

10th Economics & Finance Conference
Rome, Italy, September 2018

A Method for Building and Forecasting the Russian Corporate Eurobonds Index in Conditions of Macroeconomic Instability

Authors: Teplova T.V., Andrianova, A.V., Sokolova, T.V.

The publication was prepared within the framework of the Academic Fund Program at the National Research University Higher School of Economics (HSE) in 2018 (grant № 18-05-0007) and by the Russian Academic Excellence Project "5-100".

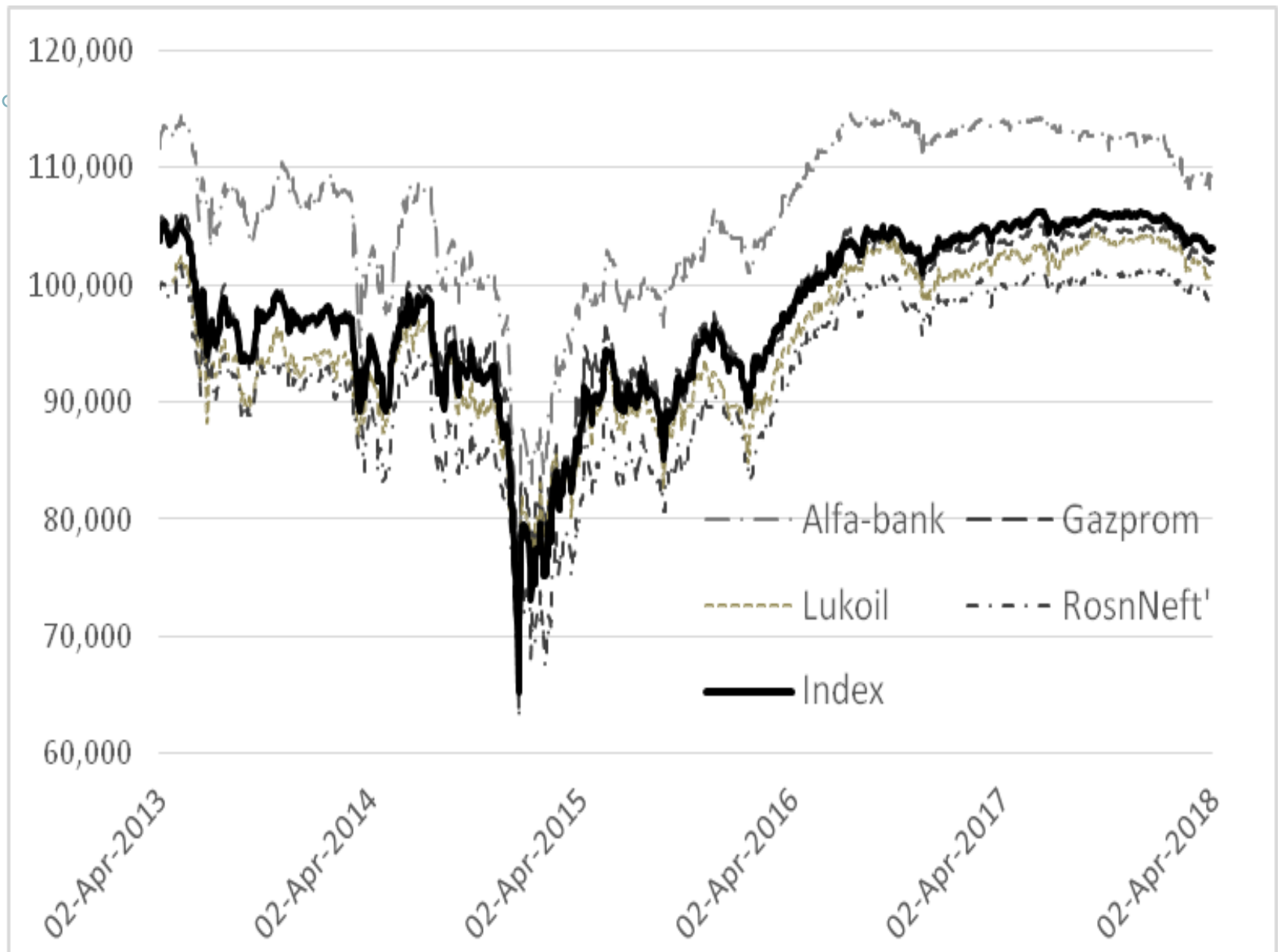
Objective of Research

Our objective is to build and forecast the dynamics of the index of the Russian corporate Eurobond market.

Our research consists of the following **stages**:

1. **Construction** of an **original index** of the Russian corporate Eurobond market.
2. Building specifications of models of different classes - ARMA with trend, ADL and ARMAX with independent variables - for describing **retrospective market dynamics**.
3. Estimation of the **quality of forecasts** on the period from 3 to 20 April 2018 and choice of the **best model specification**.

Eurobond index and some issues in its composition



Building models without independent variables

We convert data in the stationary form by taking first-differences.

- The results of the Dickey–Fuller test for the Eurobond index

Modifications	Level test	First-level test
Without a constant	0.626	<0.0001
With a constant	0.415	<0.0001
With a constant and trend	0.247	<0.0001

We check the presence of structural shifts.

The results of the Chow test for the structural shifts

Type of structural shifts	F	p-value	Conclusion
Leap	437.20	<0.0001	No
Angle change	1236.78	<0.0001	No
Leap and angle change	1.47	0.2253	Yes

We simulate the corresponding trend:

$$y_t = 73,0661 + 0,02895*time + 28,5049*d2 - 0,05597*d2*time$$

where d2-dummy variable belongs to the interval after 16/12/2014.

Building models without independent variables

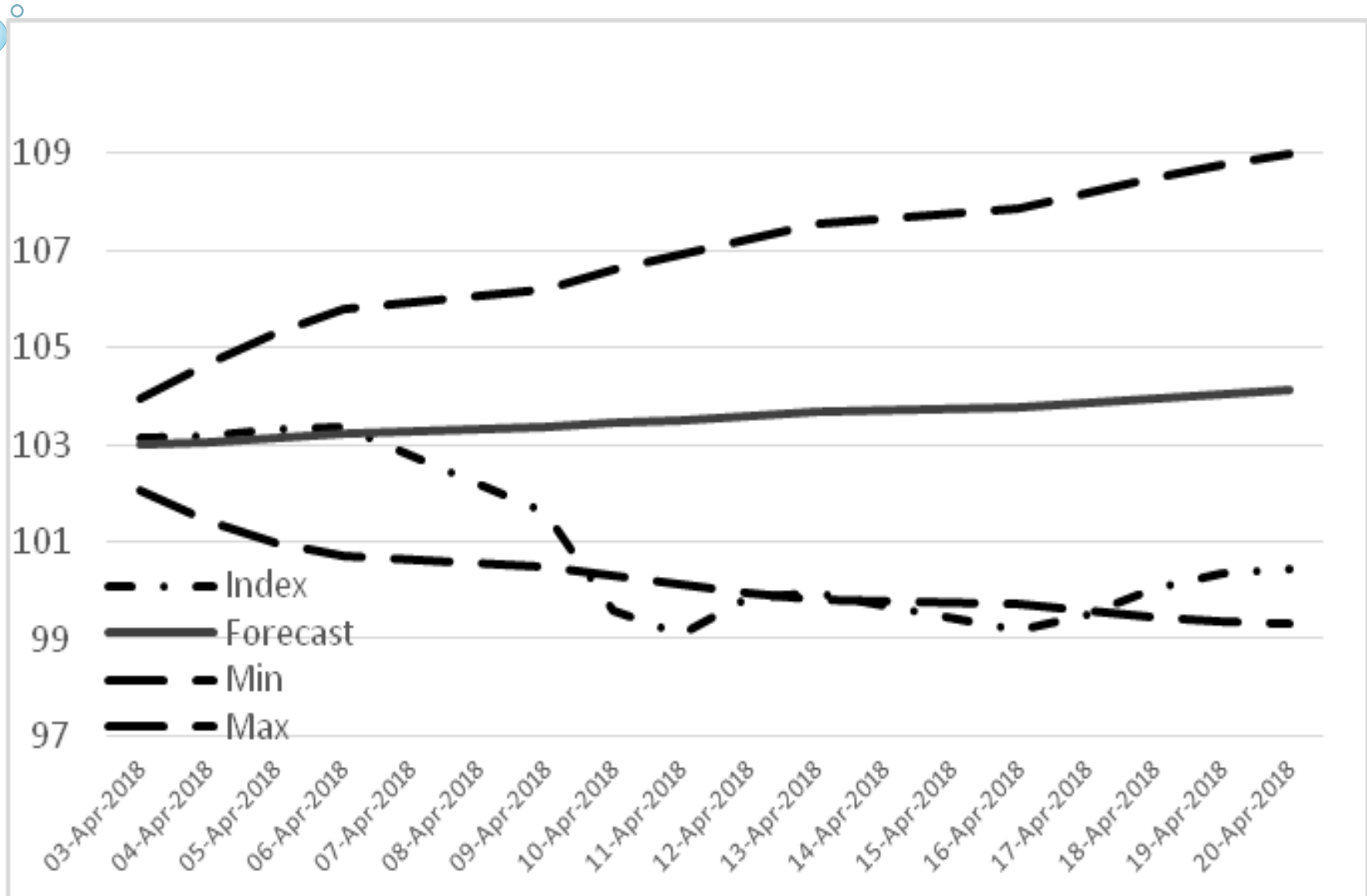
The results of the Dolado procedure show that it is possible to build ARMA(p,q) models with the trend.

Results of building ARMA(10,4) models with the trend

Variable	Coefficient	St. error	Z-statistics	p-value
Const	79.2470	4.89682	16.18	0.00001***
phi 1	1.39505	0.0273769	50.96	0.00001***
phi 2	-0.913574	0.0331276	-27.58	0.00001***
phi 4	0.816010	0.0453244	18.00	0.00001***
phi 5	-0.376342	0.0496498	-7.580	0.00001***
phi 7	0.160060	0.0409690	3.907	0.00001***
phi 8	-0.16585	0.0536630	-3.011	0.0026***
phi 9	0.161046	0.0458199	3.515	0.0004***
phi 10	-0.0993330	0.0273152	-3.637	0.0003***
theta 2	0.436275	0.0275177	15.85	0.00001***
theta 3	0.649710	0.0256901	25.29	0.00001***
theta 4	-0.0660059	0.0330883	-1.995	0.0461**
time	0.0222462	0.00542382	4.102	0.00001***
d	26.4975	6.68788	3.962	0.00001***
dt	-0.0755563	0.0149946	-5.039	0.00001***

Quality of forecast

The model does not take into account the negative shock of 9 April 2018



Building models using independent variables

We consider the following macroeconomic parameters and stock indices:

- 1) RTS index of the Russian stock market (calculated in US dollars);
- 2) the price index of the Russian energy market RTS Oil and Gas;
- 3) the index of government ruble bonds (RGBI);
- 4) the exchange rate of the dollar-ruble pair.

We check the presence of cointegration between the Eurobond index and independent variables by means of Engle-Granger method:

Coefficient	Index RTS	Oil index	Bond Index	Dollar-ruble exchange rate
Const	82.7074	78.4367	2.07692	96.5631
λ	0.0135446	0.115299	0.735629	0.0166355

Building models using independent variables

We check the stationarity of residuals of cointegration models:

Modifications	Index RTS	Oil index	Bond Index	Dollar-ruble exchange rate
Without a constant	0.1652	0.152	0.04958	0.073
With a constant	0.61	0.5863	0.3148	0.396
With a constant and trend	0.2283	0.1926	0.7322	0.2546
Stationary residues	No	No	Yes	Yes
Presence of cointegration	No	No	Yes	Yes

Lags of the following order of independent variables are significant:

- ✓ RTS – 0 and 1,
- ✓ RTS oil index – 0 and 1,
- ✓ bond index – 0, 1 and 5,
- ✓ dollar-ruble exchange rate – 0 lag

ADL(p,q) models

Results of building the ADL(1,1) model using the RTS index

Variable	Coefficient	St. error	Z-statistics	p-value
Const	0.000770638	0.0127005	0.06068	0.9516
phi 1	0.159498	0.0277807	5.741	0.0000***
Δ RTS	0.00808106	0.0007482556	10.80	0.0000***
Δ RTS 1	0.00428677	0.000629442	6.810	0.0000***
Δ Bondindex	0.432315	0.0225339	19.19	0.0000***
Δ USDRUB	-0.109642	0.0159914	-6.856	0.0000***

Results of building the ARCH(4) + ADL(1,1) model with RTS index

Variable	Coefficient	St. error	Z-statistics	p-value
Const	-0.0186506	0.00593554	-3.142	0.0017**
phi 1	0.205729	0.0258697	7.953	0.0000***
Δ RTS	0.00435905	0.000530501	8.217	0.0000***
Δ RTS 1	0.00257762	0.000512064	5.034	0.0000***
Δ Bondindex	0.321921	0.0172751	18.63	0.0000***
Δ USDRUB	-0.0682180	0.0136766	-4.988	0.0000***
alpha(0)	0.0209596	0.00265383	7.898	0.0000***
alpha (1)	0.439612	0.0534937	8.218	0.0000***
alpha (2)	0.137795	0.0288488	4.776	0.0000***
alpha (3)	0.136946	0.0307869	4.448	0.0000***
alpha (4)	0.285647	0.0425210	6.718	0.0000***

ARMAX(p,q,k) models

Results of building the ARMAX(1;5,2;8,1) model with RTS index

Variable	Coefficient	St. error	Z-statistics	p-value
Const	-0.00208240	0.0130234	-0.1599	0.8730
phi 1	1.06647	0.0227994	46.78	0.0000***
phi 5	-0.0702681	0.0216031	-3.253	0.0011***
theta 1	-0.913446	0.0340460	-26.83	0.0000***
theta 2	-0.167469	0.031327	-5.348	0.0000***
theta 8	0.0852615	0.0169199	5.039	0.0000***
Δ RTS	0.00804378	0.000737363	10.91	0.0000***
Δ RTS 1	0.00415865	0.000623022	6.675	0.0000***
Δ RGBI	0.442599	0.0220774	20.05	0.0000***
Δ USDRUB	-0.106069	0.0157568	-6.732	0.0000***

ARMAX(p,q,k) models

Results the ARMAX(3,2,1) model using the RTS oil index

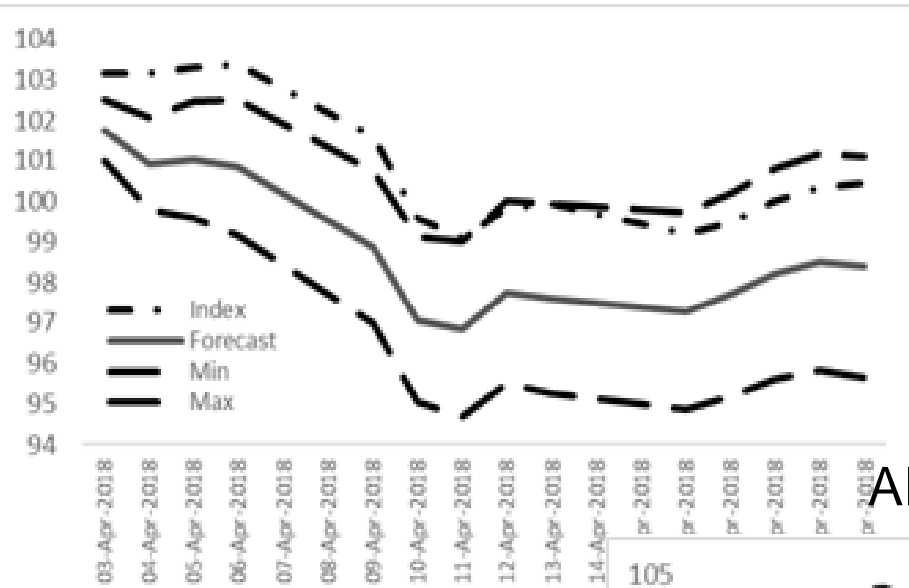
Variable	Coefficient	St. error	Z-statistics	p-value
Const	-0.000635648	0.00834030	-0.07621	0.9392
phi 1	0.169606	0.0276961	6.124	0.0000***
phi 2	0.827567	0.0664550	12.45	0.0000***
phi 3	-0.178065	0.0277502	-6.417	0.0000**
theta 2	-0.860332	0.0629847	-13.66	0.0000***
Δ OilIndex	0.0446840	0.00489290	9.132	0.0000***
Δ OilIndex 1	0.0265997	0.00419114	6.347	0.0000***
Δ RGBI	0.458499	0.0223281	20.53	0.0000***
Δ USDRUB	-0.116631	0.0159434	-7.315	0.0000***

Information criteria values for models using independent variables

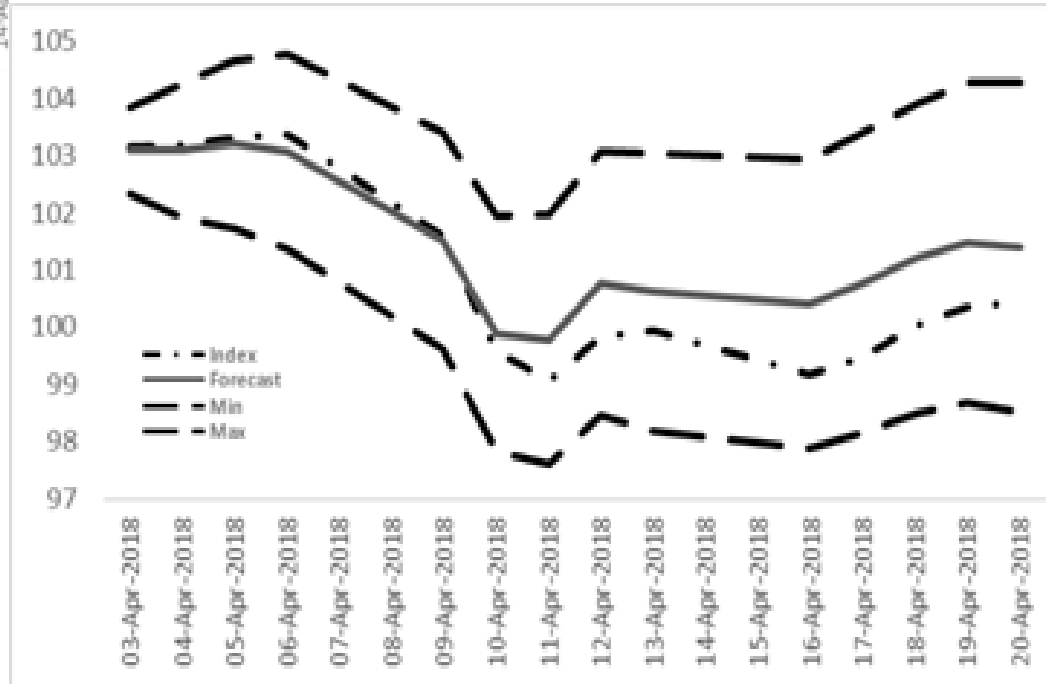
	Index RTS	Oil index
AIC	1215.239	1249.406
BIC	1272.135	1301.130
HQIC	1236.584	1268.811

Quality of forecasts

ARMAX model based on RTS index



ARMAX model based on oil index



Conclusions

- ✓ We propose an original method to build and forecast an index of the Russian corporate Eurobond market.
- ✓ Impact of shocks on the Russian financial market makes it impossible to predict the index using ARMA models without independent variables.
- ✓ Construction of ADL models with exogenous variables is also insufficient to predict the dynamics of the Eurobond index. The addition of ARCH processes for residuals did not result in a significant improvement in the ADL models.
- ✓ Both ARMAX models using the RTS index and the oil index can be considered adequate. Meanwhile, the ARMAX model using the oil index has a simpler lag structure and gives the most accurate forecast.