Fundamental Factors Affecting the MOEX Russia Index: Retrospective Analysis[1]

Agata Lozinskaia[1[0000-0001-8723-275X]] and Anastasiia Saltykova[2[0000-0002-4147-6350]]

[1] National Research University Higher School of Economics, Perm, Russia
[2] National Research University Higher School of Economics, Perm, Russia
ADSaltykova@hse.ru

Abstract. This paper is an empirical study of the changing nature of the dependence of fundamental factors on the stock market index, which is the trend identified earlier in the Russian stock market. We empirically test the impact of daily values of fundamental factors on the MOEX Russia Index from 2003 to 2018. The analysis of the ARIMA-GARCH (1,1) model with a rolling window reveals that the change in the power and direction of the influence of the fundamental factors on the Russian stock market persists. The Quandt-Andrews breakpoint test and Bai-Perron test identify the number and likely location of structural breaks. We find multiple breaks probably associated with the dramatic falls of the stock market index. The results of the regression models over the different regimes, defined by the structural breaks, can vary markedly over time. This research is of value in macroeconomic forecasting and in the investment strategy development.

Keywords: Russian stock market, fundamental factors, structural instability, structural breaks, rolling regression, breakpoint tests.

1 Introduction

Fundamental analysis is widely used to study the Russian stock market [1, 5, 12, 16, 17, 23, 27] and has great importance to study stock market deeply. Despite relative success of using fundamental analysis, there is now mounting evidence that the parameters of regression models are unstable and subject to structural breaks. Structural instability in the Russian stock market is reflected in the high variability of estimated coefficients [1, 23] and in presence of the structural breaks [12]. Some researchers of Russian stock market believe that this is caused by a change in the stock market regimes [12]. Structural instability was also found for foreign stock markets [18, 20, 26].

Failure to take into account the structural breaks in financial data results in many undesirable consequences. For example, the use of static statistical models leads to underestimating the true relationship between variables and complicates the prediction [12]. Understanding how fundamental factors affect the Russian stock market has great significance in macroeconomic forecasting, in particular in the field of early warning systems for financial crises [10, 28], and in the investment strategy development. It was revealed that some fundamental factors are good signals for identifying systemic risks in the Russian market, for instance, the oil price is one of the indicators of credit risk [28]. Therefore, before the using of such factors for forecasting, it is important to detect structural breaks and to identify the factors or events caused them.

The present study aims to examine the impact of daily values of fundamental factors on the MOEX Russia Index from 2003 to 2018. As a basic variable describing the global character of Russian stock market, the MOEX Russia Index contains information about the most liquid stocks of the largest Russian companies. This article is organized as follows. We firstly provide an overview of the fundamental factors of the stock markets and present the recent developments in the field of structural instability. Then we estimate ARIMA and ARIMA-GARCH models for understanding the relationship between variables on average in the interval. Next we analyze how the influence of fundamental factors has changed over the years, by applying a regression analysis with a rolling window. Then we use statistical tests to detect the change points and explain the breaks together with the nearby big economic events.

2 Theoretical background

2.1 Fundamental factors of Russian stock market

There is a substantial literature on studying different fundamental factors to explain the dynamics of the Russian stock market. These factors reflect the degree of integration of the Russian stock market into the international financial market, state of the economy and the stock market participants.

The international integration of the Russian stock market with other countries is reflected in the dependence on the stock market indices and the indicators of the foreign credit markets. For example, the positive and significant influence of the US stock market on average over the interval was revealed by analyzing the daily [12, 16, 23] and weekly returns on stocks and indices of the Russian stock market [1]. The influence of the NIKKEI 225 index on the MICEX index was found significantly positive on daily data from 2001 to 2010 [23]. It was revealed on daily data from 1995 to 2011 the Russian stock market to the greater extent is influenced by the volatility of the German and Japanese stock markets, and to a lesser extent by the volatility of the Hong Kong, Korean and British stock markets [5]. The negative impact of 3-month US Treasury bills rate in Russian stock market was identified in earlier studies [1].

The state of the main economic sectors in the country is reflected in, for example, indicators of the credit and money markets and macroeconomic indicators. The influence of the 1-month Moscow interbank offer rate on MSCI index on average is negative on weekly data from 1995 to 2005, while the indicators of the Russian money market are statistically insignificant on weekly data from 2000 to 2004 [1]. The GDP index is the least significant of the other macroeconomic factors on monthly data from January 2007 to September 2008 according to analysis of MICEX index by using

EGARCH model [14]. The influence of exchange rate was found statistically insignificant for weekly data from 1995 to 2004 on average over the interval [1].

Most of the Russian stock market value is in export-oriented energy companies. Therefore, indicators of their financial statements depend on the dynamics of external factors, in particular, on the price of oil. The positive statistically significant effect of oil prices was revealed on daily data from 2001 to 2006 [23]. Although there was no significant effect of oil prices on the profitability of Russian stocks [17] on monthly data from 1995 to 2003. In addition, it was found that the market reacted negatively to dividend announcements on average over the period from 2010 to 2012 [8]. The performance of Russian stock market is also influenced by other factors, for example, public opinion [13] and news events [15, 16]. However, the researchers study them separately from the factors mentioned above.

From the above analysis, we can conclude that in recent years, dynamic of the Russian stock market is defined by the international integration the US and Japan stock market indices and the interest rates of the US and Russian credit markets, exchange rate, and by the oil prices, influencing the financial statement of the stock market participants, represented by companies in the fuel and energy sector.

2.2 Detecting the structural instability of Russian stock market

The majority of studies have concentrated on investigating the influence of the fundamental factors on average over a defined time period, while some researchers mentioned above [1, 12, 23] found that inside this time period the influence of the fundamental factor change significantly. For example, the rolling regression analysis on weekly data indicates that the regression coefficients for the American MSCI index have been halved throughout the period 2000- 2003 and the explanatory power of the regression varies from a few percent in 2003 to nearly 50% in 2004 [1]. In addition, in the literature there are conflicting results on the influence of fundamental factors in different time intervals, for example, in studying the influence of oil prices [17, 23] and stock markets indexes of other countries [5, 27].

A possible reason for such instability is the presence of structural breaks was tested for stock markets in other countries, e.g., the UK and Japan [2], the USA [2, 22, 26, 29], Hong Kong [2], China [20] etc. Some early attempts to test for a structural break in Russian stock market are found in analyzing the degree of dependence of the indices MICEX and RTS on the dynamics of the S&P 500 index and Brent crude oil price on daily data for the period 1997-2014 [12]. It was found that the regression coefficients can vary markedly over the different intervals identified by structural breaks. The presence of the structural breaks in the volatility of returns for "Gazprom" ordinary shares on the daily data for the period of 2006-2016 has been also proven by the using new method based on the moving likelihood ratio statistics in the piecewise-specified GARCH-models [9]. Structural breaks can be caused by a number of reasons: changing in the stock market regimes [12] or in monetary and debt management policies, market sentiments and speculative bubbles [24].

Building on these pioneering literatures we conduct an update retrospective analysis in the Russian stock market over a longer time interval the with aggregation of a large number of fundamental factors and analyze the structural instability in terms of time and factors. The present paper contributes to the existing literature by formally testing for structural breaks a multivariate and bivariate regression models of the MOEX Russia Index based on fundamental factors appearing in the extant literature.

3 Data

This paper uses daily data of the MOEX Russia Index (IMOEX) and fundamental factors for the period of January 21, 2003 - April 13, 2018. Data from the daily closing prices of S&P500 (S&P500) and NIKKEI 225 (NIKKEI), Brent crude oil price (BRENT) and ruble/USD official exchange rates (USDCB) are published on the official website of Finam. 3-month US Treasury bills rate (TBILL) and 1-month Moscow interbank offer rate (MIBOR) are from the official website of the Central Bank of the Russian Federation and US Department of Treasury, respectively. Data on the Moscow interbank offer rate is available until December 30, 2016.

Weekends and holidays are deleted from the data. We use log-return, $\Delta\ln(p_t) = \ln(p_t/p_{t-1})$, of stock market indexes, oil price and exchange rate and first differences ($\Delta y_t = y_t - y_{t-1}$) of interest rates in the Russian Federation and the USA which are stationary based on the ADF and PP tests. Tab. 1 below gives descriptive statistics of the data. Log-return of IMOEX and BRENT were most volatile among other log-return of variables during our sample period. And the Russian interest rate is more volatile than interest rate in the USA.

Table 1. Descriptive statistics of the log returns and first differences

	Mean	Median	Max	Min	Std. Dev.
Δln(IMOEX)	0.000516	0.000884	0.020129	-0.206571	0.252261
Δln(NIKKEI)	0.000241	0.000372	0.014270	-0.121110	0.094941
Δln(S&P500)	0.000288	0.000556	0.011282	-0.094695	0.097743
Δln(BRENT)	0.000214	0.000501	0.018324	-0.099065	0.152417
Δln(USDCB)	0.000176	-0.000010	0.007610	-0.128638	0.102993
ΔMIBOR	-0.000655	0.000000	0.278815	-2.360000	3.460000
ΔTBILL	0.000147	0.000000	0.046688	-0.810000	0.940000

4 Methodology

To analyze the structural instability, we estimate ARIMA and ARIMA-GARCH models with fundamental factors of Russian stock market. GARCH models are used for modeling time series data when the data exhibits heteroscedasticity and volatility clustering and are most popular in the econometrics literature for modeling the indicators on the Russian stock market [17, 16, 21, 23]. We select the lag order p and the order of moving average q for ARIMA (p,d,q) model based on minimizing the Akaike information criteria and the Schwartz information criteria. Due to the insignificance of the regression coefficients and the difficulty in interpreting a large number of lags we use the lag order p=1 applied in the earlier studies of the Russian stock market [23].

Since the trading session in New York opens later than trading in Moscow, only the previous day's S&P returns can be used in regression explaining stock market returns in Moscow [18, 23]. American markets continue to operate, while Russian domestic markets are already closed, hence we include lagged 3-month US Treasury bills rate in equations [1]. The exchange rate and the price of Brent crude oil are lagged in estimated equations too. The NIKKEI is taken without a lag of 1 day, since the trading session in Japan is closed before the Moscow trading session opens [18, 23]. The MIBOR is also taken without a lag of 1 day [1]. In this paper to explain the dynamics of the Russian stock market we include fundamental factors used in recent econometric studies of the structural instability in Russian stock market [1, 12, 16, 18, 23, 26].

Thus, the equation to be estimated is:

$$\Delta\ln(IMOEX)_t = \beta_0 + \beta_1 * \Delta\ln(IMOEX)_{t-1} + \beta_2 * \Delta\ln(SANDP)_{t-1} + \beta_3 * \Delta\ln(BRENT)_{t-1} + \\ + \beta_4 * \Delta\ln(NIKKEI)_t + \beta_5 * \Delta\ln(USDCB)_{t-1} + \beta_6 * \Delta MIBOR_t + \beta_7 * \Delta TBILL_{t-1} + \varepsilon_t. \quad (1)$$

where $\beta_1 \ldots \beta_7$ are unknown regression coefficients and ε_t is an error term, t = 2, ..., 3479. For a multivariate model with using Russian short-time interest rate, MIBOR, the time period until 2016:12 will be used.

Then, the ARIMA-GARCH (1,1) model with fundamental factors is estimated to check the stability of the regression results. The GARCH model (1,1) is widely used in econometric papers for analysis of the Russian stock market [16, 23]. Hence, ε_t error term could follow process: $\sigma_t^2 = \alpha_0 + \alpha_1\varepsilon_{t-1}^2 + \gamma\sigma_{t-1}^2$.

Further, by analogy with existing econometric studies of the structural instability in Russian stock market [1, 18, 23], we use rolling regressions with the ARIMA-GARCH model (1,1) with fundamental factors specification in order to estimate time-varying coefficients β_i in equation (1). The window length is 240 days that is approximately equal to the number of trading days per year excluding weekends and holidays. Equation (1) is estimated for the interval (t-240, t) for each t (t> 241) and regression coefficients β_i (t), i = 1, ..., 8, t = 241, ..., 3478.

In the presence of structural instability, the most important issue is to detect the change points. When the break point is known, testing for structural breaks is a standard and, for instance, can be based on the Chow test. When the break point is unknown, it is required to use valid for unknown break points statistical procedures. In this paper the Quandt-Andrews and Bay-Perron tests are used to search for unknown structural changes in the models by analogy with existing econometric studies of the Russian [12] and American [26] stock markets. More specifically, we use the Quandt-Andrews test [3, 4, 25] to test for a structural break at an unknown date for a given regression equation. The algorithm is the application of the Chow test for each observation τ between surrounding dates or observations, τ_1 and τ_2. The most likely change point is an observation for which F-statistic $F(\tau)$ is maximum. The maximum value of the all calculated individual Chow F-statistics is:

$$MaxF = \max_{\tau_1 \le \tau \le \tau_2} (F(\tau)) \quad (2)$$

While the Quandt-Andrews test is primarily designed to test for a single structural break, multiple breaks may exist. We also use the Bai-Perron test [6, 7] to test for multiple structural breaks at unknown dates. We consider a standard model of multiple linear regression with T periods and potential structural breaks *m* that divide the sample into *m + 1* different regimes. The null hypothesis of no breaks is tested against the alternative hypothesis of an unknown number of breaks with an upper-bound, m*, using two statistics UDmax and WDmax [6]. In addition to the multivariate model, we test for structural breaks in six bivariate regression models of the IMOEX to identify breaks for each of the six fundamental factors listed in the previous section. After that we analyze the possible dates of change points and interpret the results.

5 Empirical results

5.1 Estimates of ARIMA and ARIMA-GARCH (1,1) models

Estimates of the regression models for the IMOEX log-return are presented in Table 2. The signs of the regression coefficients are resistant to changing of model specification. All variables in ARIMA-GARCH (1,1) model, with the exception of the log-return of exchange rate and the first differences of the US interest rate are statistically significant at 1% level; Russian short-term interest rate is statistically significant at 10% level. Similar signs of the regression coefficients for the log-return of the MICEX, S&P 500, NIKKEI 225 stock indexes and oil price were noted in [23] on daily log-return data of the MICEX index from 2000 to 2010. It indicates that, on average, over a given interval, these fundamental factors retain their influence.

Table 2. Estimates of equation (1) in period 2003:1 – 2016:12

	ARIMA	ARIMA-GARCH (1,1)
$\Delta\ln(\text{IMOEX})_{t-1}$	-0.0954***	-0.0722***
	(0.0354)	(0.0213)
$\Delta\ln(\text{NIKKEI})_t$	0.3847***	0.1960***
	(0.0652)	(0.0240)
$\Delta\ln(\text{S\&P500})_{t-1}$	0.1179	0.1060***
	(0.0762)	(0.0349)
$\Delta\ln(\text{BRENT})_{t-1}$	0.1024***	0.0621***
	(0.0244)	(0.0135)
$\Delta\ln(\text{USDCB})_{t-1}$	0.0215	0.0077
	(0.0396)	(0.0347)
ΔMIBOR_t	-0.0055***	-0.0025*
	(0.0018)	(0.0015)
ΔTBILL_{t-1}	-0.0157	0.0025
	(0.0177)	(0.0076)
Constant	0.0005	0.0010
	(0.0003)	(0.0003)
Variance		
$\widehat{\varepsilon_{t-1}^2}$	-	0.1143***
		(0.0213)

$\widehat{\sigma_{t-1}^2}$	-	0.8660*** (0.0255)
Adjusted R^2	0.1030	0.0801
Observations	3478	3478

Notes: *, **, *** indicate significance at the 10%, 5%, and 1% levels, respectively; robust standard errors are given in parentheses.

5.2 Estimates of models in rolling windows

Further, we run rolling regression for ARIMA-GARCH (1,1) model with fundamental factors to analyze how the influence of fundamental factors on the Russian stock market has changed over the years. The evolution of regression coefficients with 95% confidence intervals is presented in Fig. 1.

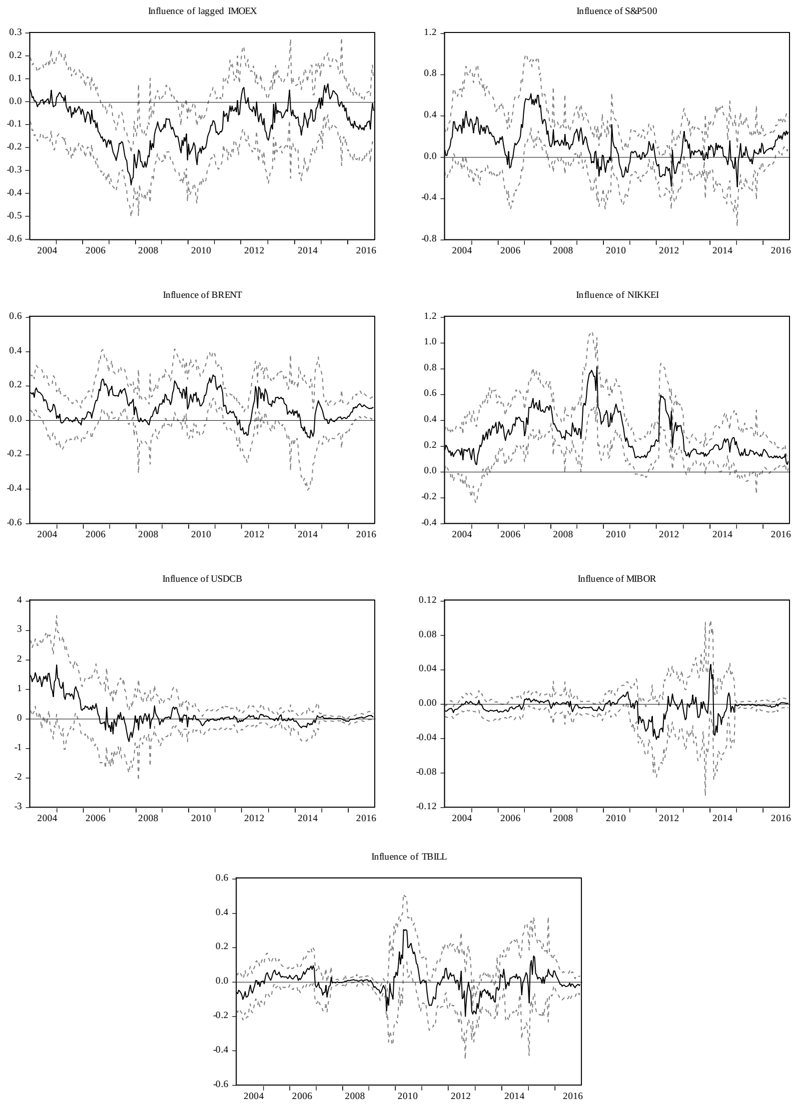

Fig. 1. Evolution of coefficients for ARIMA-GARCH (1,1) model with fundamental factors

The influence of NIKKEI turns out to be strong positive in June-October 2009: the regression coefficient is from 0.67 to 0.81, more than three times that the average value, 0.19, in this period. In the last years the degree of its influence has been decreasing however, influence is the statistically significant: the Japanese market is the nearest to the Russian stock market in terms of closing time, and it absorbs the latest news from the global financial market that appeared after the closing of the trading session in the USA on the previous trading day [23].

The influence of the interest rates of the USA and Russia is the most unstable: during the period their influence constantly switched from positive to negative that greatly complicates the economic interpretation of these factors.

The evolution of the regression R^2 is depicted in Fig. 2. The explanatory power of the regression varies considerably, from almost zero, observed May 15, 2005 and in February – December 2015 to nearly 25% in June-September 2009. Similar findings were noted in [1, 18, 23]. In [23] the sharp increase in explanation power during the crisis of 2008–2009 was explained by high values of market returns and volatility for a given period of time.

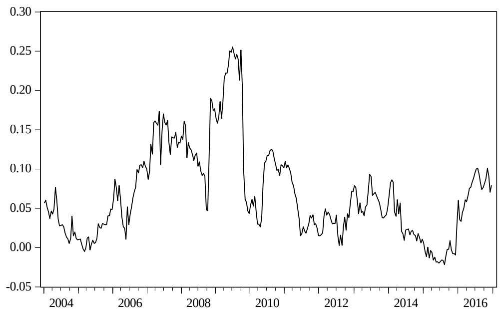

Fig. 2. Evolution of the regression R^2

The results indicate that influence of all fundamental factors on the IMOEX is not constant: the power and direction of the influence change during the period. Maximum values of regression coefficients for NIKKEI, S&P500, BRENT and lagged IMOEX are several times greater than the average during the period. The greatest impact of NIKKEI has been on IMOEX during the 2009 crisis, BRENT – in 2006, 2009-2010, S&P500 and lagged IMOEX – in 2007 that includes the pre-crisis, crisis and post-crisis periods.

5.3 Detection of structural breaks in multivariate model

The result of the Quandt-Andrews test for the ARIMA model with fundamental factors is presented in Fig. 3. The maximum value of F-statistics (16.46) is statistically significant at 1% level and is reached on November 28, 2008. It is the most likely point of a structural break.

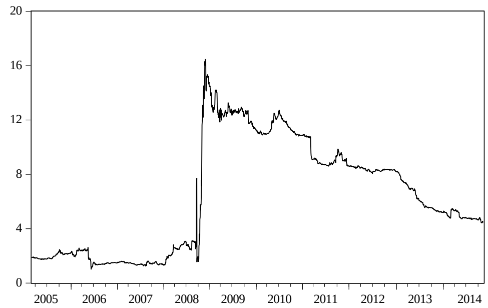

Fig. 3. F-statistics for the Quandt-Andrews test for the ARIMA model with fundamental factors

Table 3 reports the results of the Bai-Perron test for identifying multiple breaks. The calculated statistics are statistically significant at 1% level. UDmax statistics indicate the presence of two breaks in the model - April 25, 2006 and November 28, 2008. WDmax statistics also indicates the presence of break on January 13, 2011.

Table 3. Bay-Perron test for the ARIMA model with fundamental factors

UDmax	WDmax (1%)	WDmax (5%)	WDmax (10%)
34.26***	43.77***	40.807**	39.437*

Notes: *,**, *** indicate significance at the 10%, 5%, and 1% levels, respectively.

The results of statistical tests indicate the most likely points of a structural breaks; however, we should explain the breaks together with the nearby big economic events. The first break date, likely, corresponds to the events in May 2006. On May 22, 2006 the MICEX index fell by 9.65 percent and reached the lowest level since January 19, 2006 - 1143.76 points. Trading had been suspended on Russian stock exchange for the first time after the market collapse on October 27, 2003 related to the Yukos affair. The second break data in November 2008 corresponds to the global financial crisis of this year. The crisis in the subprime mortgage market in the United States led to a liquidity crisis of world banks, a crisis in the real sector of the economy and a production decline in many countries. For three months the capitalization of Russian companies fell by three quarters and a drop in oil prices results in economic slowdown. Thus, the results indicate that the structural breaks are probably defined by the dramatic falls of the stock market index that had a significant impact on the economy.

The results of the regression models over the different regimes, defined by the structural breaks, presented in Table 4, can vary markedly over time. The maximum value of R^2, 28 %, is reached in the second time period, including the pre-crisis and crisis periods. Similar values of R^2 were noted in rolling regression model. In the first and third periods, the R^2 does not exceed 5 %. In all models, NIKKEI and BRENT have a positive effect at a 1% level. For these factors, the slope coefficients are almost three times smaller as we move from the second regime to the third regime, so that the predictive power of these factors is substantially reduced over the last eight years of the full sample.

Table 4. Regression model estimation results in different regimes, defined by the structural breaks

	(1) 21.01.2003-24.04.2006			(2) 25.04.2006-27.11.2008			(3) 28.11.2008-30.12.2016		
	β_0	β_1	R^2	β_0	β_1	R^2	β_0	β_1	R^2
C	0.002**		0.04	-0.001		0.28	0.001*		0.05
Δln(IMOEX)$_{t-1}$		0.005			-0.162**			-0.104***	
Δln(S&P500)$_{t-1}$		0.212***			0.225			0.012	
Δln(BRENT)$_{t-1}$		0.093***			0.263***			0.082***	
Δln(NIKKEI)$_t$		0.243***			0.788***			0.241***	
Δln(USDCB)$_{t-1}$		0.450			-0.386			0.020	
ΔMIBOR		-0.005**			-0.009			-0.004*	
ΔTBILL$_{t-1}$		0.001			-0.031			0.012	

Notes: *,**, *** indicate significance at the 10%, 5%, and 1% levels, respectively; robust standard errors are given in parentheses.

5.4 Detection of structural breaks in bivariate models

Structural breaks for different fundamental factors can occur at different dates. Table 5 presents the results for statistically significant bivariate regression models with fundamental factors of the Russian stock market – NIKKEI, S&P 500, BRENT and MIBOR. We find evidence of single structural break in three of six bivariate regression models in the second half of 2008, in period of the global financial crisis that was revealed for multivariate regression model. There is evidence of multiple structural breaks in bivariate predictive regression models of IMOEX based on the NIKKEI 225 index. In addition to the breaks identified for the multivariate regression model, the most likely change points are also April 7, 2011 and March 17, 2014. The results indicate that structural breaks for multivariate and bivariate regression models can differ.

Table 5. Quandt-Andrews Test and Bai-Perron Test for Paired Regression Models

	β_0	β_1	R^2	QA test		BP test	
				MaxF	Breakpoint	WDmax (1%)	Breakpoint
Δln(S&P500)$_{t-1}$	0.0004 (0.0003)	0.3133*** (0.0665)	0.03	22.01***	25.11.2008	11.84	-
Δln(BRENT)$_{t-1}$	0.0005 (0.0003)	0.1345*** (0.0270)	0.02	5.75*	25.08.2008	9.77	-
Δln(NIKKEI)$_t$	0.0004 (0.0003)	0.3998*** (0.0602)	0.08	43.14***	02.12.2008	20.50***	26.05.2006 02.12.008 07.04.2011 17.03.2014
ΔMIBOR$_t$	0.0006 (0.0003)	-0.0051*** (0.0020)	0.01	2.99	27.02.2007	9.53	-

Notes: *, **, *** indicate significance at the 10%, 5%, and 1% levels, respectively; robust standard errors are given in parentheses.

The presence of structural breaks was tested earlier on daily data from 1997 to 2014 [12]. There was evidence of three structural breaks in bivariate regression model of IMOEX based on S&P 500 index (June 21, 2003; June 5, 2007 and April 12, 2011), and four structural breaks in bivariate regression model of IMOEX based on Brent oil (December 19, 2001; January 18, 2006; July 18, 2008 and July 21, 2011). It can indicate that the results may depend on the statistical procedure, the time period, transformations for the data, and data frequency is used in the work. Despite the fact that in this study no identical breaks were detected, the presence of structural breaks for these fundamental factors is confirmed.

6 Conclusion

In this paper, building on these pioneering literatures about changing nature of the dependence of fundamental factors in Russian stock market, we study the effect of daily values of fundamental factors on the MOEX Russia Index over a longer time interval (2003-2018). This study updated the results of earlier papers. The results indicate that influence of fundamental factors on the IMOEX is not constant: the power and direction of the influence change during the period. It is observed for both multivariate and bivariate regression models. The regression coefficients for the different regimes, defined by the structural breaks, can vary markedly over time by several times. For this reason, failure to consider the structural breaks in financial data results in underestimating the true relationship between variables. However, the results indicate that structural breaks for multivariate and bivariate regression models can differ.

The structural breaks in the multivariate regression model of MOEX Russia Index (April 25, 2006 and November 28, 2008) are probably associated with the dramatic falls of the stock market index. It can be caused by a sharp change in dynamics of fundamental factors or other factors and events that were not taken into account in regression models but affected the behavior of investors. Understanding the probable causes of the changing nature of relationships between variables can be used to predict the influence of fundamental factors on the stock market index in the future.

The using of other methods to detect structural breaks, for example, the using of the Markov-switching time series model [11, 19] is one of the directions for future research.

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