard of living of citizens [65].

Paul't Hart the professor of public administration at the School of Governance gives more specific definition of economic crisis. It determines the deterioration of the economy because of a significant decline in production, disruption of existing production ties, bankruptcy of enterprises, growth of unemployment and, as a result, a decline in living standards and welfare of the population [66].

First of all, it should be noted that crises can be of different scales. Crises can be general and local, explicit, and latent, periodic and irregular, regular and random, severe and light, protracted and sudden in figure 2.

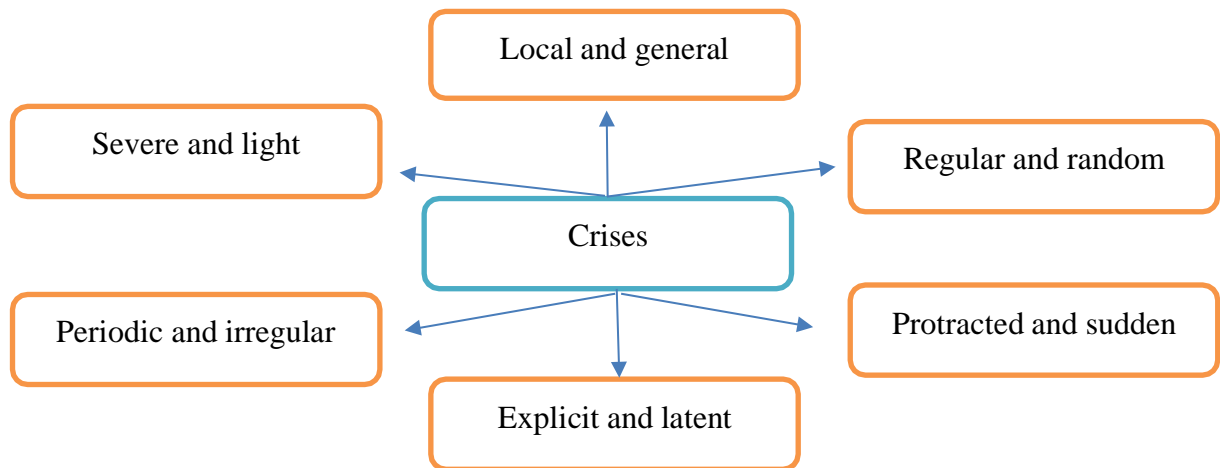


Figure 2 – Types of crises (compiled by the author based on [58])

The problem of sustainability of the stock exchange has been studied by many economists, scientists, and organizations. In 2009, the first Sustainable Stock Exchanges (SSE) global dialogue was opened in New York by UN Secretary General Ban Ki-moon and featured approximately 100 leaders from institutional investors,

stock exchanges and regulatory bodies. The SSE was a product of collaboration between various UN and UN related organizations working on responsible investment, ESG disclosure and corporate sustainability.

In 2011, as a result of its dialogues within the SSE initiative, Aviva Investors convened the Corporate Sustainability Reporting Coalition. This coalition now includes over 40 organizations, primarily institutional investors, managing in excess of US\$1.6 trillion.

According to this report markets are driven by information. If the information they receive is short term and thin then these characteristics will define markets. Based on the UN-backed Principles for Responsible Investment we have it is believed that consideration of environmental, social and governance (ESG) issues are relevant to firm-level performance.

The dominant view is that business can profit from sustainability when solving the social and environmental problems of the world through new growth opportunities [68], through opportunities for innovation [69] or for profit [70]. The underlying assumption set in this perspective is that business will not pursue environmental and social initiatives if these do not provide economic advantages to the business.

Banerjee arrives at the same conclusion with regard to corporate social responsibility (CSR) and links it to the primary focus in the literature on the financial impact and on the company not on the outcomes for society.

The main indicator of a sustainability activity of stock exchange is the stock index, which determines the sustainability of the market, and the volatility of the stock index reflects the state of the market as a whole. To improve the index of the stock exchange index, external factors can be influenced [11]:

- GDP;
- development of production in the industrial sector;
- the volume of investments in fixed assets;
- refinancing rate.

Among one of the most significant objective macroeconomic indicators that indicate the state of the economy is the Gross Domestic Product.

Lumir Kulhanek researched the relationship between European stock markets and GDP. According to the research, there is a long-term relationship between the stock index and GDP. GDP growth or decline is primarily associated with production. With the growth of production, there is an increase in investment and savings. The stock market is a convenient tool for finding investments and investing, which is why, with the growth of GDP, there is an increase in interested parties to the stock market [9].

However, many researchers are convinced that GDP alone cannot be used to predict stock indices. So, Paolo Mauro tested five hypotheses, among which there was a direct relationship between GDP growth and stock market returns. The result of his research was the conclusion that, in addition to GDP, it is necessary to apply other macroeconomic variables for forecasting accuracy [19].

External factors include:

- exchange rate;
- oil price;
- inflation;
- Fed rate;
- S&P index.

Minsoo Lee, Christopher Gan, Jun Zhang, Hua Hwa Au Yong studied the relationship of macroeconomic indicators such as the exchange rate, consumer price index, gross domestic product, long-term interest rate, money supply, oil prices, short-term interest rate with the stock market index in New Zealand (NZSE40). As a result of the study, it was proved that money supply, GDP and interest rate affect the stock index [41].

The exchange rate has a large impact on a country's exports and imports, as well as on the competitiveness of enterprises. When the exchange rate of the national currency falls, the positions of exporters are strengthened, because the cost of the goods sold decreases for foreign buyers. In turn, the rise in the exchange rate has a negative impact on domestic producers. Also, the exchange rate affects the value of export-oriented companies, which leads to a change in the value of shares.

Leading American economist Martin Feldstein investigated the relationship between inflation and stock returns. In one of his hypotheses, he stated that higher inflation forces tax rates to rise, and this leads to higher costs for companies. These findings were confirmed by two brilliant economists Chin-Fang Chi and Chin-Chuan Yeh [56].

In modern conditions, when absolutely all countries of the world talk about renewable energy sources, about environmental protection. So far, no one has given up on oil as the main source of energy, because it is the most important source of sustainability in the production and economy of the country. These reasons, like a number of others, undoubtedly cause a constant demand for oil, and the volatility of its cost can lead to a prolonged economic crisis. Research into the relationship between oil and stock exchanges is relevant and justified.

To conclude, it is impossible to consider the activities of the stock exchange separately from the stock market because these are complementary concepts. The stock market has more complicated structure and includes greater numbers of participants.

Stock exchanges play a vital role in economic development as one of the primary tools for the allocation of capital in both emerging economies and developed ones. The exchange's indices are used by the financial services industry and politicians alike as a barometer of economic health and a predictor of financial well-being. There are several factors effected sustainability of stock exchange. One of the factors influencing the activity of the stock exchange is the crisis.

## **1.2 Methods of Sustainability of the Stock Exchange During the Crisis**

Stock Exchanges can play a major role in facilitating transparency of sustainability risks and better corporate sustainability performance. Among the key international policy developments that underpin the increasing number of stock exchange initiatives on sustainability, the main is the outcome of Rio+20 United Nations Conference on Sustainable Development. European Commission has also adopted a proposal for a directive enhancing the transparency of companies on social and environmental matters on April 16, 2013 by changing existing Accounting Directives. Earlier on 6 February 2013, the European Parliament had adopted two resolutions connected with Social Responsibility, acknowledging the importance of company transparency on environmental and social matters [44].

The SSE initiative is a joint project organized by the United Nations-backed Principles for Responsible Investment (PRI), the United Nations Conference on Trade and Development (UNCTAD), the United Nations Environment Programme Finance Initiative (UNEP-FI), and the United Nations Global Compact (UNGC). This study was completed using a combination of publicly available information, survey responses and findings at the time of research. Exchange entity ownership information was accessed from Bloomberg, January 2012.

In this research 27 Stock Exchanges all over the world were surveyed in 2012 and 2014 and described. An exchange entity could refer to either the holding company of a single or multiple exchange or a single exchange.

According to articles there are several methods which are used for surveying the sustainability of stock exchange.

Every method is unique and can be chosen for such research. The most popular methods which could be categorized into two categories: qualitative and quantitative methods. They are shown on figure 3.



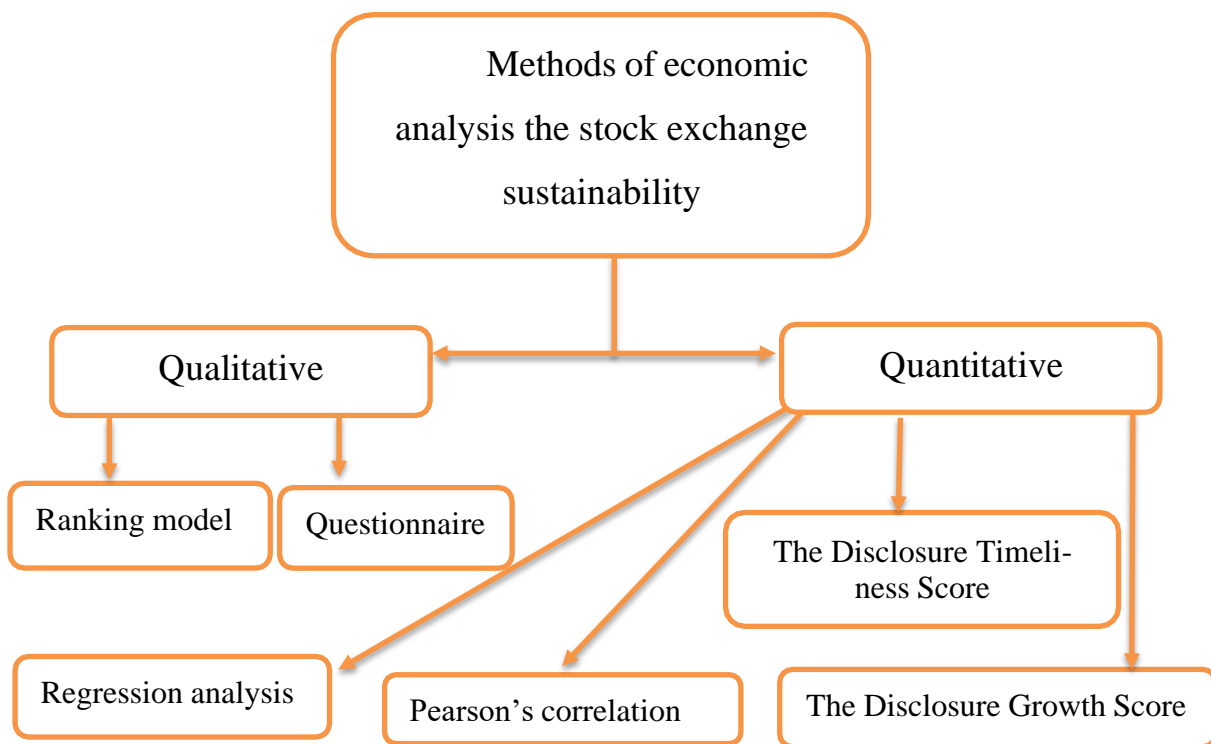


Figure 3 – Methods of economic analysis (compiled by the author based on [53])

Aviva group urge policy-makers of all description to arrest the slowdown in quantitative, indicator-based corporate sustainability reporting by implementing policies that encourage or mandate listed companies (and large listed companies in particular) to measure and publicly disclose their performance on the seven first-generation sustainability indicators. Aviva has the following number of methods to accumulate the sustainability stock exchange [52]:

- the Disclosure Score 50%;
- the Disclosure Growth Score 20%;
- the Disclosure Timeliness Score 30%.

Mark Wilson the Group Chief executive officer Aviva believes that this particular set of methods is suitable for compiling a rating of the sustainability of exchanges.

The most popular fundamental statistical method is regression analysis [15]. Regression methods are extremely important in econometrics because economists are not able to use controlled experiments. Researches usually seek natural experiments in the absence of evidence from controlled experiments. Observational parameters could be subject to omitted-variable bias. In this case a list of problems

which must be addressed can use causal analysis of simultaneous-equation models [16].

World Federation of Exchanges has used regression analysis in their survey. There are a couple of benefits of using regression analysis.

1. It shows the relationships between dependent variable and independent variable.
2. It shows the strength of impact of multiple independent variables on a dependent variable.

There are a lot of different kinds of regression techniques which could be used to create predictions. Such techniques are driven by three metrics such as number of independent variables, type of dependent variables and shape of regression line. World Federation of Exchanges uses the Linear Regression [65].

Sustainable Stock Exchanges Initiative prefers to use leverage a unique global network of stock and Pearson's correlation, the test statistics that measures the statistical relationship, or association, between two continuous variables. It is known as the best method of measuring the association between variables of interest because it is based on the method of covariance. It gives information about the magnitude of the association, or correlation, as well as the direction of the relationship [66].

Marcin Kalinowski the professor in WSB university in Gdansk researched this problem. The aim of his article is to assess the level of stock exchanges sustainability support and examine the relationship between the stock market size and sustainability support level. To achieve the aim the assessment tool has been created. Sustainability Support Index is a synthetic stock markets sustainability support measure. It helps to compare stock exchange sustainability support levels [63].

There were 19 questions in the survey made in 2012. For this research purpose 4 questions were considered as the most important. Selection was made considering assessment objectivity and comprehensiveness. Important in the selection process

was also data reliability. Assumption was that variables are the various actions associated with internal regulations, external regulations, investors, and listed companies.

The questions used to conduct research in this article were as follows:

- Does the exchange make its own ESG disclosures?
- Is the exchange a signatory of PRI?
- Has the exchange launched sustainability related indices?
- Has the exchange offered sustainability guidance for listing companies?

Answers to the questions in the conducted questionnaire allowed to assess overall sustainability support level on a scale from 0 to 1 in four categories (ESG disclosure, PRI signatories, sustainability indices, sustainability guidance for listing companies). Each category has been proposed as support variable assessing stock exchanges sustainability. All variables were assigned equal weights.

It is represented by formula

$$SSI = \sum_{i=1}^4 x_i, \quad (1)$$

where

SSI – sustainability support index;

$x_1$  – ESG disclosure (Yes – 1, No – 0, GRI – 0,5);

$x_2$  – PRI signatories' disclosure (Yes – 1, No – 0);

$x_3$  – sustainability index (Yes – 1, No – 0, plan – 0,5);

$x_4$  – sustainability guidance for listing companies (Yes – 1, No – 0).

SSI is a stock markets sustainability support synthetic measure. It can be used to compare overall stock exchange sustainability support level. The SSI index may not reflect all sustainability initiatives that exchanges have been internally pursuing or contemplating. This tool gives the opportunity of initial overall sustainability support assessment [53].

These methods and articles are aimed at studying the sustainability of the state of the exchange and not its activity. In addition, the study was carried out over a long

period of time and there is no data on changes in sustainability during the crisis. Therefore, a different research model is used to analyze the sustainability of the exchange's activity during the crisis. In spite of the fact that there is not enough research devoted to the sustainability of the stock exchange activity it was found out that exchange index is the main factor of sustainability.

Thus, in this chapter it is revealed that there is a huge amount of research devoted to the sustainability state of stock exchanges and their impact on the sustainability of the economy. However, the problem of sustainability of the stock exchange activity has not been studied sufficiently.

In conclusion, there are a certain number of methods for determining the effectiveness of the stock exchange, but there is not a single method for predicting the effectiveness of the stock exchange.

### **1.3 Methodology of Building the Econometric Model and Forecast of Stock Exchange**

In this paper, we developed our own method for predicting the sustainability of the Moscow Stock Exchange based on Regression analysis, Linear regression and least square methods.

The research on stock market prediction techniques has eventually moved into the technological realm. Machine learning approach is one of the common techniques. The approach of machine learning is by examining a potentially liner or non-liner relationship that exists with the availability of enough indicators [8]. Machine learning is a branch of artificial insurance. This approach finds patterns in training datasets and form their own rules which are then used for making forecasts in testing datasets [20].

Regression techniques are part of the machine learning approach. Francis Galton used term “regression” to describe a biological phenomenon. Later his work was developed into the statistical context by Undy Yule and Karl Pearson [10]. Common

regression analysis involves inputs of numerical data which may consist of infinite or wide range of values.

Stock index is an indicator of the sustainability of the stock exchange. It is influenced by two types of factors, external and internal. In this paper financial research is carried out for the analysis of internal factors, while econometric research is used for the analysis of external factors.

In order to analyse factors influencing MOEX Russia Index we need to construct initial dataset. This table will display the dynamics of factors over the past 19 years. The dataset will contain statistics from the Rosstat website. Then we will assess each factor individually by means of MS Excel software. The influence of each regressor on the dependent variable will be estimated by plotting the relationship and evaluating the level of the coefficient of determination ( $R^2$ ). The higher the coefficient is, the more the variable  $x$  affects  $y$ .

Coefficient of determination is calculated the following way

$$R^2 = \frac{\text{var}(\hat{y})}{\text{var}(y)} = 1 - \frac{\text{var}(e)}{\text{var}(y)} \text{ and } 0 \leq R^2 \leq 1 \quad (2)$$

where

$R^2$  – determination coefficient;

$\text{var}(\hat{y})$  – variance of calculated  $y$  values;

$\text{var}(y)$  – variance of observed  $y$  values;

$\text{var}(e)$  – variance of residuals.

The basic rule the closer  $R^2$  to 1, the better. If  $R^2$  are equal to 1, then the regression accurately describes the sample. It means that all variables lie on the regression line. If  $R^2 = 0$ , then the regression gives nothing to describe the sample and such model could not be used to create a prediction.

After selecting two or three variables with best R-squared we construct a new dataset which will contain only main regressors. Then we need to conduct regression

analysis of the data. In order to do that we will use the function Data – Analysis Package – Regression. After that regression statistics should be examined carefully.

There are three tables with our regression outputs: regression statistics, ANOVA table and coefficients table. Multiple R, R-squared, Adjusted R-squared, Standard Error and Observations are indicators that are presented in regression statistics table. We need to analyse them all and see if these indicators are adequate and within the normal range.

To determine the statistical significance of the coefficient of determination the null hypothesis is tested.  $H_0$  for F-statistics

$$F = \frac{R^2(n-2)}{1-R^2} \quad (3)$$

where

F – criterion for F-statistics;

$R^2$  – determination coefficient;

n – number of observations.

Then the best factors will be chosen we will build the linear regression because it establishes a relationship between dependent variable Y and one or more independent variables X using a best fit straight line (also known as regression line) and also used to see the dependence of factors visually.

It is represented by an equation

$$Y = a + bX + e, \quad (4)$$

where

a – intercept;

b – slope of the line;

e – error term.

Correlation analysis will help us to establish if there are a relationship between indicators which were selected. We need to find out the determination between variables. That is why, we have to build a correlation model. The correlation matrix is a table, at the intersection of the rows and columns of which are the correlation coefficients between the corresponding values. It makes sense to build it for several variables which is shown in table 9.

After that using Data Analysis, we calculate the Regression function and get the simulation result. Received the report on the results of the regression analysis we interpreter the regression statistics.

In data analysis, autocorrelation is widely used for analyzing and modeling time series and allows you to describe the dynamic properties of a time series. The higher the autocorrelation of the time series, the more closely related its observations. The Durbin-Watson test is used to detect autocorrelation in time series. Statistics (measure of consistency)  $U$  Darbin-Watson is given in all special applied computer programs and has view

$$u = \frac{\sum_{i=2}^n (\Delta y_i - \Delta y_{i-1})^2}{\sum_{i=1}^n \Delta y_i^2} \quad (5)$$

The Durbin-Watson statistic is related to the sample correlation coefficient between neighboring observations by the following relation [6]:

$$u = 2(1 - r) \quad (6)$$

Obviously, if the sample correlation coefficient  $r$  turns out to be close to zero (no autocorrelation), then the value of the concordance indicator will be close to two. The closeness of the concordance indicator  $u$  to zero indicates the presence of positive autocorrelation, to four – negative.

For the Durbin-Watson statistic, there are two threshold values  $U_n$  and  $U_b$  depending on the number of trials, the number of input variables and the significance level of the criterion  $\alpha$ .

The entire range of possible values of the concordance indicator is divided into the following decision-making areas which are shown at the figure 4.

- 1)  $U_b < 4 - U_n$  – the area of acceptance of the null hypothesis about the absence of autocorrelation;
- 2)  $U_n < U < U_b$  or  $4 - U_b < U < 4 - U_n$  – areas of uncertainty;
- 3)  $0 < U < U_n$  and  $0 < 4 - U < 4 - U_n$  – the area of acceptance of the alternative hypothesis about the presence of positive autocorrelation;
- 4)  $4 - U_n < U < 4 - U_b$  – the area of acceptance of the alternative hypothesis of negative autocorrelation.

One important way of using the test is to predict the price movement of a particular stock based on historical data.

The decision-making areas are presented below on the figure 4.

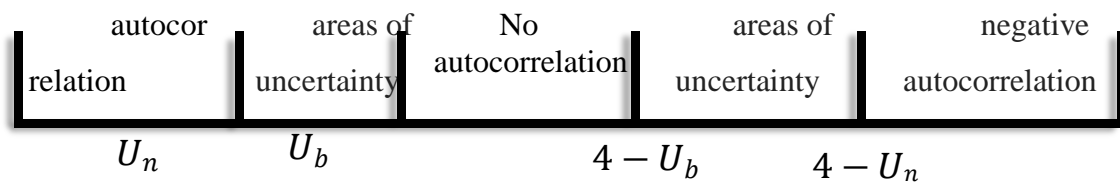


Figure 4 – Decision-making areas [59]

One important way of using the test is to predict the price movement of a particular stock based on historical data.

In order to check our model for the presence or absence of autocorrelation, we use functions in Excel. First of all, we perform regression analysis using the data parameters add-in. To analyze for the presence of autocorrelation we need to output the residuals. Then we calculate our individual decision-making area using the formulas. And last but not least, we compare the value that we got using the Durbin-Watson formula with our decision field.

Then the Least Squares Method will be used to predict our future values of IMOEX Index. This method is often used for forecasting the near future. It is very easy to use and has a small error.



The least squares method is used in the work not only due to its ease of use but also due to its availability. Calculations require minimal knowledge of Excel and a few hours of free time.

Thus, in this paragraph we described our methodology of econometric modeling and forecasting of factors influencing exchange index. We have chosen the methods and ways that we will use to construct and evaluate econometric models in this coursework and have chosen and described a method for forecasting MOEX Russia Index.

## **2 Analysis of the Stock Exchange Trends**

### **2.1 Analysis of Stock Exchange Macroeconomic Statement**

While financing is at the heart of what exchanges do, stock exchanges have also historically played a strong role in the development of capital market institutions, standards and corporate practices. More recently, this traditional role of promoting good governance has expanded to include the introduction of capital market policies and instruments designed to promote more sustainable investment practices, address the challenges posed by climate change, and support the achievement of the Sustainable Development Goals (SDGs).

Modern stock exchanges are an important institution of the country's economy. This is explained by the fact that at present the society has formed the need for their presence in the national economic complex. The essence of economic needs expresses the need realized by society, and its satisfaction is possible with the help of the functioning and development of material production, which, through the products produced or the services provided, creating the basis for the consumption process, occurs within the framework of certain socio-economic relations.

In order to improve the index of the stock exchange index, the government influences certain factors, which can be classified as follows:

- 1) environmental factors (infrastructure, scientific and technical bases, geographic location of the country, all types of resources, volumes of markets for consumer and industrial goods). These factors can only be changed in the long term;
- 2) internal factors, which include government interest, management of investor expectations, sustainability of administrative.

Participants of the stock exchange also play an important role; the system of interaction of all market participants is, at first glance, a rather simple structure. The group of participants itself is subdivided into international and intermarket. However, brokers can rightfully be considered direct exchange participants, since they provide access to other participants. Both residents and non-residents can act as investors in accordance with Figure 5.

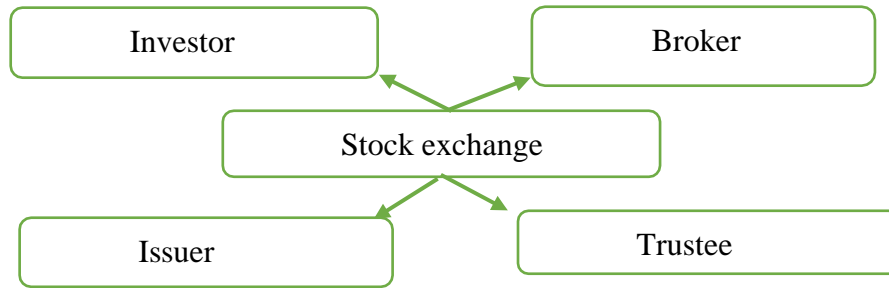


Figure 5 – Exchange participants [9]

Having considered the foreign experience in stimulating investment activity, one can identify key positive changes in the investment sphere of the national economy. There is a Comparison of regulation of the process of attracting foreign capital through the stock exchange in Table 1.

Table 1 – Comparison of regulation of the process of attracting foreign capital through the stock exchange (compiled by the author)

Main Indicators	USA	Great Britain	Russia	China
Investment Attractiveness	Hight	Hight	Medium	Hight
A clear legal framework	For all types of investments	For inbound investments	Dual interpretation of laws	For all types of investments
Main authority in charge of investments Securities and Exchange	Commission of Trade and Investment Service	Commission British Trade and Investment Service	Central Bank	State Committee of the People's Republic of China for Development and Reform (SCRD)
Investment Insurance	Insurance up to 500 thousand dollars	Insurance up to 50 thousand pounds	Is absent	Is absent
Tax Incentives	yes	yes	yes	yes

European brokers also have the option of insuring assets for both residents and non-residents. However, its limit is much lower than in the United States. For

example, in the UK, FSCS can compensate up to 50 thousand pounds if an investment company stops operating between 1 January 2010 and 31 March 2019, or up to 85 thousand pounds if it happened after 1 April 2019.

The insurance system works if the broker has lost clients' assets. The insurance does not cover price fluctuations because it is a common investment risk. In other words, if the stocks you have bought fall in price or a default is declared on bonds, you should not count on insurance.

On the table 2 we can see other main indicators of stock exchanges.

Table 2 – The main indicators of stock exchanges [9]

Indicator	Years						Growth rate 2015 to 2020, %
	2015	2016	2017	2018	2019	2020	
Average world oil price (U.S. dollars per barrel)	52	44	52	71	64	41	30
Average DXY Index	97	98	94	94	97	98	48,5
The dynamics of oil production in the world, mln. tons	4355	4368	4380	4474	4485	4692	2432,5
Average MSCI EM	897	842	1086	1182	1112	1095	543

The base indicator was taken as a basis – 100, relative to this figure, an increase or decrease in the value of the dollar was determined. The starting point was March 1973, when most countries switched to a floating exchange rate of national currencies. The MSCI Emerging Markets Index captures large and mid-cap representation across 24 Emerging Markets (EM) countries.

There are sixteen stock exchanges in the world that have a market capitalization of over US\$1 trillion each. They are sometimes referred to as the "\$1 Trillion Club". These exchanges accounted for 87% of global market capitalization in 2019. Some exchanges do include companies from outside the country where the exchange is located in table 3.

Table 3 – The main indicators of Russian stock exchanges [12]

Indicator	Years						Growth rate 2014 to 2020, %
	2015	2016	2017	2018	2019	2020	
Refinancing rate, %	13,5	10,5	8,95	7,5	7	5	3,5
IMOEX Index	1600	1964	2004	2306	2864	2800	1432
Russia GDP	1363,5	1276,8	1574,2	1669,6	1669	1483	835

The MICEX is a key stock index tracking the performance of the 50 most liquid Russian stocks from the main sectors of the Russian economy. It is denominated in Rubles. Another key index is the RTSI, which does the same as the MICEX but is denominated in US Dollars. Both indices trade under the umbrella of the MOEX since the aforementioned merger.

Moscow Exchange provides exhaustive and convenient access to the Russian financial markets. The Exchange's markets offer clients trading opportunities across a diversified range of asset classes all combined with best-in-class post-trade services.

Today, Moscow Exchange is the main liquidity and price discovery center for Russian instruments. Moscow Exchange hosts trading in equities, bonds, derivatives, currencies, money market instruments and commodities. The Group also includes Russia's central securities depository "the National Settlement Depository" and the National Clearing Centre, which performs the function of central counterparty. Moscow Exchange ranks among the world's top 20 exchanges by total capitalization of shares traded, and also among the 10 largest exchange platforms for bonds and derivatives trading.

Securities of over 700 issuers are admitted to trading on the equity and bond markets of Moscow Exchange. The Exchange is also a leader in driving modernization of Russia's financial markets infrastructure and promoting Moscow as an international financial center. Over the past two years, long awaited infrastructure reforms were implemented: the central securities depository and central counterparty

were qualified by the Bank of Russia and started to operate at full strength; international central securities depositories began servicing equity and bond markets clients and the equity market was transferred to the T+2 settlement cycle with partial pre-funding. All these changes have made trading on Moscow Exchange as convenient as on the world's leading marketplaces and has resulted in growth of trading volumes.

Moscow Exchange has implemented reforms that simplify the listing process and brought it fully in line with international standards. Just as important, the new listing rules have strengthened corporate governance requirements for listed companies.

Moscow Exchange's RTS and MICEX indices are the major benchmarks for the Russian stock market and are widely used by portfolio managers to develop investment strategies. The Exchange is continually working to expand its range of indices and improve product support and refine the rules governing market data usage for all types of clients.

## **2.2 The Microeconomic Assessment of Moscow Exchange Group's**

While today it is possible to purchase almost everything online, there is usually a designated market for every commodity. A stock market is a similar designated market for trading various kinds of securities in a controlled, secure and managed environment.

Moscow Exchange's Equity & Bond Market is the CIS and CEE's largest equity and bond market. Moscow Exchange is among the top 30 leading stock exchanges worldwide.

The Russian stock market is one of the largest markets in Europe with an indicator of trading volumes at the end of 2018. more than 900 trillion rub. The market has several trading platforms, many listed participants, more than a thousand different instruments. Today the Moscow Exchange is the main platform for attracting capital to the national economy. Against the background of unfavorable external

factors, investments are becoming almost a determining factor in maintaining GDP growth.

It is not unreasonable to talk about good prospects for the market in this direction – there is a tendency to increase market participants, increase trade turnover both by increasing the financial literacy of the population and by state programs to support investors. At the same time, the Russian stock market attracts the attention of many foreign traders and investors. There are several reasons for this: the Russian market is fundamentally undervalued and combines one of the highest dividends yields and the lowest multiples relative to peers. This is largely due to the structure of the market and its asymmetry in favor of the oil and gas sector, whose securities are significantly underestimated by the market.

In 2019, the stock index of the Moscow Exchange reached its record value of 3009 points, and the total capitalization of the Russian stock market amounted to 48 trillion rubles. in accordance with figure 6. This is an absolute record for the Moscow Exchange.

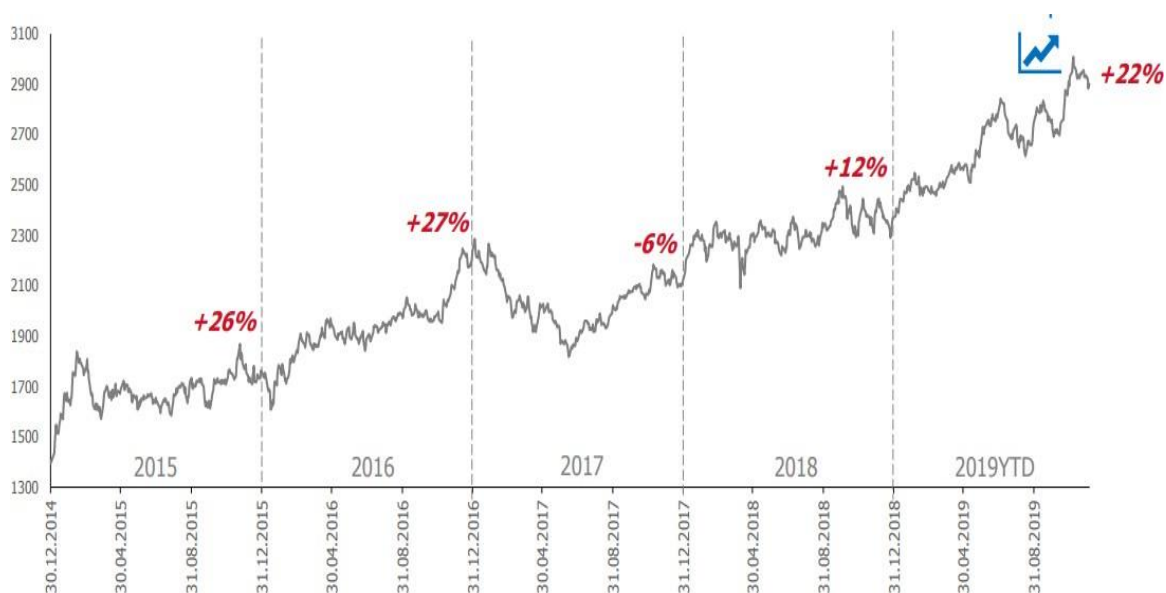


Figure 6 – Values of the Moscow Exchange index [9]

A number of factors contributed to these indicators:

- rise in oil prices;
- active participation of the banking sector in the stock market;

- increase in corporate bonds;
- high dividend yield from Russian issuers, etc.

One of the major disadvantages of the Russian securities market is the commodity nature of economy. Hence, there is a strong dependence of economic activity on movements of the price of commodities. Besides, the Russian stock market is also characterized by low investment activity of companies and private investors.

The development of the stock exchange is negatively affected by the insufficient number of qualified intermediaries capable of providing conditions for attracting foreign investors due to technical and informational underdevelopment. The availability of modern brokerage trading platforms makes it easier for participants to go public. And the availability of a variety of financial instruments attracts more investors.

That is why, the increase in new innovative trading platforms with the function of customer support in various languages, convenient and easy to use, contributes to the attraction of foreign investors to the Russian economy in accordance with the following table 4.

Table 4 – Key disadvantages of the technical infrastructure of the Moscow Exchange (compiled by the author)

Key disadvantages	Brief description of the main problems of the development of the technical infrastructure of the Moscow Exchange
Improving brokerage trading platforms	Working directly with the exchange, brokers must provide their clients with modern tools
Information base	Disclosure is necessary to establish a relationship of trust between the broker and the client
The language barrier	For a foreign investor, it seems rather difficult to interact with the Russian market due to the prevalence of the Russian language over other

The advanced IT technologies used by the Exchange allow ensuring high levels of uninterrupted operation and fault tolerance of the trading and settlement infrastructure. The development of the financial platform presupposes the extension of



the capabilities of the Exchange's accounting infrastructure to a wide range of financial assets. Initiatives in this area will lead to an expansion of the service offer for savings instruments and information assets.

In 2019, the implementation of projects in the field of building bridges between exchanges and globalizing access to investor markets continued. A bridge between the London Stock Exchange and the Shanghai Stock Exchange (Shanghai-London Stock Connect) began to function. At the moment, the Moscow Exchange is developing a strategic partnership with the Kazakhstan Stock Exchange (KASE), which will contribute to the creation of a single financial market for the EAEU countries.

One of the main principles of the development of the exchange currency market is the provision of various services for the execution of orders for different volumes and types of clients, and in the future, for the clearing of their transactions. In August 2019, derivatives market participants were provided with an online registration service for new clients.

Thus, online registration of clients became available in all major markets of the Exchange: stock, foreign exchange and derivatives. With the help of the new service, the clients of the traders were able to access and start making transactions with futures and options within a few seconds from the moment of concluding an agreement with a broker or a bank. Previously, this procedure took almost a day. Since the service was provided, more than 220 thousand client accounts have been opened in the derivatives market. To increase the inflow of foreign investors, this technology should be improved by providing round-the-clock support in different languages of the world.

Since the most important indicator of the activity of the Moscow stock exchange is the stock index, the activity of the exchange should be aimed at increasing the index. These social activities increase the level of popularity of the exchange and gives an additional increase in investors and also increases the level of confidence among the population, which affects the growth of the exchange index, which is the main indicator of the sustainability of activities.

Another weak feature of the Russian stock market is the insufficient development of regional equity markets. Today, there are only 7 operating stock exchanges officially registered by the Central Bank of the Russian Federation, with MOEX being the largest. The other 5 exchanges are located in Moscow (the capital of the Russian Federation) or Saint Petersburg (the second significant city of the Russian Federation) and specialize predominantly in trading commodities and raw materials, or currencies. The only regional stock exchange is the Crimean stock exchange, located in Simferopol. Detailed analysis is presented on table 5.

Table 5 – SWOT-analysis for Moscow Exchange Group (compiled by the author)

<b>Strength</b>	<b>Weaknesses</b>
<ul style="list-style-type: none"> <li>• Size and growth rate of Russian Economy</li> <li>• Exclusive vertically-integrated platform offering chain of services               <ul style="list-style-type: none"> <li>• Biggest venue in the region (TOP-5 in bond trading volumes and TOP-10 in stock trading in Europe)</li> <li>• Cycle-protected business model, steady performance during financial crisis</li> </ul> </li> <li>• Central Securities Depository</li> <li>• Experienced management team</li> <li>• Central Bank leading role in shareholding and transaction monetary policy through exchange</li> </ul>	<ul style="list-style-type: none"> <li>• Unfavorable investment climate</li> <li>• Inconsistency of post-trading infrastructure with world best practice</li> <li>• Switch of issuers to the foreign venues</li> <li>• Liquidity transfer to LSE</li> <li>• Shortage of long-term local investors</li> <li>• Corporate governance standards not compliant with international practice</li> <li>• Not integrated IT platform</li> <li>• Disintegrated tariff model</li> </ul>
<b>Opportunities</b>	<b>Threats</b>
<ul style="list-style-type: none"> <li>• New markets: increase of trading volumes after the creation of CSD, introduction of T+n and collateral management</li> <li>• Development of local investors base</li> <li>• Increase in number of instruments</li> <li>• Participation of government in development of financial market, realization of IFC plan</li> <li>• Listing and admission to trade securities of Russian and CIS issuers</li> <li>• Execution of government privatization plans leads to growing free float</li> <li>• Increase in government borrowings and bonds issuance</li> <li>• Exclusive Yuan trading</li> </ul>	<ul style="list-style-type: none"> <li>• Next wave of financial crisis</li> <li>• Inadequacy to meet competition challenges from the side of major exchanges</li> <li>• Invasion of OTC trading platforms</li> <li>• Delay in legislation reforms</li> </ul>

According to the work and SWOT-analysis of the Moscow Stock Exchange, the trading platform should be made more convenient to use, and reduce restrictions

between residents and non-residents of the Russian Federation. An important role is played by the distance attractive country itself to attract foreign investors as well as domestic investors.

The Russian stock market is very young compared to international stock markets. It is characterized by high volatility, unsustainability, and other features:

- low investment activity of companies and private investors;
- insufficient development of regional equity markets;
- close positive relationship between the Russian and foreign markets;
- high dependence on commodity prices.

Despite Russian stock market is known the risky one it has a potential. One of the ways of making it more attractive for investor and less risky it is the changing the tool of operating the market – the stock exchange. The indicator of the performance of the stock exchange can be considered financial growth, which reflects the well-being of the exchange.

An annuity is a stream of cash flows. A perpetuity is a type of annuity that lasts forever, into perpetuity. The stream of cash flows continues for an infinite amount of time. In finance, a person uses the perpetuity calculation in valuation methodologies to find the present value of a company's cash flows when discounted back at a certain rate. As we can see from the table 6 our Cash Flow is rising.

Table 6 – Perpetuity Stream with Interest Rate and Growth Rate of Moscow Exchange Group for year [9]

Time	Cash Flow, \$	Discount Rate	Discount Factor	Present Value, \$	Cumulative PV, \$
2018	14 827,2	8,95	0,11	1656,67	1656,67
2019	15 980,3	7,5	0,13	2130,71	3787,38
2020	15 530,8	7	0,14	2218,69	6006,06
				Net Present Value (Sum)	6006,06

There is a graph below to illustrate the results of perpetuity stream of the Moscow stock exchange. The graphic was chosen as the most common way of visual

information. As we can see with the cashflow figure 7, it went down in 2019, that was caused by a coronavirus infection. As it paralyzed business in most spheres and had a bad impact on trade.

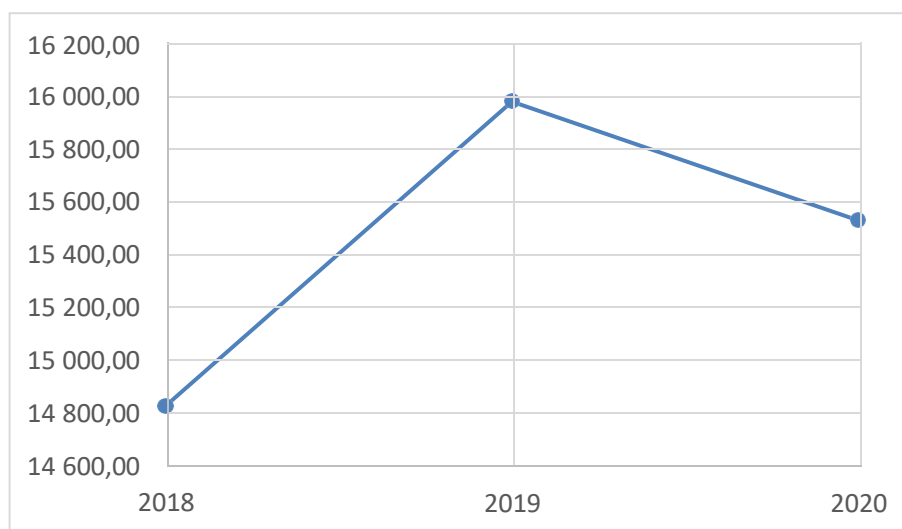


Figure 7 – Perpetuity Stream with Cash Flow of Moscow Exchange Group, \$

Discounted cash flow (DCF) is a valuation method used to estimate the value of an investment based on its expected future cash flows. DCF analysis attempts to figure out the value of an investment today, based on projections of how much money it will generate in the future. This applies to both financial investments for investors and for business owners looking to make changes to their businesses, such as purchasing new equipment.

As we can see from the table 7 our Discounted Cash Flow is rising. That became possible because of the risk-management that was implemented by the Central Bank.

Table 7 – Discounted Cash Flow of the Moscow Exchange Group [9]

Time	Project Cash Flow, \$	Interest Rate, %		Discount Factor	Present Value, \$
		average	total		
2018	14 690	4,6	4,4	0,22	3193,48
2019	15 873	4,7	4,4	0,21	3377,23
2020	15 467	4,2	4,4	0,24	3682,62
Net Present Value (Sum):					13530,47

Discounted cash flow (DCF) helps determine the value of an investment based on its future cash flows. The present value of expected future cash flows is arrived at by using a discount rate to calculate the discounted cash flow. If the discounted cash flow is above the current cost of the investment, the opportunity could result in positive returns.

A common size income statement is an income statement in which each line item is expressed as a percentage of the value of revenue or sales. It is used for vertical analysis, in which each line item in a financial statement is represented as a percentage of a base figure within the statement.

Common size financial statements help to analyze and compare a company's performance over several periods with varying sales figures. The common size percentages can be subsequently compared to those of competitors to determine how the company is performing relative to the industry.

Table 8 shows common-size Financial Statement of the Moscow Exchange. First of all, it helps to understand the size of Moscow Stock Exchange, its capacity and potential. Also, this report provides the overview of management system and how effective were measures.

Table 8 – Common-Size Financial Statement of the Moscow Exchange [9]

Indicator	Meaning			Growth rate (+, -), %
	2018	2019	2020	
Part 1 Performance Measures				
Market Value Added, mln., rub.	1987	1995	1934	(0,03)
Market-to-book-ratio	0,99	0,98	0,87	(0,11)
EVA, mln., rub.	(1265690)	(1155737)	(1343567)	0,16
Return on capital ROC, %	4,8	5,6	4	(0,28)
Return on equity (ROE), %	0,13	0,13	0,11	(0,26)
Return on assets (ROA), %	0,13	0,15	0,11	(0,26)

Continuation of table 8

Part 2 Sustainability Measures				
Asset turnover	0,2056	0,2059	0,2065	(0,29)
Inventory turnover	–	–	–	–
Days in inventory	–	–	–	–
Receivables turnover	354,7	359,1	369,8	0,03
Average collection period (days)	23	23	23	–
Profit margin	75	85	67	(0,05)
Operating profit margin	55	54,7	50	0,08
Part 3 Leverage Measures				
Long-term debt ratio	–	–	–	–
Long-term debt-equity ratio	–	–	–	–
Total debt ratio	89	92	97	(0,05)
Times-interest-earned	(15,54)	(16,83)	(17,85)	0,06
Cash coverage ratio	(15,54)	(16,83)	(17,85)	0,06
Part 4 Liquidity Measures				
Net-working-capital-to-total-assets	95324,5	92267,67	88167,4	(0,04)
Current ratio	1,2	0,9	1,01	0,12
Quick ratio	0,1	0,1	0,1	0,0003
Cash ratio	0,1	0,1	0,1	0,0003

According to the work and SWOT-analysis of the Moscow Stock Exchange, the trading platform should be made more convenient to use, and reduce restrictions between residents and non-residents of the Russian Federation. An important role is played by the distance attractive country itself to attract foreign investors as well as domestic investors. For this, a certain set of measures should be taken to improve the investment climate in Russia. It is possible to use close interaction with the CIS countries to create a single trading platform that will attract more investors.

## 2.3 The parameters of the Stock Exchange

In order to improve the index of the stock exchange, the government influences certain factors, which can be classified as follows [11]:

1) environmental factors (infrastructure, scientific and technical bases, geographic location, all types of resources, volumes of markets for consumer or industrial goods). These factors can only be changed in the long term [2];

2) internal factors, which include government interest, management of investor expectations, sustainability of administrative

Let's consider the external factors and their influence in more detail. These include:

- GDP;
- development of production in the industrial sector;
- the volume of investments in fixed assets;
- refinancing rate.

One of the most significant objective macroeconomic indicators that indicate the state of the economy is the Gross Domestic Product.

With the rising numbers of new participants on the market, the world financial system has become much more complicated, as have the processes taking place in it. We are talking about developing countries that continue to grow and have a great impact on the economy of the planet.

The following indicators are used as variables: IMOEX Index, oil price, oil production, MSCI Emerging Markets Index, trade-weighted US dollar index, TED-spread.

The last parameter is the difference between the three-month Libor1 rate and the interest rate on Treasury bills. The TED spread is often used to study the situation in the credit market. Its increase means that the economy begins to decline, the yield on "risk-free" securities falls, and distrust between banks increases.

Below is the Paned-Date table 9. It was created to analyze indicators affecting the sustainability of the Moscow Stock Exchange.

Table 9 – Panel Data-Set of Moscow Stock Exchange Indicators (compiled by the author)

Year	IMOEX Index (Y)	Average world oil price ( $X_1$ )	Average DXY Index ( $X_2$ )	Average TED Spread ( $X_3$ )	The dynamics of oil production in the world, mln. tons ( $X_4$ )	Average MSCI EM ( $X_5$ )
2001	207,8	24,4	117,6	0,38	3597	387
2002	270,7	25	107,3	0,19	3678	413
2003	498,9	28,9	96,7	0,21	3743	431
2004	562,9	38,3	88,3	0,25	3834	439
2005	698,3	54,4	87,8	0,41	3859	650
2006	1498,3	65,4	86,2	0,47	3878	870
2007	1816,8	72,7	79,3	0,94	3913	1147
2008	984,2	97,7	75,6	1,55	3931	784
2009	1063,7	61,9	79,8	0,54	3977	784
2010	1546	79,6	81	0,21	3997	1032
2011	1553,9	111	74,9	0,28	4008	984
2012	1412	121,4	79,7	0,34	4120	1005
2013	1397,5	108,8	81,3	0,21	4129	975
2014	1437,9	98,9	82,7	0,2	4223	978
2015	1600	52,4	97,3	0,26	4355	897
2016	1964	44	98,1	0,43	4368	842
2017	2004	54,4	94,2	0,33	4380	1086
2018	2306	71,1	94,8	0,37	4474	1182
2019	2864	64	97,9	0,27	4485	1112

There are several currencies in the foreign exchange market that can quite strongly affect MOEX Russia Index, therefore, in this work, the trade-weighted US dollar index is used, which is the weighted average value of the American currency rate against seven currencies of developed countries (euro, Canadian dollar, Japanese yen, British pound, Swiss franc, Australian dollar and Swedish krona).

To achieve this goal, the correlation is calculated, the time series are analyzed visually, the autocorrelation and private autocorrelation functions of the time series are built to determine the type of stationarity, and the cause-and-effect relationships between the variables are established.

The time period for studying the activities of the exchange is 20 years, which includes 3 crises. The Russian economy passed confidently at the beginning of the 2000s. The finally completed market reforms had an effect, the price of oil was high,



and Russian business was gradually learning how to work. However, the Russian economy was still developing and was seriously dependent on the global situation.

In 2007, a mortgage crisis began in the United States, which quickly turned into a financial one and spread to the markets of other countries.

In our country, the crisis began with the collapse of the stock market in the summer of 2008. At that time, Russian companies had a record amount of external debts – they had to turn to the government for help to pay off. As a result, Russia was among the most affected countries in the world. There are many factors at play here.

Russia, like any developing economy, during the crisis suffered from a sharp outflow of capital, which rushed to developed countries, primarily to the United States. Secondly, in connection with the crisis, the price of oil and metals, which accounted for a large part of Russia's GDP, fell sharply. Both of these factors, combined with high budget spending, have led to the fact that the Russian economy has fallen more than in most countries of the world.

Russia is a country dependent on oil resources, and despite the high profits from this type of activity in 2014, this led to a crisis. Russia remained heavily dependent on energy exports. Sooner or later, this dependence was to play its negative role. This is exactly what happened in 2014, when global oil prices plummeted. In just a few months, the price of a barrel of Brent oil has almost halved: in June, this oil traded at \$115, (7126 R), but by the end of December the price fell to \$55, (3408 R) per barrel. This was mainly due to the fact that the OPEC countries refused to cut production.

The decline continued in 2015. Stabilization and price growth began only at the end of 2016, when the OPEC member countries nevertheless agreed to reduce production.

For Russia, whose budget was half dependent on oil revenues, and the share of the fuel and energy sector in exports was about 70%, this was a catastrophic blow. The dollar rose from 32 R per dollar at the beginning of the year to 56 R per dollar, and reached 79 R on Black Tuesday.

An additional blow to the Russian economy was caused by sanctions related to the annexation of Crimea, which were imposed by the United States, the European Union, Japan, Switzerland and other countries during 2014. As a result of the sanctions, Russia's largest banks and energy companies have been cut off from foreign financing and investment. The IMF predicted that due to the sanctions, Russian GDP would decrease by 1–1.5%, and in the medium term this could lead to a loss of 9% of GDP. But the effect of the sanctions was still less significant than the consequences of the oil shock.

Despite the fact that all crises are of a different nature, each of them has a direct impact on the activities of the stock exchange. The purpose of this master's work is not only to analyze the sustainability of the Moscow Stock Exchange, but also to develop a methodology for predicting it's activity.

### 3 Econometric Modeling and Forecasting of the Stock Exchange trends

#### 3.1 Panel Data Set of Moscow Stock Indexes and processing market price

Panel data combines both spatial data and time series and combines the strengths of each of these types of data. This makes it possible to build more adequate and meaningful models for studying the true cause-and-effect relationship between various variables, which seems impossible within the framework of only temporal or only spatial data.

A balanced panel is a dataset in which each panel member is observed every year

$$n = N \times T \quad (7)$$

where

$N$  – panel members and;

$T$  – periods;

$n$  – the number of observations.

The following advantages of using panel data are listed:

- panel data allows for individual heterogeneity;
- panel data provide an opportunity to study the dynamics of changes in the individual characteristics of population units;
- panel data is better able to identify and measure effects that are simply not detectable in only time series or only spatial data.

In this work, the following variables were taken:

- average world oil price;
- average DXY Index;
- average TED Spread;
- the dynamics of oil production in the world, mln. tons;
- average MSCI EM.

Variation for the dependent variable and recreation presented Appendix A.

Column overall deviation is used to estimate the intergroup regression.

Operators "between" and "within" are useful when manipulating data with double indices. They allow us to conveniently decompose observation vectors over mutually orthogonal components, which greatly simplifies the process of obtaining analytical expressions for model estimates.

Oil is considered to be the main source of energy, because it is the most important source of sustainability in the production and economy of the country. So, there is an influence on stock market. The result is presented on the table 10.

Table 10 – Variables for the construction of the Simple Liner regression Model (compiled by the author)

Year	IMOEX Index (Y)	Average world oil price (X <sub>1</sub> )
2001	207,8	24,4
2002	270,7	25
2003	498,9	28,9
2004	562,9	38,3
2005	698,3	54,4
2006	1498,3	65,4
2007	1816,8	72,7
2008	984,2	97,7
2009	1063,7	61,9
2010	1546	79,6
2011	1553,9	111
2012	1412	121,4
2013	1397,5	108,8
2014	1437,9	98,9
2015	1600	52,4
2016	1964	44
2017	2004	54,4
2018	2306	71,1
2019	2864	64

To check the relationship between oil prices and the stock index of the Moscow Exchange, we construct a linear regression of average world oil price in picture 8. The relationships were modeled by using linear predictor functions whose unknown model parameters were estimated from the data-set.

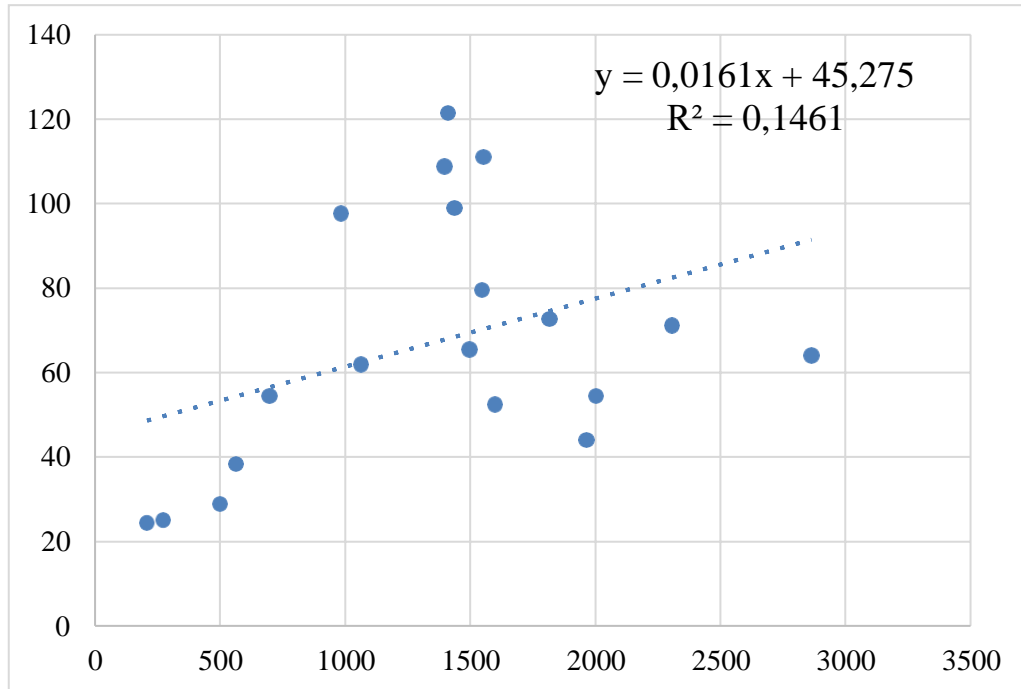


Figure 8 – Linear regression of average world oil price (compiled by the author)

Linear regression is one of the most popular types of regression analysis, and it was used extensively in practical applications. The main reason is the simplicity of this method as if models which depend linearly from their unknown parameters are easier to fit than models non-linearly related to their parameters. That is why, the statistical properties of the resulting estimators are easier to determine.

As we can see from the figure 6 our  $R^2$ , the relationship between oil prices and the stock index of the Moscow Exchange, is weak. Let's calculation of the Simple Linear Regression model's Parameters and pay attention to the table 11. Calculation of the simple linear regression model's parameters need to be calculated by formulas which are presented in the following table 11.

Table 11 – Calculation of the Simple Liner Rogation model's Parameters (compiled by the author)

Year	Y	X <sub>1</sub>	x * y	x <sup>2</sup>	y <sup>2</sup>
2001	207,8	24,4	5070,32	595,36	43180,84
2002	270,7	25	6767,5	625	73278,49
2003	498,9	28,9	14418,21	835,21	248901,21
2004	562,9	38,3	21559,07	1466,89	316856,41
2005	698,3	54,4	37987,52	2959,36	487622,89
2006	1498,3	65,4	97988,82	4277,16	2244902,89
2007	1816,8	72,7	132081,36	5285,29	3300762,24
2008	984,2	97,7	96156,34	9545,29	968649,64
2009	1063,7	61,9	65843,03	3831,61	1131457,69
2010	1546	79,6	123061,6	6336,16	2390116
2011	1553,9	111	172482,9	12321	2414605,21
2012	1412	121,4	171416,8	14737,96	1993744
2013	1397,5	108,8	152048	11837,44	1953006,25
2014	1437,9	98,9	142208,31	9781,21	2067556,41
2015	1600	52,4	83840	2745,76	2560000
2016	1964	44	86416	1936	3857296
2017	2004	54,4	109017,6	2959,36	4016016
2018	2306	71,1	163956,6	5055,21	5317636
2019	2864	64	183296	4096	8202496
Sum	25686,9	1274,3	1865615,98	101227,27	43588084,17
	659816832	1623840,49			
slop, m=	0,0161				
y-int, b=	45,27				
r=	0,38220315				
R2	0,14				

According to  $R^2$  the relationship between oil prices and the stock index of the Moscow Exchange is weak.

Let's repeat the same steps with another indicator to find dependence between variables (IMOEX Index and Average MSCI EM) on the table 12.

Table 12– Variables for the construction of the Simple Liner regression Model (compiled by the author)

Year	IMOEX Index Y	Average MSCI EM ( $X_5$ )
2001	207,8	387
2002	270,7	413
2003	498,9	431
2004	562,9	439
2005	698,3	650
2006	1498,3	870
2007	1816,8	1147
2008	984,2	784
2009	1063,7	784
2010	1546	1032
2011	1553,9	984
2012	1412	1005
2013	1397,5	975
2014	1437,9	978
2015	1600	897
2016	1964	842
2017	2004	1086
2018	2306	1182
2019	2864	1112

The MSCI Emerging Markets Index stands for Morgan Stanley Capital International (MSCI), and is an index used to measure equity market performance in global emerging markets. It has influence on stock market. The graphic can be seen on the following figure 9.

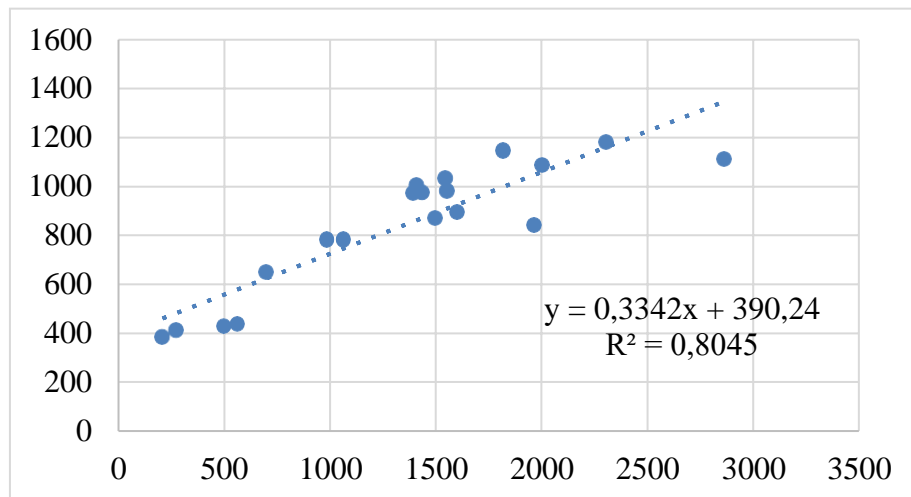


Figure 9 – Linear regression of average MSCI EM (compiled by the author)

According to  $R^2$  the relationship between MSCI EM and the stock index of the Moscow Exchange is strong. So, MSCI EM has influence on Russian stock market.

In this case, Y is the main parameter IMOEX Index and  $X_5$  is a variable which is expressed as Average MSCI EM. With the help of linear regression, you can not only view the current state and interaction of the selected two parameters, but also consider their movement in the near future.

Unfortunately, this forecast is optimal only for a short period of time. A forecast using linear regression is not possible for a period of more than 10 years, since this type of forecast is based on the change in two parameters over the selected analysis period and does not take into account external factors of influence. Accordingly, this leads to errors in the results. The degree of error will increase proportionally the longer the prediction period will be.

That is why this type of analysis is used in this work with the condition of the user of a non-professional player on the stock exchange. To make more accurate forecasts, other programs and models are used that are difficult to understand and use, and in some cases expensive. The calculation presented on the following table 13.



Table 13 – Calculation of the Simple Linear Regression model's Parameters (compiled by the author)

Year	IMOEX Index (Y)	Average MSCI EM ( $X_5$ )	$x * y$	$x^2$	$y^2$
2001	207,8	387	80418,6	149769	43180
2002	270,7	413	111799,1	170569	73278
2003	498,9	431	215025,9	185761	248901
2004	562,9	439	247113,1	192721	316856
2005	698,3	650	453895	422500	487622
2006	1498,3	870	1303521	756900	2244902
2007	1816,8	1147	2083869	1315609	3300762
2008	984,2	784	771612,8	614656	968649
2009	1063,7	784	833940,8	614656	1131457
2010	1546	1032	1595472	1065024	2390116
2011	1553,9	984	1529037,6	968256	2414605
2012	1412	1005	1419060	1010025	1993744
2013	1397,5	975	1362562,5	950625	1953006
2014	1437,9	978	1406266,2	956484	2067556
2015	1600	897	1435200	804609	2560000
2016	1964	842	1653688	708964	3857296
2017	2004	1086	2176344	1179396	4016016
2018	2306	1182	2725692	1397124	5317636
2019	2864	1112	3184768	1236544	8202496
Sum	25686,9	15998	24589286	14700192	43588084
	659816831	255936004			
slop, m=	0,33				
y-int, b=	390,24				
r=	0,89692678				
R2	0,8				

Panel data is data that contains information about the same set of objects for a number of consecutive periods of time. This method is used in the study of consumer behavior, employment, unemployment, income and wages, production functions and dividend policy of firms, in international and interregional comparisons.

Traditionally, sample data is presented in the form of tables "object-attribute": objects are arranged in rows, and attributes in columns. For panel data, another dimension is added - time. There are some advantages of panel data. First, a larger number of observations provides a more efficient estimation of the parameters of the econometric model. Secondly, it becomes possible to control the heterogeneity of objects. Third, the ability to identify effects that are not available in the analysis of spatial data.

### **3.2 Algorithms of the Econometric Modeling Process of Stock Exchange**

Regression and correlation analysis – statistical research methods. These are the most common ways how to show the dependence of a dependent parameter on one or more independent variables.

Correlation analysis can help to establish if there are a relationships between indicators in one or two samples. For example, between the operating time of the machine and the cost of repairs, the price of equipment and the duration of operation, the height and weight of children, etc.

If there is a relationship, does an increase in one parameter lead to an increase (positive correlation) or a decrease (negative) in the other? Correlation analysis helps the analyst to determine whether the value of one indicator can predict the possible value of another. We need to find out the determination between variables. That is why, we have to build a correlation model.

The correlation matrix is the easiest way to identify the relationship between different parameters. It can be used not only in non-professional research, but also as one of the first steps in scientific and practical research of any complexity. The correlation matrix also examines changes in two or more factors but excludes many external influences. Thus, this method of identifying the relationship between various parameters is less sensitive, which reduces its accuracy. Despite a number of shortcomings, the Correlation Matrix is used in many studies as the first step towards selecting the necessary parameters.

The correlation matrix is a table, at the intersection of the rows and columns of which are the correlation coefficients between the corresponding values. It makes sense to build it for several variables which is shown in table 14.

Table 14 – Correlation matrix of Moscow Stock Indexes (compiled by the author)

	Column 1	Column 2	Column 3	Column 4	Column 5	Column 6
Column 1	1					
Column 2	0,382	1				
Column 3	- 0,215	- 0,796	1			
Column 4	- ,0135	0,206	- ,0362	1		
Column 5	0,883	0,320	- 0,100	-0,140	1	
Column 6	0,896	0,656	- 0,488	0,092	0,763	1

According to the correlation matrix from table 14, only the last two indicators have a strong relationship. Thus, only the last two variables should be used in the further model. Let`s see the values of the variables on the figure 10.

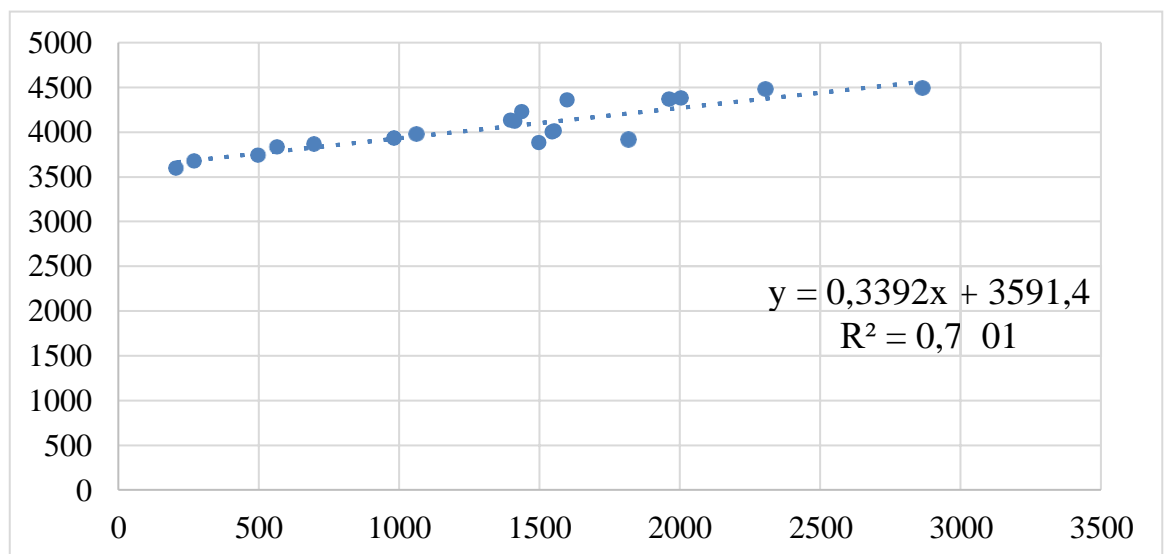


Figure 10 – The dynamics of oil production in the world, mln. Tons (compiled by the author)

There is a strong connection between y and x. The relationship is direct: increasing y – increasing x, decreasing y - decreasing x.

The model looks like

$$y = a_0 + a_1x_1 + a_2x_2 + \varepsilon \quad (8)$$

So, we choose a linear model

$$y = a + bx \quad (9)$$

Our model has the form

$$y = 0,3392x + 3591,4 \quad (10)$$

where

y – IMOEX index;

x – The dynamics of oil production in the world;

R<sup>2</sup> – coefficient of determination.

In our case, 0.78, or 78%. This means that the calculated parameters of the model explain the relationship between the studied parameters by 78%. The visual format shown on the following figure 11.

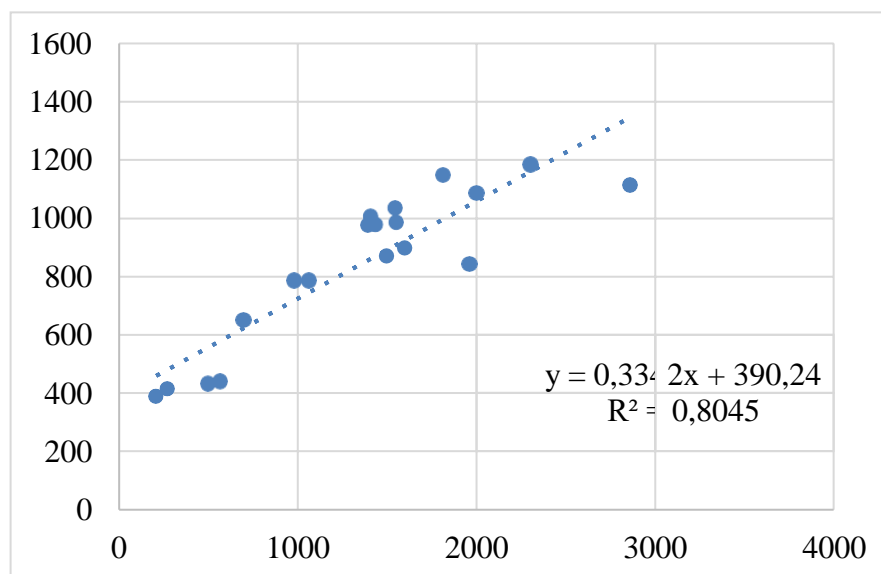


Figure 11 – Average MSCI EM (compiled by the author)

In our case, 0.80, or 80%. This means that the calculated parameters of the model explain the relationship between the studied parameters by 80%.

We are going to find the parameters of the model and evaluate the quality using the tools of the Excel. First of all, we need indicators that have a strong dependence on the Moscow Stock Exchange index. Thus, our data set will be consisting of three variables which are also presented on the table 15:

- Moscow Stock Exchange index;
- the dynamics of oil production in the world;
- average MSCI EM.

Table 15 – The Data set for the Moscow Stock Indexes (compiled by the author)

Year	IMOEX index	The dynamics of oil production in the world, mln. tons ( $X_4$ )	Average MSCIEM ( $X_5$ )
2001	207,8	3597	387
2002	270,7	3678	413
2003	498,9	3743	431
2004	562,9	3834	439
2005	698,3	3859	650
2006	1498,3	3878	870
2007	1816,8	3913	1147
2008	984,2	3931	784
2009	1063,7	3977	784
2010	1546	3997	1032
2011	1553,9	4008	984
2012	1412	4120	1005
2013	1397,5	4129	975
2014	1437,9	4223	978
2015	1600	4355	897
2016	1964	4368	842
2017	2004	4380	1086
2018	2306	4474	1182
2019	2864	4485	1112

Using Data Analysis, we calculate the Regression function and get the simulation result. The table 16 shows the output of the regression analysis between the

base parameter IMOEX index and the variables The dynamics of oil production in the world and Average MSCI EM:

Table 16 – Regression statistics of Moscow Stock Indexes (compiled by the author)

Parameters	Indicator Volume
Multiple R	0,947975776
R-square	0,898658071
Adjusted R-square	0,88599033
Standard Error	236,9043745
Observations	19

Received the report on the results of the regression analysis we interpret the regression statistics.

The multiple R indicates that 89% changes in the dependent variable Y can be explained by changes in the explanatory variables included in the model. In our case, 0.89, or 89%. This means that the calculated parameters of the model explain the relationship between the studied parameters by 89%. The higher the coefficient of determination, the better the model. Good - above 0.89. Bad - less than 0.5. So, we have strong determination, that means we have a good model.

Adjusted R - square - corrected coefficient of determination, where n is the number of observations, k is the number of explanatory variables. Regression statistical error, where is the unexplained variance. And observations mean a number of observations 19.

ANOVA (Analysis of Variance) is used to establish the influence of individual factors on the variability of a feature, the value of which can be obtained empirically as a random variable Y. The ANOVA for the Moscow Stock Exchange can be seen on the following table 17.

Table 17 – ANOVA (compiled by the author)

	df	SS	MS	F	Meaning F
Regression	2	7962903,58	3981451,79	70,94	1,11
Residual	16	897978,92	56123,68		
Total	18	8860882,50			

As if F (column "F") for the factor is greater than the critical level of the F-distribution (column "F-critical"), this factor has an impact on the analyzed parameter.

The paper considers methods for constructing a regression model based on panel data. Panel data examined. Two factors are presented and investigated over time. The model has been tested for adequacy. Research results can be used in practice.

### **3.3 Forecasting of the future Stock Exchange Trends**

Serial correlation, also called autocorrelation, refers to the degree of correlation between the values of variables across different data sets. It is usually used when working with time series data in which observations occur at different points in time (e.g., wind speed measured on different days of the week). If for example the speed values in time are more similar than the values that occurred farther apart in time, the data is said to be correlated. Autocorrelation can be positive or negative.

In data analysis, autocorrelation is widely used for analyzing and modeling time series and allows you to describe the dynamic properties of a time series. The higher the autocorrelation of the time series, the more closely related its observations. The Durbin-Watson test is used to detect autocorrelation in time series.

Autocorrelation, if ignored, worsens the predictive qualities of the regression model. The presence of autocorrelation can be established using rank correlation methods.

The most famous method for detecting autocorrelation is the Durbin-Watson method. In order to check our model for the presence or absence of autocorrelation, we use functions in Excel. First of all, we perform regression analysis using the data parameters add-in. To analyze for the presence of autocorrelation we need to output the residuals. Next, we use the formulas shown in the table 13. Then we calculate our individual decision-making area using the formulas. And last but not least, we compare the value that we got using the Durbin-Watson formula with our decision field. The Autocorrelation presented on the following table 18.

Table 18 – Autocorrelation (compiled by the author)

Observation	Leftovers	$X_2$	X-X-1	$X_2^2$
1	68,52186672	4695,25	-	
2	-6,14467804	37,76	-74,67	5575,09
3	115,7643067	13401,37	121,91	14861,80
4	55,58944837	3090,19	-60,17	3621,01
5	-142,1555288	20208,19	-197,74	39103,08
6	319,2423086	101915,65	461,40	212887,96
7	197,6904544	39081,52	-121,55	14774,85
8	-137,3437356	18863,30	-335,03	112247,91
9	-114,8219906	13184,09	22,52	507,23
10	-12,46233211	155,31	102,36	10477,50
11	50,55446922	2555,75	63,02	3971,12
12	-260,149836	67677,94	-310,70	96537,17
13	-242,8339828	58968,34	17,32	299,84
14	-323,1641856	104435,09	-80,33	6452,94
15	-208,5648182	43499,28	114,60	13133,02
16	218,099548	47567,41	426,66	182042,48
17	-106,2030288	11279,08	-324,30	105172,16
18	-58,12092667	3378,04	48,08	2311,89
19	586,5026413	343985,35	644,62	415539,54
		897978,92		1239516,59

Our Durbin-Watson Indicator is 1,38 it belongs in areas of no autocorrelation. That means that we do not have an autocorrelation so, we can use the Least Squares Method to predict our future values of IMOEX Index. This method is often used for forecasting the near future. It is very easy to use and has a small error. Let`s use the formulas to predicted values for the next 5 years. The result presented on the following table 19.



Table 19 – Least square method (compiled by the author)

T	Y	$X * Y$	$X^2$	$Y^2$	predicted Y	error
1	207,8	207,80	1	43180,84	1354,80	1147,00
2	270,7	541,40	4	73278,49	1354,48	1083,78
3	498,9	1496,70	9	248901,21	1354,17	855,27
4	562,9	2251,60	16	316856,41	1353,85	790,95
5	698,3	3491,50	25	487622,89	1353,53	655,23
6	1498,3	8989,80	36	2244902,89	1353,21	-145,09
7	1816,8	12717,60	49	3300762,24	1352,90	-463,90
8	984,2	7873,60	64	968649,64	1352,58	368,38
9	1063,7	9573,30	81	1131457,69	1352,26	288,56
10	1546	15460,00	100	2390116,00	1351,94	-194,06
11	1553,9	17092,90	121	2414605,21	1351,62	-202,28
12	1412	16944,00	144	1993744,00	1351,31	-60,69
13	1397,5	18167,50	169	1953006,25	1350,99	-46,51
14	1437,9	20130,60	196	2067556,41	1350,67	-87,23
15	1600	24000,00	225	2560000,00	1350,35	-249,65
16	1964	31424,00	256	3857296,00	1350,04	-613,96
17	2004	34068,00	289	4016016,00	1349,72	-654,28
18	2306	41508,00	324	5317636,00	1349,40	-956,60
19	2864	54416,00	361	8202496,00	1349,08	-1514,92
20	1348,76					
21	1348,45					
22	1348,13					
23	1347,81					
24	1347,49					
190	25686,90	320354,30	2470	43588084,17		
10	1351,94		130			

With a forecast for the next five years from 2020 to 2024, we can interpret them graphically to visualize the upward or downward trend in the MOEX Russia Index. The result presented on the following figure 12.

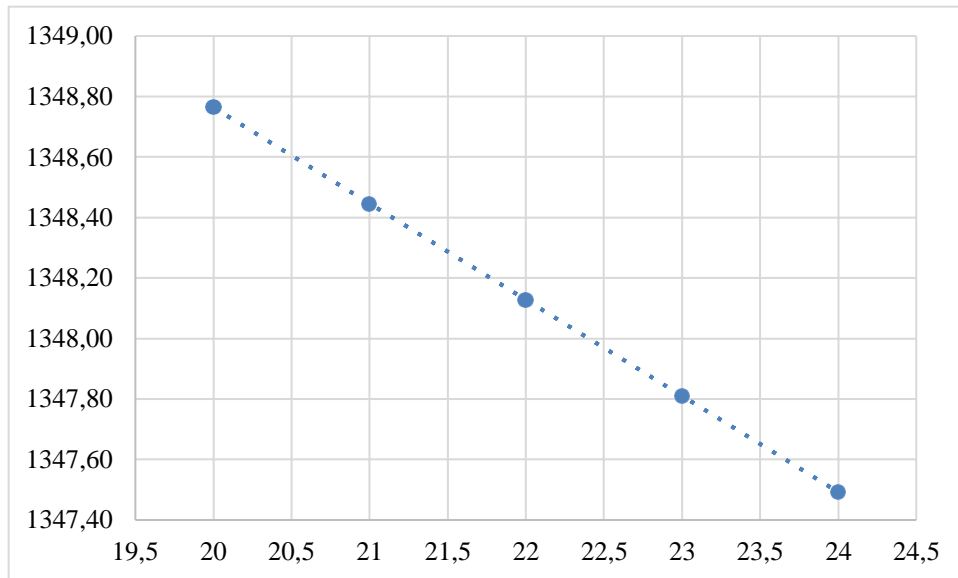


Figure 12 – Forecast the MOEX Russia Index (compiled by the author)

According to our chart, we have a downward trend in the stock index. This means that in the next five years we will observe an imperceptible decline in the Moscow Stock Exchange Index. These conclusions were obtained after conducting a regression analysis using the least squares method to find the predicted value.

In conclusion, the dynamics of oil production in the world and Average MSCI EM have the strongest and most significant impact on the performance of the Moscow Stock Exchange. Thus, in order to influence the sustainability of the Moscow Stock Exchange, these two indicators should be influenced. Impact refers to both direct and indirect. In this case, the direct impact is limited and can be identified in the regulation of oil prices. Indirect methods of influence are to increase economic sustainability and growth.

## CONCLUSION

Master thesis on the topic improving the sustainability of the Moscow stock exchange during the economic crisis has achieved the main goal of investigating the parameters effecting sustainability of the stock exchange. Based on them the method of improving the sustainability was developed based on econometric regression and Least square method.

During the research it was explored that it is impossible to achieve goals implementing measures only to Stock exchange. As a stock exchange is one of the most important part of the stock market and it is impossible to analyze this organization without referring to the whole market. What is more, index of stock exchange is an indicator of economy of the country and greatly influenced by external factors.

As a result of the first chapter, it is possible to highlight the key points that were formulated by the author on the basis of the study:

1. Financial markets play an increasingly important role in the global economy, they determine its health and sustainability. Firstly, this is approving the fact that there is a strong positive relationship between the development of the financial market and the economic growth of a country.

2. Stock exchange and the stock market are not synonymous, but in practice the border between them is blurred. The difference lies in the fact that these two concepts express a different level and a different degree of economic relations. The stock exchange itself is a participant in the processes taking place in the securities market.

3. The sustainability of the stock exchange is influenced by many factors, both external and internal.

4. Sustainable index is represented by stock exchange index.

The second chapter is devoted to the analysis of financial indicators and internal factors. According, to the work and SWOT-analysis of the Moscow Stock Exchange, the trading platform should be made more convenient to use, and reduce restrictions between residents and non-residents of the Russian Federation. An important role is played by the distance attractive country itself to attract foreign investors as well as domestic investors.

In the third chapter, the SUS of the Moscow Stock Exchange was analyzed for the period 2011-2020. The negative impact of the crisis, as well as external factors on the sustainability of the Moscow stock Exchange (the dynamics of oil production in the world, mln. Tons and average MSCI EM). Moscow stock exchange has a strong dependence on external factors, especially in the threat sector. In conclusion, the dynamics of oil production in the world and Average MSCI EM have the strongest and most significant impact on the performance of the Moscow Stock Exchange.

Thus, in order to influence the sustainability of the Moscow Stock Exchange, these two indicators should be influenced. Impact refers to both direct and indirect. In this case, the direct impact is limited and can be identified in the regulation of oil prices. Indirect methods of influence are to increase economic sustainability and growth. That is why, the focus of the study is on external factors.

Additionally, the author added value lies in providing the methodology of the building the econometric model for predicting trends of the sustainability of the Moscow stock Exchange for ordinary user.

For the research science articles and government data base were used. Excel was chosen as the main tool for analyzing and selection feasible parameters and for creating tables and graphics. Gretel was chosen for creating and analyzing regression models. All that programs are free and user-friendly. That is why, everyone can create their own analyze or predict the trends of stock exchanges. This method can be used for any kind of user, however it contains an error which is admissible for “sofa” user but unacceptable for professional user or organization.

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## APPENDIX A

### Variation for the Dependent Variable and Recreation

Id	Time	Variable	Individual mean	Over-all mean	Overall deviation	Between deviation	Within deviation	Within deviation (modified)
1	1	24,4	67,07	1009,8	-985,39	-942,72	-42,67	967,12
1	2	25	67,07	1009,8	-984,79	-942,72	-42,07	967,72
1	3	28,9	67,07	1009,8	-980,89	-942,72	-38,17	971,62
1	4	38,3	67,07	1009,8	-971,49	-942,72	-28,77	981,02
1	5	54,4	67,07	1009,8	-955,39	-942,72	-12,67	997,12
1	6	65,4	67,07	1009,8	-944,39	-942,72	-1,67	1008,12
1	7	72,7	67,07	1009,8	-937,09	-942,72	5,63	1015,42
1	8	97,7	67,07	1009,8	-912,09	-942,72	30,63	1040,42
1	9	61,9	67,07	1009,8	-947,89	-942,72	-5,17	1004,62
1	10	79,6	67,07	1009,8	-930,19	-942,72	12,53	1022,32
1	11	111	67,07	1009,8	-898,79	-942,72	43,93	1053,72
1	12	121,4	67,07	1009,8	-888,39	-942,72	54,33	1064,12
1	13	108,8	67,07	1009,8	-900,99	-942,72	41,73	1051,52
1	14	98,9	67,07	1009,8	-910,89	-942,72	31,83	1041,62
1	15	52,4	67,07	1009,8	-957,39	-942,72	-14,67	995,12
1	16	44	67,07	1009,8	-965,79	-942,72	-23,07	986,72
1	17	54,4	67,07	1009,8	-955,39	-942,72	-12,67	997,12
1	18	71,1	67,07	1009,8	-938,69	-942,72	4,03	1013,82
1	19	64	67,07	1009,8	-945,79	-942,72	-3,07	1006,72
2	1	117,6	89,50	1009,8	-892,19	-920,29	28,10	1037,89
2	2	107,3	89,50	1009,8	-902,49	-920,29	17,80	1027,59
2	3	96,7	89,50	1009,8	-913,09	-920,29	7,20	1016,99
2	4	88,3	89,50	1009,8	-921,49	-920,29	-1,20	1008,59
2	5	87,8	89,50	1009,8	-921,99	-920,29	-1,70	1008,09
2	6	86,2	89,50	1009,8	-923,59	-920,29	-3,30	1006,49
2	7	79,3	89,50	1009,8	-930,49	-920,29	-10,20	999,59
2	8	75,6	89,50	1009,8	-934,19	-920,29	-13,90	995,89
2	9	79,8	89,50	1009,8	-929,99	-920,29	-9,70	1000,09
2	10	81	89,50	1009,8	-928,79	-920,29	-8,50	1001,29
2	11	74,9	89,50	1009,8	-934,89	-920,29	-14,60	995,19
2	12	79,7	89,50	1009,8	-930,09	-920,29	-9,80	999,99
2	13	81,3	89,50	1009,8	-928,49	-920,29	-8,20	1001,59
2	14	82,7	89,50	1009,8	-927,09	-920,29	-6,80	1002,99
2	15	97,3	89,50	1009,8	-912,49	-920,29	7,80	1017,59
2	16	98,1	89,50	1009,8	-911,69	-920,29	8,60	1018,39

**APPENDIX A (CONTINUED)**

2	17	94,2	89,50	1009,8	-915,59	-920,29	4,70	1014,49
2	18	94,8	89,50	1009,8	-914,99	-920,29	5,30	1015,09
2	19	97,9	89,50	1009,8	-911,89	-920,29	8,40	1018,19
3	1	0,38	0,41	1009,8	-1009,4	-1009,4	0	1009,8
3	2	0,19	0,41	1009,8	-1009,6	-1009,4	0	1009,6
3	3	0,21	0,41	1009,8	-1009,6	-1009,4	0	1009,6
3	4	0,25	0,41	1009,8	-1009,5	-1009,4	0	1009,6
3	5	0,41	0,41	1009,8	-1009,4	-1009,4	0	1009,8
3	6	0,47	0,41	1009,8	-1009,3	-1009,4	0	1009,8
3	7	0,94	0,41	1009,8	-1008,8	-1009,4	1	1010,3
3	8	1,55	0,41	1009,8	-1008,2	-1009,4	1	1010,9
3	9	0,54	0,41	1009,8	-1009,2	-1009,4	0	1009,9
3	10	0,21	0,41	1009,8	-1009,6	-1009,4	0	1009,6
3	11	0,28	0,41	1009,8	-1009,5	-1009,4	0	1009,7
3	12	0,34	0,41	1009,8	-1009,4	-1009,4	0	1009,7
3	13	0,21	0,41	1009,8	-1009,6	-1009,4	0	1009,6
3	14	0,2	0,41	1009,8	-1009,6	-1009,4	0	1009,6
3	15	0,26	0,41	1009,8	-1009,5	-1009,4	0	1009,6
3	16	0,43	0,41	1009,8	-1009,4	-1009,4	0	1009,8
3	17	0,33	0,41	1009,8	-1009,5	-1009,4	0	1009,7
3	18	0,37	0,41	1009,8	-1009,4	-1009,4	0	1009,7
3	19	0,27	0,41	1009,8	-1009,5	-1009,4	0	1009,6
4	1	3597	4049,95	1009,8	2587,21	3040,16	-452,95	556,84
4	2	3678	4049,95	1009,8	2668,21	3040,16	-371,95	637,84
4	3	3743	4049,95	1009,8	2733,21	3040,16	-306,95	702,84
4	4	3834	4049,95	1009,8	2824,21	3040,16	-215,95	793,84
4	5	3859	4049,95	1009,8	2849,21	3040,16	-190,95	818,84
4	6	3878	4049,95	1009,8	2868,21	3040,16	-171,95	837,84
4	7	3913	4049,95	1009,8	2903,21	3040,16	-136,95	872,84
4	8	3931	4049,95	1009,8	2921,21	3040,16	-118,95	890,84
4	9	3977	4049,95	1009,8	2967,21	3040,16	-72,95	936,84
4	10	3997	4049,95	1009,8	2987,21	3040,16	-52,95	956,84
4	11	4008	4049,95	1009,8	2998,21	3040,16	-41,95	967,84
4	12	4120	4049,95	1009,8	3110,21	3040,16	70,05	1079,84
4	13	4129	4049,95	1009,8	3119,21	3040,16	79,05	1088,84
4	14	4223	4049,95	1009,8	3213,21	3040,16	173,05	1182,84
4	15	4355	4049,95	1009,8	3345,21	3040,16	305,05	1314,84
4	16	4368	4049,95	1009,8	3358,21	3040,16	318,05	1327,84

**APPENDIX A (CONTINUED)**

4	17	4380	4049,95	1009,8	3370,21	3040,16	330,05	1339,84
4	18	4474	4049,95	1009,8	3464,21	3040,16	424,05	1433,84
4	19	4485	4049,95	1009,8	3475,21	3040,16	435,05	1444,84
5	1	387	842,00	1009,8	-622,79	-167,79	-455,00	554,79
5	2	413	842,00	1009,8	-596,79	-167,79	-429,00	580,79
5	3	431	842,00	1009,8	-578,79	-167,79	-411,00	598,79
5	4	439	842,00	1009,8	-570,79	-167,79	-403,00	606,79
5	5	650	842,00	1009,8	-359,79	-167,79	-192,00	817,79
5	6	870	842,00	1009,8	-139,79	-167,79	28,00	1037,79
5	7	1147	842,00	1009,8	137,21	-167,79	305,00	1314,79
5	8	784	842,00	1009,8	-225,79	-167,79	-58,00	951,79
5	9	784	842,00	1009,8	-225,79	-167,79	-58,00	951,79
5	10	1032	842,00	1009,8	22,21	-167,79	190,00	1199,79
5	11	984	842,00	1009,8	-25,79	-167,79	142,00	1151,79
5	12	1005	842,00	1009,8	-4,79	-167,79	163,00	1172,79
5	13	975	842,00	1009,8	-34,79	-167,79	133,00	1142,79
5	14	978	842,00	1009,8	-31,79	-167,79	136,00	1145,79
5	15	897	842,00	1009,8	-112,79	-167,79	55,00	1064,79
5	16	842	842,00	1009,8	-167,79	-167,79	0,00	1009,79
5	17	1086	842,00	1009,8	76,21	-167,79	244,00	1253,79
5	18	1182	842,00	1009,8	172,21	-167,79	340,00	1349,79
5	19	1112	842,00	1009,8	102,21	-167,79	270,00	1279,79