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Capital Market Anomalies in Economic History

St. Petersburg Stock Exchange in the Time of Economic Depression, War and Revolution: Does Instability Matter?

Leonid Borodkin^{*}, *Anna Konovalova*^{**} and *Gregory Perelman*^{***}

Abstract: The first shares were issued in Russia in the end of the 18th century but only on the eve of the 20th century the St. Petersburg Stock Exchange became an important financial institution in Russia, exerting an ever-increasing influence on the country's financial markets. By reconstructing dynamics of daily stock prices of industrial securities traded at the St. Petersburg Stock Exchange in 1900-1914 we fill the gap in the study of Russian financial markets before World War I. As we established the dynamics included two peaks corresponding to the two periods of intensive economic growth. However the stock dynamics of big Russian metallurgical companies reached an intermediate peak in 1905—1906, in a period generally considered to be one of political crisis and economic stagnation. The given work is focused on finding-out of this anomalous behavior of stock prices. Authors come to conclusion that anomalies of the Russian stock market were associated with display of speculative tendencies in the period of unstable political and economic conjuncture. We used methods of nonlinear dynamics to detect chaotic regimes in stock prices time series.

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* Moscow Lomonosov State University, e-mail: borodkin@hist.msu.ru

** Moscow Lomonosov State University, e-mail: annavkon@gmail.com

*** University of San-Francisco, e-mail: greg@gperelman.com.

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Introduction

While stock exchanges in European countries were well established financial institutions at the end of the nineteenth century and were playing important roles in their respective economies, securities trading in Russia even in the early 1890s remained a relatively insignificant part of economic life with only a narrow following within Russian society. However, with the Russian economy experiencing explosive growth rates in the second half of the 1890s and then again during the take off of 1909-1914, trading of securities of joint stock companies on Russian exchanges and in particular on the St. Petersburg Stock Exchange became an important part of Russia's economic life. Contemporaries observed this significant shift in the role of the exchanges and, as was noted in *Banking Encyclopedia* published in Russia in 1916, pointed out that the exchanges became "the center of economic life, not just appendages of secondary importance... the growth of large corporations and the joint stock corporations as a dominant form of economic organization, made it impossible to expand existing businesses and create new ones outside of the exchanges"¹. And, answering a common criticism at the time that trading of securities represented just gambling and swindling on the part of a small group of speculators, another contemporary publication, the *Commercial Encyclopedia* pointed out that "in the final account, only the exchanges determine the fair value of corporate securities"².

The St. Petersburg Stock Exchange was smaller than exchanges in London, Paris and Berlin but it played a significant force in Russian financial markets and the number of securities traded was not far behind that of the New York Stock Exchange. In 1914, there were 295 share issues listed in St. Petersburg and 521 in New York. When the Dow Jones Industrial Average was first calculated 18 years earlier (in 1896), the number of issues in New York was 383³, only 30% more than the number of shares listed in the St. Petersburg Stock Exchange in 1914.

Since the end of the 19th century the St. Petersburg Stock Exchange experienced certain anomalies in the capital markets. Among several anomalies we should mention stock market crash in 1899 when the prices at the St. Petersburg Stock Exchange dropped down within three days of September. This sharp falling begun on September, 23rd, 1899 in "black day" of the St. Petersburg Stock Exchange when, as the outstanding Russian economist of that time, M. Tugan-Baranovskii said, the general wreck of the exchange values happened and that became "the real catastrophe that burst out absolutely unexpectedly for our exchange commercial and industrial spheres".

¹ *Bankovskaia entsiklopedia* [Banking Encyclopedia]. Vol. II (1916). P. 234.

² *Kommercheskaia entsiklopedia M. Rotshilda* [Commercial Encyclopedia of M. Rothchild]. (1900). P. 326.

³ On history of the St. Petersburg Exchange see Lizunov P.V. (2002) P. 208. Data on the New York Stock Exchange are taken from the NYSE web-site historical data: <http://www.nyse.com> Table: Number of listed issues - annual statistics (1874-1955).

Taking into account classification of stock market anomalies (i.e. not corresponding EMH) we should mention that at St. Petersburg Stock Exchange in 1900s contemporaries witnessed what we call the “January Effect” and even the “S&P Index effect” (if we can compare the announcement of a stock's inclusion into the S&P 500 index with the effect of inclusion of Russian pre-Revolution stocks into the list of Paris stock exchange quotation).

Despite the significant number of issues traded in St. Petersburg, we are not aware of the dynamics of Russian leading companies share prices. This paper presents our work in reconstructing such daily dynamics for leading industrial companies in the period 1900-1914. The collected data allowed us to see the dynamics of stock prices and to find out the effect of significant growth of exchange stock prices in 1905-1906 - exclusively unsuccessful years from the point of view of an economic and political situation in Russia. The question we asked is how to explain the anomalous (mentioning the efficient market concept) growth of stock prices of metallurgical⁴ shares and how political instability influenced the dynamics of share prices. We use regression analysis and methods of nonlinear dynamics to answer this question.

The paper is organized as follows. Section I provides a brief description of the St. Petersburg Stock Exchange and Russian corporations before 1914. In Section II we describe our data and methodology. Section III reviews stock prices dynamics, its connection to financial activities of industrial companies. Section 4 gives the results of analysis of prices dynamics instability.

I. St. Petersburg Stock Exchange and joint stock corporations in Russia.

The St. Petersburg Exchange was established almost at the same time as the city of St. Petersburg and its 200-year anniversary was celebrated in 1903 together with the anniversary of the city itself. As was the case at other European bourses, the brokers of the St. Petersburg Exchange in the early years were dealing exclusively in commodities. Trading in securities, including in the shares of a small number of Russian corporations, started at the St. Petersburg Exchange (*Birzha*) in the early 1830s. In 1836 Russia adopted a corporate law, which with some modification was in force until 1917. The law was contradictory in its desire to encourage creation of corporations and to simultaneously maintain strict control of the incorporation process⁵. Despite many attempts at modernization of corporate law through the second half of the nineteenth and early twentieth centuries, the concessionary system of incorporation existed to the end of the tsarist regime. Under this system, each incorporation application was to be

⁴ Following Russian industrial statistics of that time metallurgical branch included metalworking enterprises as well.

⁵ Owen, Thomas C. (1991) P. 15-24.

reviewed by appropriate ministries (most often the Ministry of Finance) and then, if approved, signed by the Tsar himself. Therefore, every corporate charter became a separate law in Russia⁶.

The trading of corporate securities was not very active in St. Petersburg until after the reforms of 1860s, when the rush of incorporations for the first time attracted the public's attention to the Exchange. Stock and bond prices were included in the official statistical compilation and were published in newspapers, which became the main data source for this study.

But the St. Petersburg Exchange began playing a significant role in Russia's economy starting only in late 1890s. This development manifested itself in the changing structure of the Exchange. In 1900, the Tsar signed a law, which finally separated the trading of securities and commodities into separate sections on the St. Petersburg Exchange, the dominant market for corporate securities in the country. By 1913 the shares of more than 200 Russian corporations were floated on the St. Petersburg Stock Exchange.

The rising importance of corporations in the country's economic life was driven by rapid industrialization take-off in Russia, which began in the second half of the 1890s. The joint stock companies became the dominant form of business enterprise, allowing for large, capital-intensive undertakings. Despite the limitations of Russian corporate law with its concessionary system of incorporation, this period witnessed considerable growth in the establishment of new joint stock companies. As Table 1 shows, from 1893 to 1901 there were 1,460 new companies established in Russia of which 1,014 actually started operations. This number is especially impressive in comparison to prior periods: from 1874 to 1881 there were 256 new incorporations, and from 1882 to 1892 only 356. Even in the nine years following 1901 (1902-1910) 1,081 new corporations were registered.

Table 1. Establishment of joint stock companies in Russia (1893-1901).

Year	Russian		Foreign		Total	
	Established	Started operations	Established	Started operations	Established	Started operations
1893	56	48	5	2	61	50
1894	64	45	3	2	67	47
1895	79	80	7	6	86	86
1896	128	95	24	25	152	120
1897	137	98	19	20	156	118

⁶ For discussions of Russian corporate law see Shepelev L. E. (1973) and Owen Thomas C. (1991).

1898	188	129	34	24	222	153
1899	305	156	73	37	378	193
1900	162	121	30	36	192	157
1901	122	61	24	25	146	86
Total	1241	833	219	177	1460	1010

Source: Shepelev L. E. *Aktsionernye kompanii v Rossii* [Joint Stock Companies in Russia]. Leningrad, 1973. p. 139.

Besides the economic growth experienced by Russia in the last decade of the nineteenth century, additional forces contributed to the establishment of new corporations. The conversion of government debt in 1890—1894 to a lower interest rate created incentives for investors to pull funds out of fixed income securities and look for higher returns elsewhere, including in the newly formed enterprises. The adoption of the gold standard in 1895—1897 attracted significant inflow of funds from foreign investors who up to that time might have stayed away from Russian ventures due to instability of the Russian ruble⁷. Additionally, Russian banks significantly increased on-call funds to stock market speculators and this added to the liquidity that is so important to flotation of new shares⁸. The combined effect of these and other influences resulted in significant price appreciation at the St. Petersburg Stock Exchange where, already in 1895, there were voices raising concern about “unreasonable speculation” and stock market “bacchanalia”. In a budget report to the Tsar in 1896, the Minister of Finance S. Witte noted that stock share speculation “was one of the most negative developments in Russian economic life.” Although wide price swings in share prices were nothing new to investors in England and France, it was the first time that Russia had experienced a price boom on such a scale, and this attracted the interest of the government and the general public.

A stock market price correction in the second half of 1896 did nothing to stop the rapid industrial growth of the country, and after a brief setback, stocks reversed their decline, rising even further in 1897. As noted in Table 1 the establishment of new corporations reached its peak in 1899 when 378 new enterprises were registered and 193 of them started operations. However, stock prices began their descent at the beginning of that same year. In the following year the economic expansion came to a halt and the number of newly established companies significantly

⁷ Outside of ruble instability, it seems the foreign investors saw Russia as a reliable destination of investments. As one respected publication pointed out in late 1917, “The question as to whether Russia will repudiate her loans is causing much discussion, but it is unlikely that any responsible Government in Russia would resort to such a disastrous policy. It should be remembered that Russia has in the past always met her engagements, even to paying us coupons presented during the Crimean War.” *The Investor Monthly Manual*. No.12. Vol. 47, London. December 1917. P. 643.

⁸ According to I.F.Gindin, as of January 1900, out of 1.2 billion rubles of total assets of Russian banks, 345 million (28%) were secured by corporate issues not guaranteed by the Russian government (mostly shares of corporations). On-call balances made up 184 million rubles, and were directly related to stock market financing. See Gindin I.F. (1948). P. 106-107.

declined.

At the beginning of the 20th century the stock market in Russia was still under the influence of the crash of the 1899. A stormy decade was ahead. This decade included the years of economic crisis, stagnation, Russo-Japanese war, First Russian revolution and subsequent economic take off in front of the World War I. How did those socio-political cataclysms influenced on stock prices dynamics?

II. Data and methodology

Considering the question on dynamics of prices at the St. Petersburg Stock Exchange, it is necessary to refer to a source giving the regular data for study. In this work we used the daily observations on the stock quotations at St. Petersburg Stock Exchange that were collected from a number of sources. Data from “The Official bulletin of share quotation at St.-Petersburg Stock Exchange” was printed in special periodicals, besides there were stock market columns in many newspapers. The basic source for our research was a newspaper "*Birzhevye vedomosti*" [“St. Petersburg’s Stock Exchange gazette”].

We used daily data for two reasons. First, to trace the direct role of political news in changes of share prices we should have detailed data (on daily basis). Second, application of nonlinear dynamics methods needs long time series (thousands of observations) so monthly or weekly data are not appropriate in such research.

Among many shares quoted at the St. Petersburg Stock Exchange there were few first-class shares that were constantly put in dealings, and their prices were daily registered in the official exchange bulletin. Mainly, these shares were metallurgical and petroleum ones. So, out of the 200 companies whose share prices were quoted at the beginning of the period under consideration, we selected three of the most well-known joint-stock machine-building companies: *Kolomenskii mashinostroitel'nyi zavod* [Kolomna Machinery Company], *Obshchestvo Putilovskikh zavodov* [Putilov Factory Company], *Russkoe Obshchestvo Mashinostroitelnykh Zavodov Gartmana* [Hartmann Machinery Co. We collected the daily prices of the largest Russian metallurgical/machine building and petroleum firms in 1900-1914 (on the base of the “St. Petersburg’s Stock Exchange gazette”, more than 4200 issues of periodicals). Construction of time series enabled the further analysis of exchange activities.

Historical time series analysis often meets unpredictable peaks of activities and periods of unstable behavior. This is just what we can reveal at the St. Petersburg Stock Exchange time series in 1905-1906 (unstable political time in Russia): we found out unexpected growth of the metallurgical companies’ shares prices. Economic historians often take into account exogenous

factors as the principle causes of a given historical phenomenon. However dynamics of share prices can be driven by endogenous factors as well. Collective behavior of many traders and gamblers can generate self-organisation effects, unstable and nonlinear dynamics, chaotic regimes (see selected bibliography in section *References II*).

Due to well-known point of view a substantial part of observed fluctuations at financial markets is caused by nonlinear nature of securities prices dynamics. Even in the absence of exogenous shocks, nonlinear market functioning can create endogenous price fluctuations and crashes. One of the most efficient approaches which have lately been applied to the analysis of unstable systems is based on the ideas of chaos theory which supposes that small, occasional fluctuations can seriously influence the development of a process. "Chaos" which appears under these conditions means that dynamics of the process become unpredictable (and not due to exogenous factors).

As it was noted by T. Vaga, chaotic markets occur when crowd behavior prevails but there isn't a strong bias in fundamentals. There are potentially dangerous periods in which price trends are likely to persist on a short-term basis but abrupt sentiment shifts between bullish and bearish states could occur as a matter of fact [Vaga T. p.130].

We use nonlinear dynamics methods, in particular algorithms of detection of the chaotic behavior, included in the software package CDA - "*Chaos Data Analyzer (The Professional Version)*". The most important characteristics of time series which are taken into account in this research are Lyapunov exponent, autocorrelation function, power spectrum, correlation dimension.

One of the most important indicators of the presence of chaos is the Lyapunov exponent which is a measure of the rate at which nearby trajectories in phase space diverge. Chaotic orbits have at least one positive Lyapunov exponent. Only the most positive exponent is calculated here. More exactly, if we shall take two trajectories $X_1(t)$ and $X_2(t)$, leaving originally from close points $X_1(0)$ and $X_2(0)$ the distance in phase space between these points grows with growth of time t :

$$|X_1(t) - X_2(t)| > A e^{\lambda t},$$

where λ – Lyapunov exponent.

For the chaotic behavior $\lambda > 0$, while if trajectories save stability, $\lambda < 0$. The algorithm of calculation of Lyapunov exponent is difficult enough. One of necessary conditions is long length of time series under consideration (as a rule the researcher needs thousand of observations). This is one of the reasons to use daily share prices in our research (the length of reconstructed time series in our case is between two and three thousands days).

III. Anomaly at St. Petersburg Stock Exchange in 1905-1906:

Industry slow down, shares prices heading up

As it was mentioned above the Russian economy in the beginning of the 20th century was in clear depressive phase.

Discussing the “world depression” of 1901-1903, M.I. Tugan-Baranovsky noted that in 1905 capitalist economies moved into a “new phase of growth” reaching a peak in early 1907⁹. Russia, however, “remained outside of the capitalist economic cycle: the world industrial growth of 1905-1907 did not touch us at all.”¹⁰. The author cites the volume of Russian pig iron production in 1900-1909 (see Table 2) in support of his conclusion¹¹.

Table 2. Russian pig iron production in 1900-1909 (millions of puds*).

1900	1901	1902	1903	1904	1905	1906	1907	1908	1909
178.0	173.2	157.5	149.3	179.9	166.6	164.2	172.5	171.1	175.3

*1 Pud = 16.4 kilograms or 36.1 pounds

After four years of declines, pig iron production increased substantially in 1904, “coinciding with a new capitalist growth wave in Western Europe.” But while in Europe the next three years witnessed a “continuous and considerable growth pattern, for us the next three years did not bring any industrial revival and on the contrary those years were of deep depression.”¹² Note that Tugan-Baranovsky considered this industry the “most characteristic in reflecting the phases of industrial cycles” and the author’s observation about pig iron production is most relevant to the years 1905-1906.

Comparing the industrial cycles of Russia and other countries, Tugan-Baranovsky noted that in the first decade of the twentieth century the world economy experienced two crises separated by a period of industrial growth. Russia, on the other hand, “did not take part in the movement of the capitalist cycle because its economy was in crises for the whole decade¹³.” Tugan-Baranovsky saw the reasons for this separate path of Russia’ economy in political conditions, which had an extremely negative influence on the industrial growth of the country: “if not for the war with Japan and the following time of uncertainty, there is not doubt that Russian industry would have experienced the same growth as the industries in the foreign

⁹ Tugan-Baranovsky M.I. (1997). P. 488.

¹⁰ Ibid. P. 489.

¹¹ Ibid.

¹² Ibid.

¹³ Ibid. P. 497.

countries did.”¹⁴ Addressing the question of shortage of investment capital to support economic growth in early 1900s, Tugan-Baranovsky asks a rhetorical question: “Would foreign capitalists have spent their money on establishment of various companies in Russia, while even those meager funds at our own disposal were leaving the country, which obviously had been the case during the revolution?”¹⁵.

In this context, we should point out the concern expressed by the Russian Ministry of Finance regarding the dramatic fall in share prices at the beginning of Russian-Japanese war. The article published under the title “From the Ministry of Finance” the *Herald of Finance, Industry and Trade* (№5, 1904) noted:

What reasonable cause could justify such a rapid drop in share prices of metallurgical enterprises, which, as is well known, with the start of military actions often receive numerous orders increasing their production volume and profitability ... The fall in stock quotations is a direct result of vexed securities holders, dissuaded by speculators, who on purpose stay away from purchases to push the prices even lower and then buy them up at a low price ... The Ministry of Finance must warn the securities’ holders from selling them at a loss for themselves and for the benefit of speculators, who on purpose spread uncertainty in order to gain from it. We need to be fair-minded and steady in our attitudes toward events in the Far East, which could create some temporary difficulties, but could not possibly disturb the economic might of Russia¹⁶.

A more differentiated evaluation of the dynamics in the Russian industrial development (in contrast with that of Tugan-Baranovsky) is contained in the fundamental work of L.B. Kafengauz¹⁷. Reviewing the production of heavy industries in 1900-1908 (“the period of crises and depression¹⁸”), Kafengauz noted that in 1903 market conditions “somewhat recovered from the crisis” and the output of the means of production grew in volume (4.7%) as well as in total value (5.1%). In 1904, industrial production growth “driven by war conditions” resulted in a rapid increase in prices and, therefore, in significant gains in the value of production (13.3%), but also increased in volume (6.5%)¹⁹. The most rapid decline in the volume of production in the heavy industry is seen in 1905 (-9.3%). However, prices gained, which to some degree was caused by the fall in production; this limited the decline in the value of output (-1.1%). In 1906 the volume of production remained flat, but price gains brought about a moderate growth in total value (3.0%). In 1907 both the volume and value rose (9.7% and 10.5% respectively), and in

¹⁴ Ibid. P. 506. At the end of the article, Tugan-Baranovsky returns to this topic: “Political conditions of Russia precluded the country from taking part in the growth of world capitalist economies in 1905-1907. Currently [the article was written in 1910] such obstacles are not present and the revival of our economy coincided with similar growth in the West”.

¹⁵ Ibid. P. 500.

¹⁶ *Vestnik finansov, promishlennosti i torgovli* [Herald of Finance, Industry and Trade]. 1904, №5 p. 178.

¹⁷ Kafengauz L.B. (1994).

¹⁸ Ibid. P. 70.

¹⁹ Ibid. P. 101.

1908 the volume remained flat (-0.4%), but the value dropped due to price pressures (-6.2%)²⁰.

Within certain categories of industrial production the dynamics was different. Overall, however, the physical volume of production dropped the most in 1905, the year when the stock market was moving up until September²¹.

Concerning the influence of revolutionary events on the stock market it seems less considerable than expected. For example, in January, 1905 when revolutionary events were on their largest scale and there was a peak of striking activity (440 thousands workers were involved) there was not a slight panic on the St. Petersburg Stock Exchange and during the 2 weeks after the “Bloody Sunday” (9 January) the share prices fallen down, but not very much substantially (on 3,5-5,1%, mostly - for enterprises located in St. Petersburg).

IV. Nonlinear dynamics at St. Petersburg Stock Exchange: Measuring the degree of instability

Let us consider the 14-years dynamics of daily quotations on joint-stock companies (see figures presented at Appendix I). All the three graphs on metallurgical companies dynamics demonstrate that after the stagnant (or even depressive) years in the beginning of 1900s there was an evident growth of stock prices during 1904 and 1905. In 1905-1907 the quotation of shares of Kolomna Machinery Company (250 rubles at face value) reached 500 rubles, Hartmann Machinery Co (150 rubles at face value) in 1905-1906 came to 370-390 rubles, Putilov Factory Co (100 rubles at face value) in 1905 reached 140-150 rubles. It is obvious that the common feature of metallurgical stock prices dynamics on the St. Petersburg Stock Exchange during the first decade of 20th century was the rising of prices in 1905-1907 - not at all the best years in sense of the economic and political situation.

How could it be that the stock prices in St. Petersburg moved up in the period of Russo-Japanese war (1904, January – 1905, August) and 1905 revolution?

We used volatility tests to verify rationality of market behavior by examining the volatility of share prices relative to the volatility of the fundamental variables that affect share prices. As a key fundamental factor that should impact on the stock prices of equities the annual profit of companies was chosen as profit with the maximal degree should determine the behavior of investors concerning the stock prospect.

We will examine all three enterprises under consideration. Data on stock quotes and profits on these enterprises is presented in Appendix II. The regression models for the annual

²⁰ Ibid.

²¹ According to Kafengauz, the biggest drop in the overall industrial production (-4.4%) was in 1905. Ibid. P. 117.

average stock prices and profits (see Table 3) shows the very weak statistical dependence between the stock price and profit of the company. Explanation power of annual profit gives no more than 15.1%.

Table 3. Regression models (Y=annual share prices, X=annual profit)

Enterprise	B ₀ , t-statistics	B ₁ , t-statistics	P-level (for X)	F	R ²
Putilov Factory Company	81.2 (4.74)	0.019 (1.82)	0.094	3.32	0.151
Kolomna Machinery Company	274.0 (4.87)	0.074 (1.703)	0.116	2.90	0.136
Hartmann Machinery Factory	199.2 (4.62)	0.0187 (0.708)	0.495	0.501	0.047

Let us notice the nonlinear character of stock prices dynamics of metallurgical companies. All the three time series show non-stationary behavior within the limits of considered time period: the years of recession are replaced by long-term rise (1905-06), then again some recession which in the end again passes into rise²².

The analyses of time series for all three companies gives forcible argument to detect the chaotic modes in dynamics of metallurgical stock prices at the St. Petersburg Stock Exchange in first decade of the 20th century. First of all calculations of Lyapunov exponent resulted in positive values (see Table 4) for all three time series. Other calculations (autocorrelation function, power spectrum, correlation dimension) support the hypothesis on the existence of chaotic regimes in all three time series (see Appendix III).

Table 4. Lyapunov exponent values

<i>Time series</i>	<i>Lyapunov exponent</i>
Putilov Factory Company	0,127+-0,024
Kolomna Machinery Company	0,131+-0,027
Hartmann Machinery Factory	0,146+-0,027

These results give more arguments to the explanation of the nature of 1905-1906 anomaly of the Russian stock market based on the display of speculative tendencies in the period of unstable political and economic conjuncture. Russian stock market periodicals of that time contain a lot of evidence of exclusively high interest of traders and speculators to the metallurgical shares. These are typical citation from issues of *Birzhevye vedomosti*" ["St.

²² In the beginning of October 1907 there was a double reduction of a face-value of Kolomna Machinery Company stock equities, and it required the additional operation of "sewing" the time series.

Petersburg's Stock Exchange gazette"] of that period: "Today metallurgical securities are most asked again", "Demand has metallurgical shares as a main subject of interest this week», etc. Securities of this group were preferred by speculation in that years.

It should be noted that the stock price bubble occurred in select (metallurgical) securities, not in all traded at St. Petersburg securities; for instance we didn't reveal bubble for petroleum shares prices in 1905-1906. It provides some support for L. Neal's interpretation of the origins of bubbles and for his view that investors behaved rationally [25, 26].

Conclusion

Dynamics of the three big Russian metallurgical companies share prices demonstrated anomalous behavior in 1905–1906. In contrast to EMH these years of economic stagnation generated by political and social cataclysms (lost war and revolution) happened to be the period of intermediate peak in their share prices dynamics. Fundamental factors (like GNP or index of industrial production) experienced decrease in that years. 1905 was a year of minimal (in 1900-1905) profit for metallurgical enterprises.

Regression model shows that annual profit is not a substantial factor to explain dynamics of share prices of Russian metallurgical companies in 1900–1914.

Detection of chaotic regimes in the analysed time series (on the basis of CDA software) gave positive results. It supports the hypothesis on the substantial role of endogenous factors associated with self-organisation effects, nonlinear behavior of small investors crowds, speculative games during the period of unstable political situation in Russia (1904–1906). In this period fundamental factors were not driving force influenced on dynamics of metallurgical securities at St.Petersburg Stock Exchange. Chaotic forces generated the "1904–1906 anomaly".

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Appendixes

APPENDIX I.

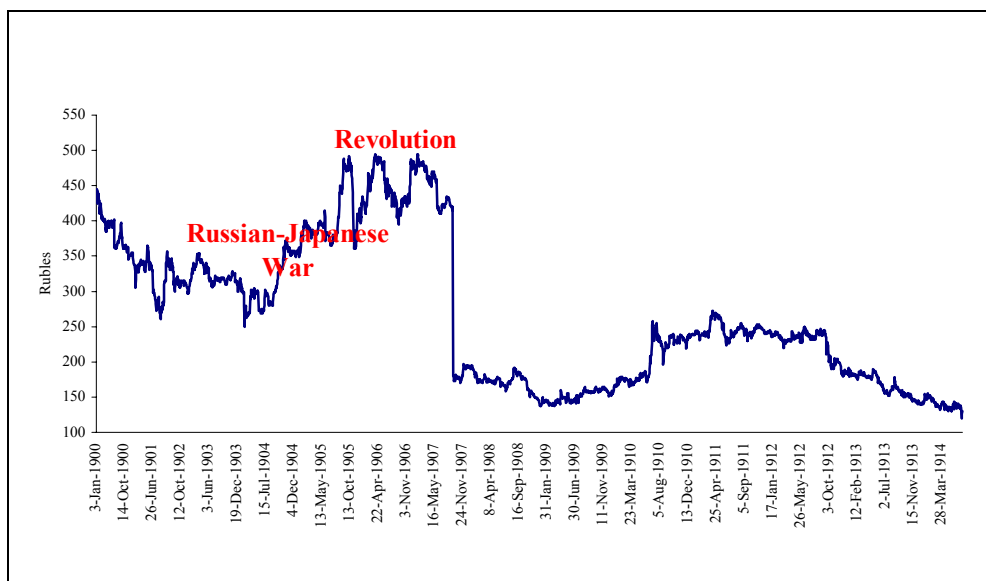
Dynamics of share prices

I.1. Dynamics of Kolomna Machinery Co share prices at St. Petersburg Stock Exchange in 1900—1914.



Source: St. Petersburg's Exchange gazette, 1900—1914.

I.2. Dynamics of Kolomna Machinery Company share prices at St. Petersburg Stock Exchange in 1900—1914.



Source: St. Petersburg's Exchange gazette, 1900—1914.

I.3. Dynamics of Putilov Factory Company share prices at St. Petersburg Stock Exchange in 1900—1914



Source: St. Petersburg's Exchange gazette, 1900—1914.

APPENDIX II.

1. Annual share prices and profit of Putilov Factory Company.

Years	Average annual share prices (rubles)	Annual profit (thous. roubles)
1900	104.66	993.985
1901	68.66	1606.899
1902	69.75	1542.722
1903	88.91	1660.664
1904	103.41	1971.925
1905	121.91	938.297
1906	92.33	2033.790
1907	97.25	732.256
1908	83.58	158.064
1909	94.5	516.793
1910	140.25	1089.867
1911	146.33	2029.278
1912	169.58	2340.721
1913	148	2874.877

Sources: *Herald of Finance, Industry and Commerce. Balances of the industrial enterprises, obliged by public accounts. 1900—1914.*

2. Annual share prices and profit of Kolomna Machinery Company.

Years	Average annual share prices (rubles)	Annual profit (thous. roubles)
1901	310.08	1487.660
1902	317.66	977.322
1903	324	834.429
1904	311	1238.381
1905	406.16	1553.155
1906	449.5	1854.158
1907	382.91	1217.836
1908	324.6	356.430
1909	292.4	1161.965
1910	403.9	1272.294
1911	472.4	1189.348
1912	431	1473.578
1913	332.8	1487.660

Sources: *Herald of Finance, Industry and Commerce. Balances of the industrial enterprises, obliged by public accounts. 1900—1914.*

3. Annual share prices and profit of Hartmann Machinery Factory.

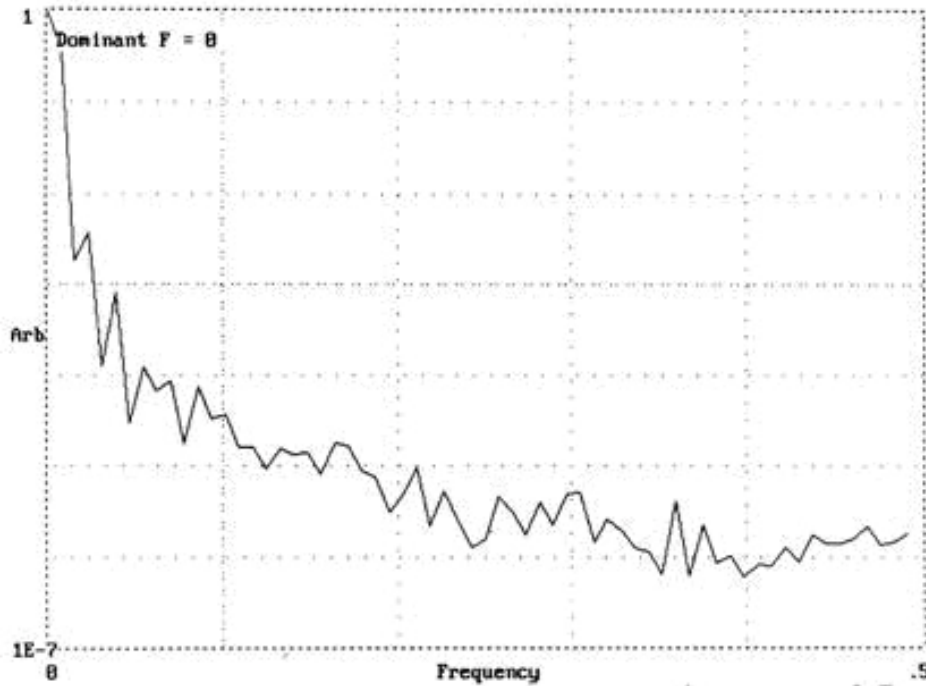
Years	Average annual share prices (rubles)	Annual profit (thous. roubles)
1902	109.60	1312.750
1903	147.63	1708.801
1904	150.92	2001.337
1905	271.70	2812.589
1906	331.91	2891.336
1907	249.75	1404.854
1908	208.08	1120.908
1909	205.83	616.455
1910	232.08	840.732
1911	266.25	928.349
1912	289.66	945.767
1913	254.58	904.628

Sources: *Herald of Finance, Industry and Commerce. Balances of the industrial enterprises, obliged by public accounts. 1900—1914.*

APPENDIX III

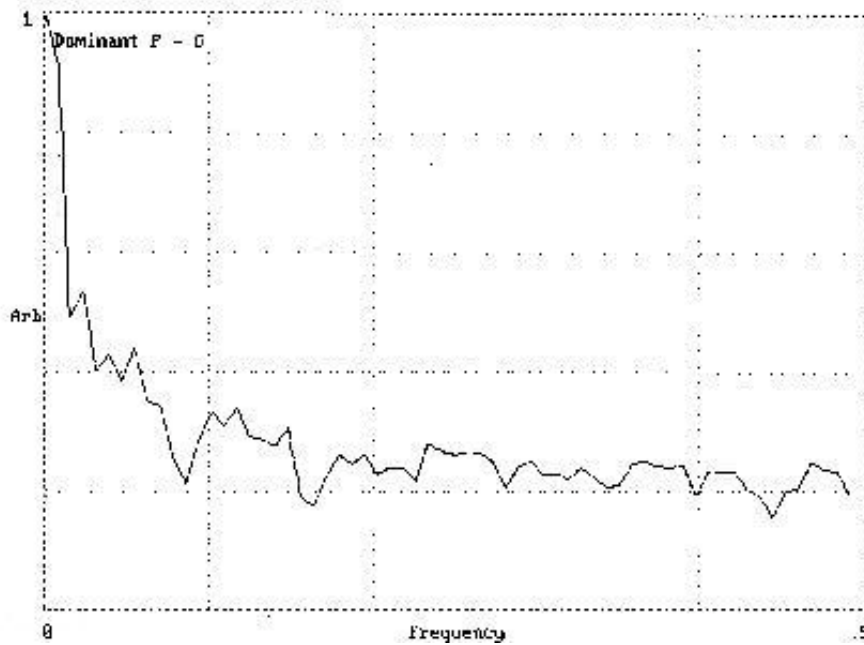
MEASURING CHAOS

III.1. Power Spectrum of Dynamics of Hartmann Machinery Company share prices.
1900—1909.



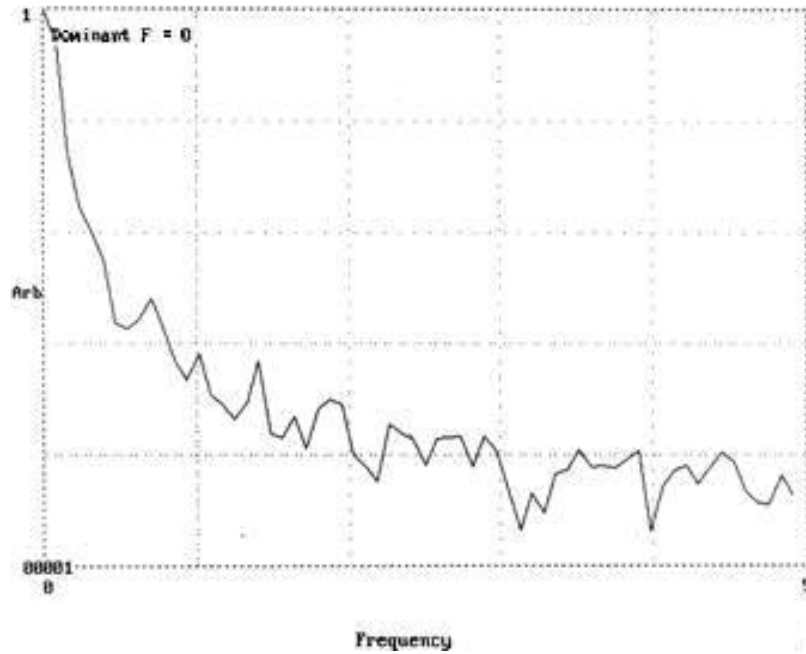
On a vertical ax the spectrum of power is set in a logarithmic scale. On a horizontal ax is spectral frequency. A spectrum exposes the clear expressed monotonous decrease.

III.2. Power Spectrum of Dynamics of Putilov Factory Company share prices.
1900—1909.



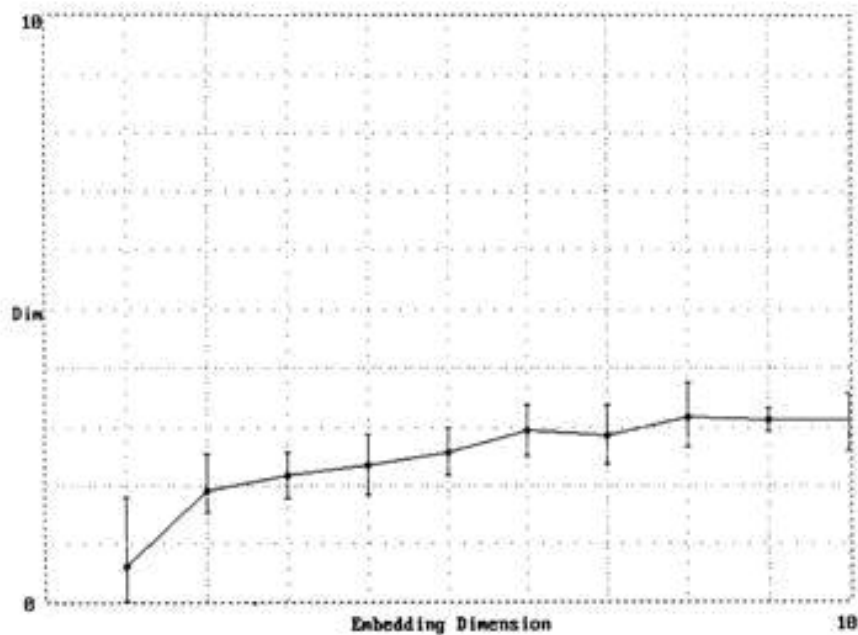
A spectrum exposes the clear expressed monotonous decrease.

III.3. Power Spectrum of Dynamics of Kolomna Machinery Company share prices. 1900—1909.

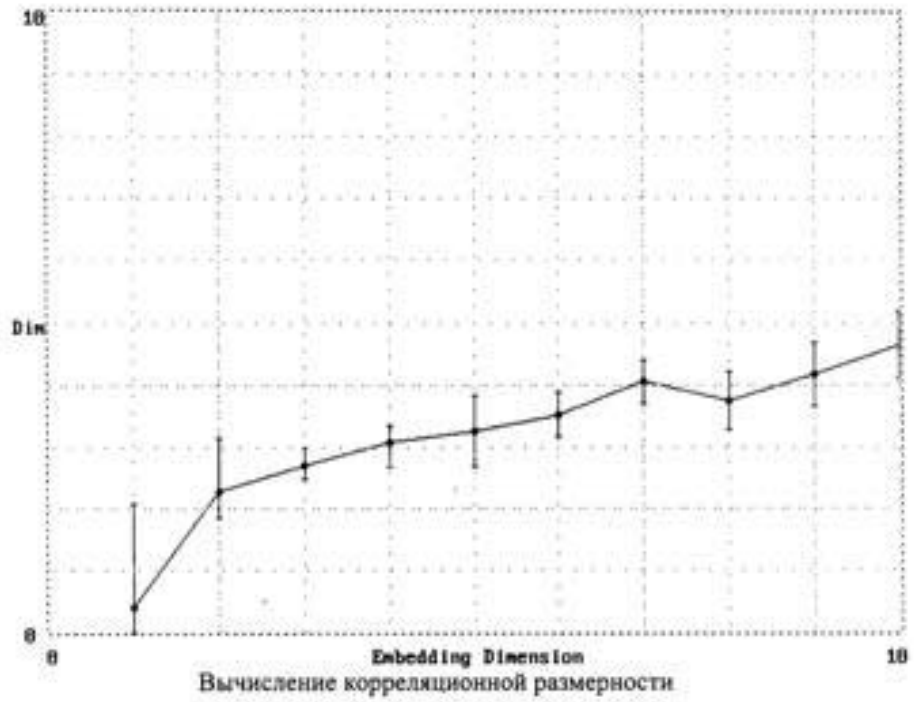


On a vertical ax the spectrum of power is set in a logarithmic scale. On a horizontal ax is spectral frequency. A spectrum exposes the clear expressed monotonous decrease.

III.4. Calculation of embedding dimension for dynamics of Hartmann Machinery Company share prices. 1900—1909.



III.5. Calculation of embedding dimension for dynamics of Putilov Factory Company share prices. 1900—1909.



III.6. Calculation of embedding dimension for dynamics of Kolomna Machinery Company share prices. 1900—1909.

