Econometric Modeling of the Dynamics of the Integration Activity of Russian Companies *

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Abstract. This paper presents an empirical analysis of the Russian market of mergers and acquisitions in 2003-2012. This analysis allowed for the conclusion that, to assess and forecast the integration activity of Russian companies, the most precise and appropriate models are seasonal autoregressive integrated moving average models built on weighted observations to eliminate the effect of the structural changes which are characteristic of developing economies. Forecasting the values of development of the market for corporate control may serve as "input" information to form a prompt regulation system for the mergers and acquisitions of holding companies, which meets current needs.

Keywords: harmonic analysis, forecasting, autoregressive integrated moving average (ARIMA) models, mergers and acquisitions (M&A), structural change

1 Introduction

Few problems of economic theory and practice give rise to more heated discussions than problems of integration. However, global practice evidences that it is major corporate entities which generate an aggregate demand and supply, and define the most important prerequisites to beat the competition. To achieve competitive advantage, a firm needs advanced technologies and a high rate of capital turnover. This is practical only when holding companies have the most favorable conditions for the generation, use and renewal of resources.

The Latin word "integratio" means "joining, consolidation of separate parts in one". There are many criteria for classifying M&A deals (the American abbreviation of 'merger and acquisition deals') and it should be noted that they are not uniform. Analysis reveals the following main types of integration deals, classified according to their direction (see Table 1).

However, the literature in economics as well as on practitioners focuses on forecasting the integration activity of Russian holdings. In recent years, thanks

* The work is performed under the grant of the President of the Russian Federation for the state support of young Russian scientists – PhDs (MK-5339.2016.6)

Table 1. Main types of M&A deal, according to the direction of integration

Integration deal types	Description
Horizontal	Merger (acquisition) between companies in the same sector manufacturing the same products or performing the same production stages
Vertical	Merger (acquisition) between companies in different economic sectors connected with the manufacturing process of certain finished products
Conglomerate	Merger (acquisition) between companies in different sectors having no common manufacturing processes (merger between a company from one sector and a company from another which is not a supplier, a customer, nor a competitor)

to accumulated statistical information about integration deals on the part of holding companies, methodological approaches to forecasting the rate of integration in Russia are starting to develop. Therefore, it is interesting to study the course of research into corporate integration processes in countries with a developed institutional environment.

2 Research on trends in M&A

Melicher in his works suggests forecasting integration activity by means of time series models and the log transformation of series [11]. Weston in his early works empirically came to support the hypothesis that the M&A of corporate entities had a wave-like formation [15].

Tollison and Shughart [14] reject the wave-like pattern of integration activities to simulate M&A processes by an autoregressive model of the 1st order. However, the fact that M&A may be described by a random-walk process gives no reason to reject the hypothesis of wave-like behavior by M&A.

In recent times, now that the hypothesis of a wave pattern of M&A is no longer provoking lively discussion in the Western research environment, but has rather became a point to support the simulation of a time pattern of M&A, new approaches have been developed. However, recent developments focus on explaining the integration activity using models with a switching parameter, where waves of M&A are caused by “switching” a discrete parameter. Markov regime switching models define the specific time intervals of M&A waves more accurately and set a unified structural process which may show waves of integration activity in industrial and cross-border companies.

Barkoulas [3] simulates the integration activity of holding companies using fractional integration tests. As he states, ARFIMA processes have hyperbolically decaying autocorrelations. Therefore, such processes have a long forecasting horizon. Fluctuations in M&A are influenced not only by the latest historical values, but also by M&A values far back in the past. Such behavior by integration processes indicates the influence of fundamental factors on trends in the integration activity of holding companies.

As regards the Russian M&A market, some rare attempts have been made to forecast integration activity, notably, studies by Musatova and Ignatishin. Musatova focuses on quarterly trends in the number of completed national M&A deals for the period from early 1995 to late Q2 2010. Due to the incomplete data available, the total value of M&A deals was not forecast [12].

The analysis of papers suggests that this focus on identifying the time behavior of the integration activity among Russian holdings and simulating integration processes in Russia is a new field of study.

3 Forecasting the trend in the number of M&A deals

It is a general practice to use finite samples in econometrics, and it is consequently important to analyze the properties of various methods of estimation and forecasting when samples are limited. The widely used approach to a comparison of methods and models is a cross-validation method [8]. In general the cross-validation method may be described as the implementation of the two following stages:

1. All available basic statistical data X are randomly divided into two subsets: X_{tr} and X_{val}. X_{tr} is used to select ("adjust") a model.
2. Each of the model options calculated at a previous stage is validated on the validation sample (X_{val}).

The available series of the trend in the number of completed M&A deals is represented in absolute values for the period from January 2003 to March 2013. The series falls into interval series because it characterizes the value of the indicator each month. Following a general principle in the cross-validation method, a monthly trend in the number of completed M&A deals for the period from January 2003 to December 2012 was used as a training sample X_{tr} (see Figure 1).

The analysis revealed that, starting from the period of time $t^* = 69$ (September 2008) the trend in the indicator under study had changed its structure. Such a period of time is characterized by the beginning of a financial and economic crisis in Russia. Buyers' and sellers' reasons for M&A during periods of economic growth differ from possible reasons for integration during a period of economic crisis, which cannot but influence the integration activity of holding companies. Foreign research has endorsed this rationale[3]. In the context of a financial and economic crisis, the reasons for integration are influenced by a significant imbalance between demand and supply in the M&A market: a sharp decrease in buyers and a great number of assets offered for sale.

[3] For example, Yagil J. Mergers and macro-economic factors // Review of financial economics. 1996. Vol. 5, No. 2. pp. 181–190

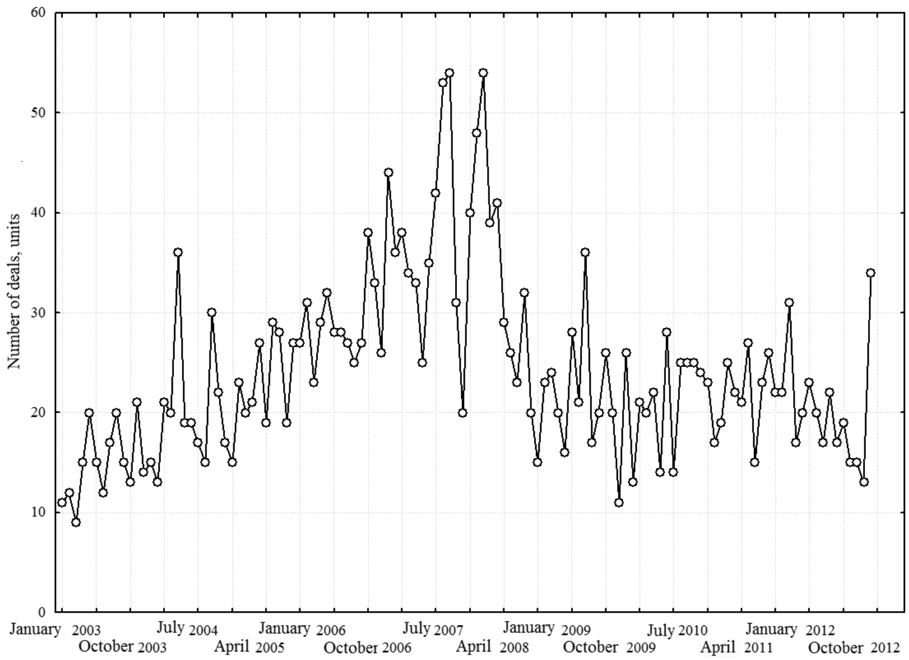

Fig. 1. Trends in the number of completed M&A deals, 2003-2012

In the case of a stable and growing economy, the main reasons for consolidation (operations and strategy) are related to potential synergetic effects, the rates of growth of business, entrance to new markets, cost reductions due to the scale of business, and others, but during an unstable period the dominating reasons would become financial and investment ones. A decline in the risk of bankruptcy and reduction of accounts payable, in particular for sellers of assets, are brought into prominence, while for buyers, the important features are diversification, tax benefits and the opportunity to pay a lower market price for assets.

Econometrics has developed several formal tests allowing us to determine whether there is a structural change in the data and at what observation point it has occurred: the Chow test, a sliding window method, the Zivot-Andrews test and others [2,6]. In the present study the Chow test was performed to test the hypothesis on the feasibility of breaking down the initial sample by subsets [5]. As $F_{observ} = 43.48 > F_{cr}(0.05; 3; 116) = 2.68$, the results show that the structural change occurred in September 2008. Therefore, it is feasible to divide the initial set into two subsets to improve the quality of the model with respect to $t^* = 69$.

Testing the hypothesis on the trend anticipates the determination and highlighting of the trend. The main approaches to this task are based on statistical hypothesis testing. To test the hypothesis on the randomness of a series, various approaches can be used; they differ from each other in terms of the power and complexity of their mathematical tools; for example, the square successive difference test (the Abbe test); a series test based on the median of a set; an "ascending and descending" series test; a testing method for means; the Foster-Stewart method and others.

According to the Foster-Stewart method, the hypothesis H_0 on a constant mathematical expectation for a period from January 2003 to September 2008 ($t = \overline{1,69}$) may be rejected. Consequently, the series of completed M&A deals has a trend component:

$$\begin{array}{rcccc} & \hat{x}_t & = & 12.21 & + & 0.4t. \\ \text{t-statistics}^4 & & & (7.20) & & (9.58) \end{array}$$

The coefficient of determination $R^2 = 57.18\%$ and the regression equation are significant, since $F_{observ} = 91.78 > F_{cr} = 3.13$.

Following the Foster-Stewart method for the period from October 2008 to December 2012 ($t = \overline{70,120}$), the hypothesis H_0 on a constant mathematical expectation with an evaluation of 21.16 was adopted. Consequently, in the series of completed M&A deals the trend component is:

$$\hat{x}_t = \begin{cases} 12.21 + 0.4t, & t \leq t^* \\ 21.16, & t > t^* \end{cases}, \quad \text{where } t^* = 69.$$

At a preliminary stage of time series modeling a seasonal component is to be studied. The spectral analysis and spectral density distribution by periods (the density being estimated according to the Parzen window method) revealed that a maximum value of the spectral density was within a 6-month period (Figure 2).

We next review statistical models to forecast the number of M&A deals completed by Russian holding companies.

The model of the number of completed M&A deals using a harmonic analysis

The harmonic analysis is the expansion of the periodic function $f(x)$ ($f(x+2l) = f(x)$) into a Fourier series. If the function $f(x)$ is set analytically, its harmonic analysis will be fully performed by applying well-known Euler-Fourier formulas to calculate the coefficients of the Fourier series.

A main objective of the harmonic analysis is the representation of $f(x)$ as the series:

$$f(x) = \frac{a_0}{2} + \sum_{n=1}^{\infty}(a_n \cos(nx) + b_n \sin(nx)) \tag{1}$$

[4] Regression coefficients are statistically significant at a 5% level, as t_{cr} $(0.05; 67) = 1.68$

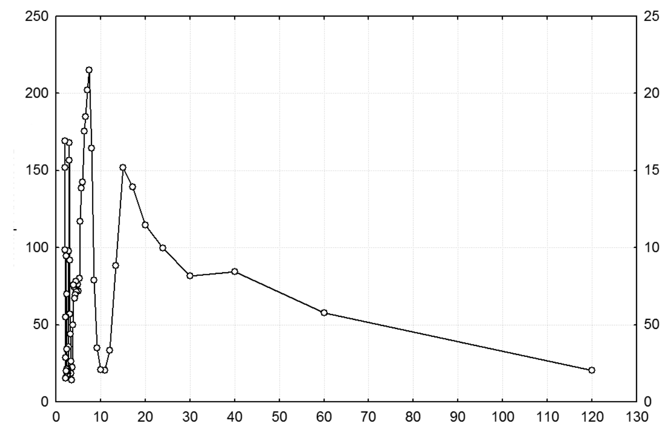

Fig. 2. Spectral density for a time series of the number of completed M&A deals

or

$$f(x) = \frac{a_0}{2} + \sum c_n \sin(nx + \varphi_n), \tag{2}$$

where $c_n = \sqrt{a_n^2 + b_n^2}$ – harmonic amplitude, φ_n – harmonic phase.

As compared to other research methods for the seasonality, harmonic analysis has some considerable advantages. It allows us to determine both a period of fluctuations (frequency) and their rate (amplitude). The seasonal component is a sum of a mean value and a series of sinusoids and cosinusoids:

$$s_t = \bar{s} + \sum_{i=1}^{n} a_i \cos(\omega_i t) + \sum_{i=1}^{n} b_i \sin(\omega_i t), \tag{3}$$

where a and b represent parameters of harmonic representation; $\omega_i$represents angular frequency measured in radians per unit of time and equal to $\omega = 2\pi f$ $(0 \leq \omega \leq 2\pi)$; $n = N/2$ (N – the length of the time series).

Given that the series of the number of completed M&A deals revealed the trend, the Fourier series was used to describe a series generated after finding a trend component in the original series. To select the best harmonic representation, coefficients of determination for equations with a different number of harmonics were calculated (see Table 2).

The model with 12 harmonics describes quite a good seasonal component of the trend in the number of M&A deals completed by holding companies in the

Table 2. Harmonic functions for the model of the number of completed M&A deals involving Russian holdings

Harmonic number	Harmonic functions	Number of harmonics	Cumulative coefficient of determination (R^2), %
1	$0.37\cos(t-2.99)$	1	4.56
2	$0.87\cos(2t-1.30)$	2	19.73
3	$1.54\cos(3t-2.05)$	3	24.86
4	$0.62\cos(4t-2.33)$	4	41.25
5	$1.50\cos(5t-1.85)$	5	43.89
6	$1.32\cos(6t-0.93)$	6	54.29
7	$1.33\cos(7t-2.07)$	7	62.56
8	$2.04\cos(8t-0.57)$	8	68.45
9	$1.3\cos(9t-1.23)$	9	71.87
10	$1.43\cos(10t-1.66)$	10	74.26
11	$1.28\cos(11t-2.62)$	11	79.23
12	$0.68\cos(12t-1.68)$	12	85.92

Russian Federation, explaining an 85.92% variation of levels. Then:

$$\hat{y}_t = \begin{cases} 12.21 + 0.4t + 0.37\cos(t-2.99) + 0.87\cos(2t-1.30) + \\ \quad + 1.54\cos(3t-2.05) + 0.62\cos(4t-2.33) + \\ \quad + 1.50\cos(5t-1.85) + 1.32\cos(6t-0.93) + \\ \quad + 1.33\cos(7t-2.07) + 2.04\cos(8t-0.57) + \\ \quad + 1.3\cos(9t-1.23) + 1.43\cos(10t-1.66) + \\ \quad + 1.28\cos(11t-2.62) + 0.68\cos(12t-1.68), & t \le t^* \\ 21.16 + 0.37\cos(t-2.99) + 0.87\cos(2t-1.30) + \\ \quad + 1.54\cos(3t-2.05) + 0.62\cos(4t-2.33) + \\ \quad + 1.50\cos(5t-1.85) + 1.32\cos(6t-0.93) + \\ \quad + 1.33\cos(7t-2.07) + 2.04\cos(8t-0.57) + \\ \quad + 1.3\cos(9t-1.23) + 1.43\cos(10t-1.66) + \\ \quad + 1.28\cos(11t-2.62) + 0.68\cos(12t-1.68), & t > t^*, \end{cases}$$

where $t^* = 69$.

A diagram of the original series of the trend in the number of M&A deals and the series generated by the model is given (see Figure 3).

To test the normality of distribution for this model, the Pearson test was applied. Since $\chi^2_{observ} = 2.46 < \chi^2_{cr}(0.05;3) = 7.8$, there are no grounds to reject the hypothesis on a normal distribution of residuals of the model. To test for autocorrelation in residuals, the asymptotic Breusch-Godfrey serial correlation test was used; it is based on an idea that, if neighboring observations are correlated, it will be obvious to expect that in the equation the coefficient ρ will be

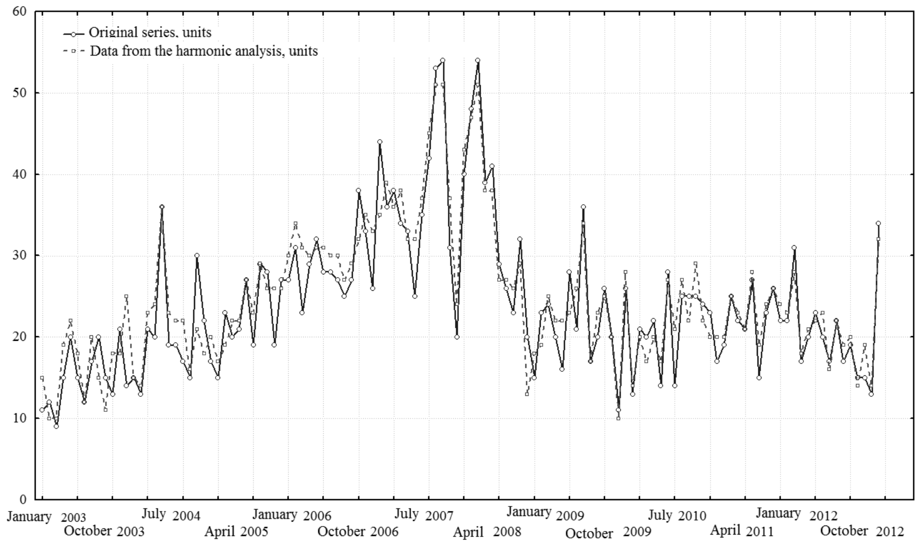

Fig. 3. The original series of the number of completed M&A deals and data from the harmonic analysis, units

significantly different from zero:

$$e_t = \rho_0 + \rho_1 e_{t-1}, \quad t = \overline{2, n}, \tag{4}$$

where e_t represents residuals of the model.

The available data show that:

$$e_t = -0.91 - 0.017 e_{t-1}, \tag{5}$$

i. e. the coefficient $\rho = -0.017$ is not significantly different from 0; consequently, there is no first-order autocorrelation in the residuals.

Econometrics has developed formal tests to determine the existence of heteroscedasticity in residuals: the Goldfeld-Quandt test, White test, Glaser test and others [9]. In this paper we performed the Goldfeld-Quandt test; according to its results $F_{observ} = 1.54 < F_{cr}(0.05; 43; 43) = 1.66$, there are no grounds to reject the hypothesis on the homoscedasticity of the residuals of the model.

To test for conditional heteroscedasticity, i. e. ARCH effects in errors of the model, an asymptotic test was used; it is based on regression e_t^2 by e_{t-1}^2

$$e_t^2 = \lambda_0 + \lambda_1 e_{t-1}^2, \quad t = \overline{2, n}.$$

The available data show that:

$$e_t^2 = 11.67 - 0.0008 e_{t-1}^2,$$

i. e. the coefficient $\lambda = -0.0008$ is not significantly different from 0, evidencing that there are no ARCH effects in errors of the model.

Thus, the test results show that the model generated by performing the harmonic analysis is relevant to the integration activity of the Russian holding companies under study.

A seasonal model of the autoregressive integrated moving average (the Box-Jenkins model) of the number of completed M&A deals

When the series under analysis includes non-random polynomial or harmonic components, their formal approximation may require too many parameters, i. e. the resulting parameterization of the model may be inefficient. In this case the Box–Jenkins method may be used

As shown above, the Russian economy is undergoing a difficult period of economic transformation accompanied by structural economic changes occurring, inter alia, in the integration activity of holdings. In the past 20 years the objective of determining the structural changes is actively pursued by, for example, D. Andrews, J. Bai, P. Perron you should give the date of each of these papers and others. The objective of adapting forecasts to the structural changes made in the data was not covered in detail.

However, Pesaren and Timmermann show in their work that this subject is important, since a failure to take into account structural changes entails wrong forecasts: data from different structural modes may cause a major shift in the forecast. The paper “Market Timing and Return Prediction under Model Instability” by Pesaren and Timmermann proposes a two-stage approach to forecasting, which is stable towards structural changes. The first stage determines when the most recent break has occurred, and the second stage uses the most relevant data from the most recent structural mode to make a forecast. If the number of observations in the mode is not large, the coefficients of the ARIMA model will determine inaccurately, with high dispersion, causing wrong results.

To eliminate this disadvantage, the paper “Selection of estimation window in the presence of breaks” by Pesaren and Timmermann proposes a method of making an optimal choice of the length of the observation window applied to make a forecast. The method uses a number of observations to estimate the coefficients of the model with low dispersion, but not so much as to give rise to any high shift of the forecast due to an increased factor of observations from other structural modes.

In the Lomonosov Moscow State University, Kitov proposed a new method of stable forecasting subject to structural changes in the regression model, which gives more accurate forecasts than the method of choosing the window length. This makes the forecasts more accurate due to its more flexible approach to data, applying continuous optimization and all the information available in the sample. This method allows for the generalization of a random number of structural changes in data [1].

An idea of the proposed approach to structural changes in forecasting the integration activity is that an optimum ratio between dispersion and a shift in forecasts is adjusted not by discrete optimization, depending not on the choice of an optimal number of observations, but on continuous optimization, by the selection of optimal weighing coefficients, which are considered in observations from every structural mode. It is assumed that:

- at the time point $t+1$ there is no structural change; otherwise, the probability of changes and distribution of model coefficients after changes would have to be taken into account,
- in asymptotics a share of the observations attributed to each of the structural modes in a total volume of the sample is constant [10].

Analytically, using Annex of the paper "The Forecasting Method with Weighted Account for Observations" by Kitov, we determined the optimal weighing coefficient $\alpha_1 = 0.98$ for one structural change for a series of M&A deals. Thus, when building the model, the data for the period from January 2003 to September 2008 were taken into account with a weighing coefficient of 0.98; consequently, the data from October 2008 to December 2012 – with a weighing coefficient of 1.

Constructing ARIMA models for the time series under study includes the following key stages: identification of a test model; assessment of model parameters and a diagnostic test of the adequacy of the model; use of the model to make a forecast [4]. Initially, following the Box-Jenkins methodology, analyzing the autocorrelation function (ACF) and the partial autocorrelation function (PACF) of the original time series is recommended (see Figure 4).

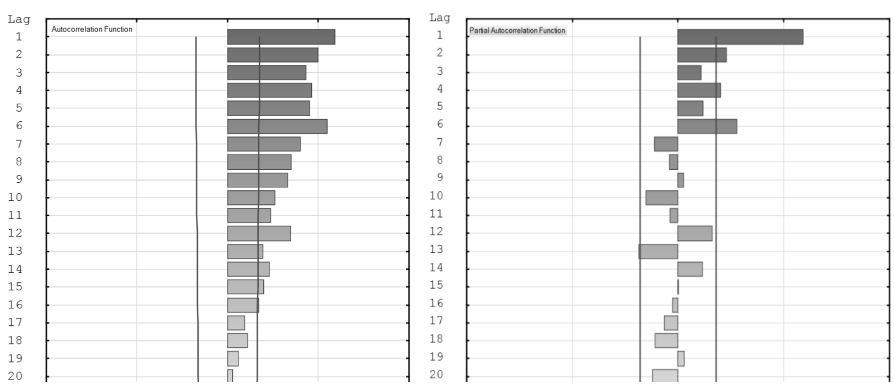

Fig. 4. Autocorrelation (ACF) and partial autocorrelation functions (PACF) of the series of the number of closed M&A deals

Figure 4 shows that the series of the number of closed M&A deals is not stationary. The Dickey-Fuller test applied for the series characterizing the number of completed integration deals proves its non-stationarity (as $t_{observ} = -1.79 > t_{cr}(0.05; 119) = -1.95$ for the parameter $\delta = -0.603$ from the equation $\Delta y_t = -0.603 y_{t-1}$, evidencing that the null hypothesis H_0 on a unit root cannot be rejected). Therefore, the series under study was adjusted by passing to a first-order difference of events and generating the stationary series, where the observation unit is $\Delta y_t = y_t - y_{t-1}$ [7].

The Box-Jenkins seasonal model was selected and fitted to the available data using a three-stage iterative procedure, consisting of identification, assessment and a diagnostic test of the model. To make an original adjustment of model parameters, let us consider ACF and PACF of the differentiated series (see Figure 5).

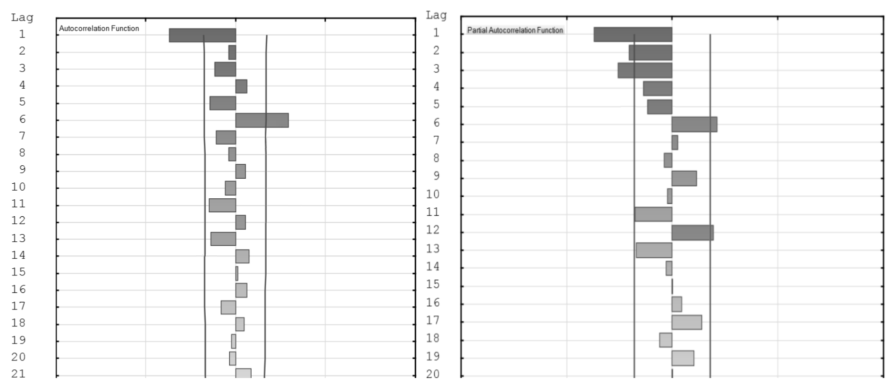

Fig. 5. Autocorrelation (ACF) and partial autocorrelation functions (PACF) of the differentiated series of the number of closed M&A deals

Figure 5 shows that ACF dies out, and PACF has peaks at lags 1, 2, and 3, while ACF has also a peak at lag 6, and PACF has peaks at lags 6 and 12. This confirms the inference made on the analysis of spectral density (see Figure 2), of a seasonal component with a six-month period. An optimal model was finally determined by searching through model parameters to minimize the statistic R^2, the mean square error and the statistic χ^2, characterizing a near-normal distribution of residuals [13]. Calculations were made in packages of application software Statistica 10.0 and SPSS 20.0.

This resulted in the following models:

1. ARIMA(3;1;0)(1;0;0);
2. ARIMA(3;1;0)(2;1;0);
3. ARIMA(0;1;3).

Because several tested models turned to be appropriate for the basic data, two requirements were followed in the final selection:

1. growth of precision (the quality of fit of the model),
2. reduction of the number of model parameters.

Regarding ARIMA(3;1;0)(1;0;0), we used the Akaike criterion AIC=6.25 and the Bayes criterion SIK=6.49; regarding ARIMA(3;1;0)(2;1;0), AIC=7.05, SIK=6.97; regarding ARIMA(0;1;3), AIC=8.93, SIK=7.89. Consequently, the ARIMA(3;1;0)(1;0;0) model was selected.

In general terms, the seasonal process of the autoregressive integrated moving average ARIMA(p;d;q)(P_s;D_s;Q_s) may be written with the lag operator B as follows:

$$(1-\alpha_1 B-\ldots-\alpha_p B^p-\beta_1 B^S-\ldots-\beta_{P_s} B^{S+P_s-1})\Delta^d\Delta^{D_S} y_t = \\ =(1-Q_1 B-\ldots-Q_q B^q-W_1 B^S-\ldots-W_{Q_S} B^{S+Q_s-1})\varepsilon_t$$

Then ARIMA(3;1;0)(1;0;0) is:

$$(1-\alpha_1 B-\alpha_2 B^2-\alpha_3 B^3-\beta_1 B^6)(1-B)y_t=\varepsilon_t. \tag{6}$$

To make an assessment of M&A and a forecast by ARIMA(3;1;0)(1;0;0), a transition to the ARIMA model was made as follows:

$$(1+0.553B+0.389B^2+0.314B^3-0.344B^6)(1-B)y_t=\varepsilon_t$$

or

$$\hat{y}_t = \underset{(4.325)}{0.447y_{t-1}} + \underset{(3.123)}{0.164y_{t-2}} + \underset{(3.785)}{0.076y_{t-3}} + \underset{(3.967)}{0.314y_{t-4}} + \underset{(5.121)}{0.344y_{t-6}} - \underset{(4.442)}{0.344y_{t-7}} + \varepsilon_t.$$

Since in this expression $t_{observ} > t_{cr}(0.95;113) = 1.981$, all the coefficients in the model provided are significant.

A diagram of the original series and the series generated by ARIMA(3;1;0)(1;0;0) is given in Figure 6.

To test the adequacy of the model, a histogram of residuals (see Figure 7) was drawn; following the diagram the distribution of residuals complies with the normal law. This conclusion is endorsed by the Pearson test ($\chi^2_{observ} = 2.28 < \chi^2_{cr}(0.05;3) = 7.8$). The available data show that $e_t = 0.05 - 0.008e_{t-1}$, i.e. $\rho = -0.008$ is not significantly different from 0; consequently, according to the Breusch-Godfrey test there is no autocorrelation in the residuals.

According to the Goldfeld-Quandt test, $F_{observ} = 1.41 < F_{cr}(0.05;43;43) = 1.66$; consequently, there are no grounds to reject the hypothesis of the homoscedasticity of residuals of the model. The asymptotic test for conditional heteroscedasticity showed no ARCH effects in model errors, since $e_t^2 = 2.03 - 0.006e_{t-1}^2$.

Thus, all the studied characteristics of the model evince its adequacy for the M&A process under study.

Precision of models of completed M&A deals

The most important characteristics of the model are the indicators of its precision. Precision may be assessed by the value of an error (imprecision) in the forecast characterizing the differences between the actual and the expected numbers of completed integration deals involving Russian holding entities. Table 3

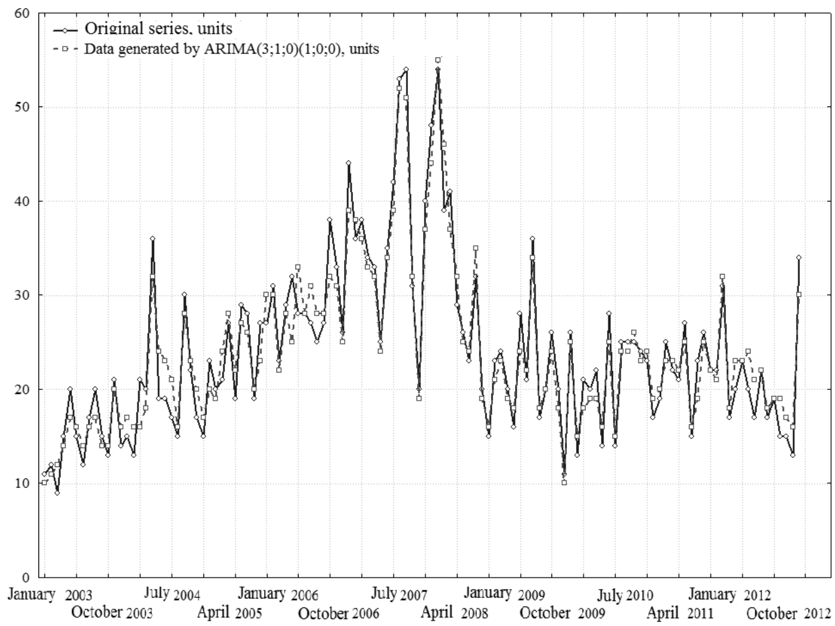

Fig. 6. The original series of the number of completed M&A deals and data generated by ARIMA(3;1;0)(1;0;0), units

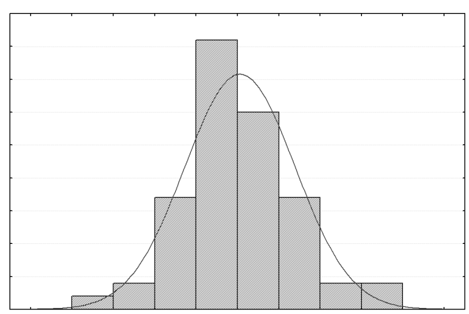

Fig. 7. Histogram of the residuals generated by ARIMA(3;1;0)(1;0;0)

characterizes the precision of the models of completed M&A deals using data of the training sample X_{tr} (January 2003 – December 2012).

According to a general procedure of the cross-validation method, all model options calculated at a previous stage are validated using data from the validation sample X_{val} (January-March 2013). Table 4 characterizes the precision of

[5] The literature often specifies that MAPE $\leq$ 10% evidences the high precision of the model; if this parameter is within a range of 10%–20%, precision may be deemed good, and when 20% < MAPE $\leq$ 50%, it is satisfactory.

Table 3. Precision of models of completed M&A deals using data from the training sample (January 2003 – December 2012)

Model	Precision characteristics			
	Error mean square	Sum squared error	Mean absolute percentage error (MAPE)[5]	Mean square error
1) Model of the trend in the number of completed M&A deals, generated by performing the harmonic analysis	11.7	1404	12.71%	3.42
2) ARIMA(3;1;0)(1;0;0)	6.39	761	9.28%	2.53

Table 4. Precision of models of completed M&A deals using data from the validation sample (January 2013 – March 2013)

Model	Precision characteristics			
	Error mean square	Sum squared error	Mean absolute percentage error (MAPE)	Mean square error
1) Model of the trend in the number of completed M&A deals, generated by performing the harmonic analysis	15.7	47	18.93%	5.39
2) ARIMA(3;1;0)(1;0;0)	7.67	23	14.23%	4.05

models of the completed M&A deals using data from the validation sample X_{val} (January 2003 – December 2012).

As models are adjusted to the data of the training sample, values of the quality criterion adjusted to the data of the validation sample X_{val} are less optimistic than those adjusted to the data of X_{tr}.

In view of the data generated, it may be concluded that a trend in the number of completed M&A deals is better described with an autoregressive integrated moving average model. Figure 8 gives the autocorrelation (ACF) and partial autocorrelation functions (PACF) of the residuals of the ARIMA(3;1;0)(1;0;0) model.

An important aspect of modeling any time series is forecasting. ARIMA(3;1;0)(1;0;0) may be used to forecast the number of M&A deals of Russian holdings for several periods ahead. Forecasting of the integration activity of the holding entities in future was performed for Q2 2013 (see Table 5).

It should be noted that the generated confidence interval bounds of the forecast for the number of closed M&A deals for Q2 2013 are fairly wide. A value of the confidence interval at the set confidence probability $\gamma = 95\%$ and dispersion of the forecasting error σ_e calculated by ARIMA(3;1;0)(1;0;0) significantly de-

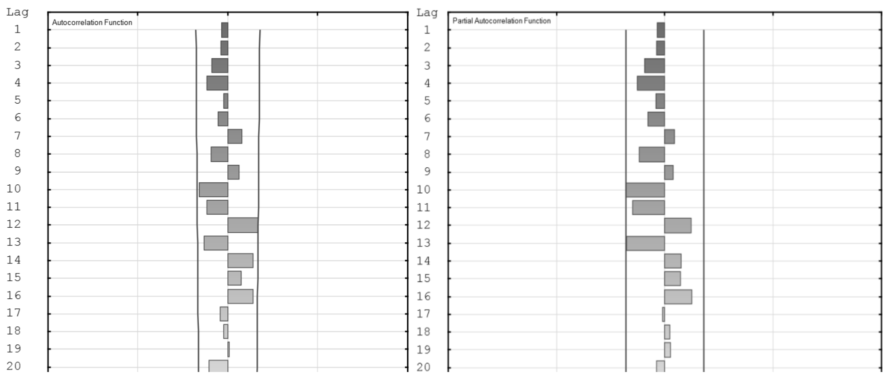

Fig. 8. Autocorrelation (ACF) and partial autocorrelation functions (PACF) of residuals of the ARIMA(3;1;0)(1;0;0) model of the series of the number of closed M&A deals

Table 5. Forecasting by ARIMA(3;1;0)(1;0;0) for Q2 2013, units

No.	Period	Actual value, units	ARIMA forecast value, units	Forecasting error	Confidence intervals	
					Left border	Right border
1	April 2013	17	20	3	10.69	29.31
2	May 2013	21	22	1	11.42	32.58
3	June 2013	18	15	3	3.64	26.36

pends on the scope of sample n. A lessening in the confidence interval by m times is ensured by an increase in the number of measurements n by m^2 times. Thus, whereas the statistical data on the Russian market of mergers and acquisitions are accumulated, all other conditions being equal, the confidence interval will be lessened.

In this case, in a period from April 2013 to June 2013 this model forecast the number of closed M&A deals with a MAPE of 13.03%, which confirmed that the model was acceptable for forecasting the completion of integration deals by holdings in the Russian M&A market.

4 Conclusions

This paper proposes a solution to the optimal forecasting of the trend in M&A deals of holding entities, subject to structural shifts in the national economy. Having analyzed the above results, we concluded that to analyze and forecast the integration activity of Russian holdings, the most precise and appropriate models were seasonal autoregressive integrated moving average ones. To evaluate the trend in M&A deals subject to structural shifts, we applied the forecasting method with a weighted account for observations, since a uniform accounting of all available observations resulted in a shift in the forecast, while accounting for the most relevant observations after the structural shift might entail a high variance in the forecast.

In particular, to forecast the trend in the number of closed M&A deals, we proposed seasonal ARIMA(3;1;0)(1;0;0) based on the weighted account for observations to eliminate the effect of the structural shift. Using ARIMA seasonal models, and factoring into the available observations with some optimally selected weights, we made the forecast for Q2 2013 on the number of closed M&A deals. Having compared the forecast to the actual data, we proved that models were acceptable for forecasting the development of the Russian M&A market to increase the efficiency and competitiveness of the Russian economy.

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