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INFRASTRUCTURE OF THE NENETS AUTONOMOUS DISTRICT AND ITS INFLUENCE ON THE REGIONAL EXTERNAL ECONOMIC ACTIVITY

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Steady development of Russian regions largely depends on the level of regional foreign economic activity, which is primarily determined by the state of the infrastructure of the region itself. This study answers the question of the impact that the infrastructure of the Nenets Autonomous District exerts on the regional foreign economic activity and assesses the role of infrastructure in the economic development of the region as a whole. At the beginning of the study, we have analyzed the main problematic aspects of the development of the region, which include, in particular, weak and underdeveloped infrastructure, a poor network of regional roads, a low supply of population and businesses with electricity and communication services. The same problems may determine low production efficiency in the region, which ultimately, together with the foreign economic activities, will determine the standard of living in the Nenets Autonomous District. The study presents a number of infrastructure factors, such as the length of roads, inland waterways, investment in fixed assets, domestic expenditure on research and development, per capita income of the population, the volume of heat energy provided, the freight turnover of the region, the volume of telecommunications services provided, as well as the gross regional product of the Nenets Autonomous District; these factors are considered as exogenous in the model. The three main indicators of the region's foreign economic activity that are exports, imports and foreign investment act as endogenous factors in the model. Based on statistical data for 2005–2015, the regression equations are constructed and the obtained dependences are analyzed. The method of constructing ADL models is applied in the study, which implies the influence of the above factors not only for the corresponding period, but also for previous periods. The resulting model equations can be used to create a strategy for the development of the region, as well as for forecasting macroeconomic processes. The main impact of infrastructure factors is on investment flows, while the impact of these factors on the flow of exports and imports is very insignificant.

Keywords: external economic activities of a region; factors of infrastructure; export-oriented approach; Nenets Autonomous District

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ИНФРАСТРУКТУРА НЕНЕЦКОГО АВТОНОМНОГО ОКРУГА И ЕЕ ВЛИЯНИЕ НА ВНЕШНЕЭКОНОМИЧЕСКУЮ ДЕЯТЕЛЬНОСТЬ РЕГИОНА

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Развитие российских регионов во многом зависит от уровня развития региональной внешнеэкономической деятельности, последняя во многом определяется состоянием инфраструктуры самого региона. Данное исследование отвечает на вопрос о

влиянии инфраструктуры Ненецкого автономного округа на развитие сферы ВЭД и оценивает роль инфраструктуры в экономическом развитии региона в целом. В начале исследования анализируются основные проблемные моменты развития региона, к которым можно отнести слабое развитие инфраструктуры, редкую сеть автомобильных дорог, низкую обеспеченность населения и бизнеса электроэнергией и услугами связи. Этими же проблемами во многом обуславливается низкая эффективность производства, что в конечном итоге совместно с внешней торговлей региона определяет уровень жизни в Ненецком автономном округе. Приводится целый ряд факторов инфраструктуры, таких как протяженность автомобильных дорог, внутренних водных путей, грузооборот, инвестиции в основной капитал, внутренние затраты на научные исследования и разработки, среднедушевые доходы населения, объем отпуска тепловой энергии, грузооборот региона, объемы оказываемых услуг связи, а также валовый региональный продукт Ненецкого автономного округа – эти факторы в модели являются экзогенными. Три основных показателя ВЭД региона – экспорт, импорт и иностранные инвестиции выступают в модели в качестве эндогенных. На основании статистических данных за период 2005–2015 гг. строятся регрессионные уравнения и анализируются полученные зависимости. Применен метод построения ADL-моделей, который подразумевает влияние вышеуказанных факторов не только за соответствующий период, но также и за предшествующие периоды. Полученные уравнения модели могут быть использованы при создании стратегии развития региона, а также для прогнозирования макроэкономических процессов. Основное влияние факторы инфраструктуры оказывают на инвестиционные потоки, при этом влияние указанных факторов на потоки экспорта и импорта весьма незначительное.

Ключевые слова: внешнеэкономическая деятельность региона; факторы инфраструктуры; стимулирование экспорта; Ненецкий автономный округ

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Introduction. The Nenets region is located in the north of the East European Plain, most of the region lays beyond the Arctic Circle. There is only one major settlement in the region, the city of Naryan-Mar, one urban-type settlement (Iskateley settlement) and 42 rural settlements. The region is rich in natural resources.¹ The Nenets Autonomous District has large reserves of crude oil, gas, copper and diamonds, whereas some of the deposits are still not fully explored. The region looks attractive for investors and it is striving to improve the basic indicators of social and economic performance.

The relevance of the research topic is based on the fact that foreign economic activity is an extremely important factor of social welfare and favorable investment climate not only in the region itself, but also in the country [1]. The role and significance of Russian regions as the subjects of international economic activities has recently increased and the local governments become

more engaged in foreign economic activity, supporting foreign business in their territories, helping regional enterprises to enter foreign markets, creating conditions for effective foreign economic activity. The infrastructure of the region exerts some serious influence on foreign economic activity of the region. The estimation of that influence makes up the core of the study.

Works of many authors are dedicated to the problems of infrastructure. For instance, Smirnova [2] conducts functional analysis of the regional infrastructure in various aspects and also clarifies the concept of infrastructure. Ilchenko and Abramova [3] assess the infrastructural potential of the region in the context of further economic development. Ref. [4] by the same authors focuses on the infrastructural development in small towns. Some researchers examine the development of certain aspects of infrastructure, in particular, Ref. [5] describes the mechanisms for improving the transport infrastructure [5]. Some works research various problematic aspects of regional infrastructure that need a whole set of measures to resolve them, see [6]. Some studies

¹ Regionalnyy portal Nenetskogo avtonomnogo okruga. URL: www.info83.ru

explore the influence of regional infrastructure on the overall economic development. For example, in [7], the authors perform the analysis of possible directions of activity which are closely connected to the infrastructure of the region.

Considerable importance for regional foreign-economic development can be attributed to territorial advantages: proximity to the markets and natural resources. The infrastructure, the auxiliary and main production facilities also play an important role in the economic development of the region.

Larionova [8] suggests that the main factors of foreign economic activity in the region should be assessed with the following system of indicators: increase (reduction) of regional import-substituting industries; growth rate of the GRP; increase (decrease) in the number of jobs; increase (decrease) of budget revenues; the influence on the living standards of the population; increase (decrease) of investments in fixed assets due to changes in the capacity of the domestic market.

Chelnokov, Gerasimov and Bykovsky [9] proposed the so-called enlarged model of the regional economy. Unlike the models where the region acts as a single structured object, the proposed model focuses on the mechanism of economic relations between various subjects of the regional economy. The considered regional macro-model is a certain compromise between the complexity and cumbersomeness of the real model of regional functioning and the need for a clear structure of basic relationships within the regional economic mechanism.

In general, all the models have common features that make it possible to identify the sequence of actions in assessing the external economic relations of a region:

- 1) calculation of the main indicators of foreign economic relations of the region;
- 2) assessment of foreign economic activity of the region on the basis of the calculated indicators;
- 3) calculation of the main indicators of regional economic development;
- 4) Identification of the features of regional economic development;
- 5) analysis of the impact of foreign economic relations on the economic development of the region.

The purpose of the study is to analyze the infrastructure of the Nenets Autonomous District

and to quantify its impact on foreign economic activity in the region.

The methodology of the study. The study develops an autoregressive model with a distributed lag (ADL-model). The model represents the dependencies of the endogenous indicators of the regional external economic activity on the exogenous infrastructural factors.

Experimental or computational study. The main indicators that characterize the regional external economic activity are the exports and imports.

Table 1
Foreign trade of the Nenets.
Autonomous District in dynamics, 2005–2016

	Regional exports, mln. USD	Regional imports, mln. USD
2005	12.9	1.5
2006	1.2	1.6
2007	228.7	7.6
2008	316.8	4.6
2009	73.4	0.2
2010	2343.8	3.9
2011	3364.3	0.9
2012	1396.3	2.3
2013	1458.2	1.8
2014	1653.4	0.7
2015	1892.4	2.0
2016	2134.7	0.7

Source: Federal Statistics Service. URL: www.gks.ru

The exports of the Nenets Autonomous District significantly prevail over its imports. Prior to 2011, the situation was rather uncertain, but since 2012 the volume of exports has become more stable.

Characterizing the infrastructure of the region, we can conclude that the infrastructure of the region is very poorly developed. Firstly, the length of the regional road network is only 366 km and the network has no connection to the network of public roads of Russia. Secondly, with an extensive coastal line over 3000 km, there are no large ports in the district. Moreover, there is no railway communication in the region, with air transport playing the key role. Thus, having analyzed the foreign economic activity and the infrastructure

of the region, we can identify the main problems of the Nenets Autonomous District:

1) underdeveloped infrastructure: lack of roads, railways, low power supply and low level of communication services;

2) small regional population, which means small permanent workforce who mainly work mainly on a rotational basis;

3) low-level of diversification of economic activity. The region largely depends on the supply of goods from other regions, whereas the delivery of goods is hampered by the poor transport infrastructure;

4) low efficiency of production and small percentage of the population with higher education.

Development of the region during the forecasted period means achievement of sustainable long-term socio-economic growth, with consideration of the mutual interests of governmental institutions, civil society, the oil and gas industry and the indigenous population, based on increased compatibility of economic activities with environmental safety. Further development of the natural resource base and active connection to Russia's transport, transit and export corridors will open up new opportunities related to the development of new fields and development of the transport and logistics infrastructure, including the activation of traffic along the Northern Sea Route.

The basis of the study is the question of assessing the infrastructural impact on the regional external economic activity. The impact will be assessed with an application of economic and mathematical modeling based on ADL-models, that is, autoregressive distributed lag models. The general methodology of the time series analysis is presented in [10]. The application of the method to economic processes has some specific features and is based upon several important principles [11]. The similar approach is used in the works researching regional development of the Russian Arctic [12–14].

The aim of the model is to evaluate the effect of exogenous indicators on endogenous ones. Exogenous indicators are indicators that characterize the regional infrastructure and human activities. Endogenous indicators are the main indicators of external economic activity of the region.

In order to evaluate the regional external activity, we will take exports, imports and inflow of foreign direct investment into the region. From the point of view of the chosen strategy, the goal is to attract investments to the region and at the same time to improve the infrastructure,

which in many cases slows down not only foreign economic activity but the socio-economic development of the region as a whole. The model can be described with the help of the resulting indicator Y^3 that is the development of external economic activity of the Nenets Autonomous District. In general, development of foreign economic activity of the region can be represented by three endogenous variables:

Y_t^{31} is the exports of goods and services of the Nenets Autonomous District during the period t ,

Y_t^{32} is the imports of goods and services of the Nenets Autonomous District during the period t ,

Y_t^{33} is the foreign direct investments in the region during the period t .

The exogenous variables selected for analysis are as follows:

Y_{t-i}^{21} is the gross regional product (GRP), mln. RUR, for the period $t-i$;

Y_{t-i}^{22} is the R&D expenditures, mln. RUR, for the period $t-i$;

Y_{t-i}^{24} is the per capita income of the population (RUR per month) for the period $t-i$;

X_{t-i}^{11} is the thermal energy sold to all consumers, thousand Gcal, for the period $t-i$;

X_{t-i}^{12} is the cargo turnover, mln. tons per km, for the period $t-i$;

X_{t-i}^{13} is the investments in fixed assets made by organizations with participation of foreign capital, mln. RUR, for the period $t-i$;

X_{t-i}^{25} is the internal waterways during the period $t-i$;

X_{t-i}^{26} is the length of the roads for the period $t-i$;

X_{t-i}^{29} is the communication services rendered to the population, per capita, RUR, for the period $t-i$;

In the course of the research, the following axioms were formulated:

Y_t^{31} is the exports of goods and services of NAD, depends on Y_{t-i}^{21} , Y_{t-i}^{22} , Y_{t-i}^{24} , X_{t-i}^{25} , X_{t-i}^{26} , X_{t-i}^{11} , X_{t-i}^{12} .

Y_t^{32} is the imports of goods and services of NAD, depends on Y_{t-i}^{21} , Y_{t-i}^{22} , Y_{t-i}^{24} , X_{t-i}^{25} , X_{t-i}^{26} , X_{t-i}^{11} , X_{t-i}^{12} , X_{t-i}^{13} .

Y_t^{33} is the foreign direct investments in the region, depends on Y_{t-i}^{22} , Y_{t-i}^{24} , X_{t-i}^{25} , X_{t-i}^{26} , X_{t-i}^{29} , X_{t-i}^{11} , X_{t-i}^{12} , X_{t-i}^{13} .

Table 2

Endogenous and exogenous variables of the model

Endogenous variables	Exogenous variables								
Y_t^{31}	Y_{t-1}^{31}	Y_{t-i}^{21}	Y_{t-i}^{22}	Y_{t-i}^{24}	X_{t-i}^{25}	X_{t-i}^{26}	X_{t-i}^{11}	X_{t-i}^{12}	
Y_t^{32}	Y_{t-1}^{32}	Y_{t-i}^{21}	Y_{t-i}^{22}	Y_{t-i}^{24}	X_{t-i}^{25}	X_{t-i}^{26}	X_{t-i}^{11}	X_{t-i}^{12}	X_{t-i}^{13}
Y_t^{33}	Y_{t-1}^{33}	Y_{t-i}^{22}	Y_{t-i}^{24}	X_{t-i}^{25}	X_{t-i}^{26}	X_{t-i}^{29}	X_{t-i}^{11}	X_{t-i}^{12}	X_{t-i}^{13}

Source: calculations of the authors.

Table 3

The correlation matrix for the first equation

		Y_{t-1}^{31}	Y_{t-1}^{21}	Y_{t-1}^{22}	Y_{t-1}^{24}	X_{t-1}^{25}	X_{t-1}^{26}	X_{t-1}^{11}	X_{t-1}^{12}
Y_{t-1}^{31}	Pearson Correlation	1	,758	,667	,644	-,292	,450	-,630	,526
	Significance		,007	,025	,032	,384	,165	,043	,096

Source: our calculations.

The first equation of the model in general form goes as following:

$$Y_t^{31} = Y_{t-1}^{31} + Y_{t-i}^{21} + Y_{t-i}^{22} + Y_{t-i}^{24} + X_{t-i}^{25} + X_{t-i}^{26} + X_{t-i}^{11} + X_{t-i}^{12}.$$

The second equation of the model in general form goes as following:

$$Y_t^{32} = Y_{t-1}^{32} + Y_{t-i}^{21} + Y_{t-i}^{22} + Y_{t-i}^{24} + X_{t-i}^{25} + X_{t-i}^{26} + X_{t-i}^{11} + X_{t-i}^{12} + X_{t-i}^{13}.$$

The third equation of the model in general form goes as following:

$$Y_t^{33} = Y_{t-1}^{33} + Y_{t-i}^{22} + Y_{t-i}^{24} + X_{t-i}^{25} + X_{t-i}^{26} + X_{t-i}^{29} + X_{t-i}^{11} + X_{t-i}^{12} + X_{t-i}^{13}.$$

The data on the relevant variables for the period from 2005 to 2015 were collected. For the calculations,² All calculations were carried out in the SPSS software. Let us explain the step-by-step algorithm for obtaining the first equation of the model. Two other equations were obtained similarly.

The first step is to check the endogenous variable for autocorrelation³ with the Box-Ljung

test. We need to determine the required lag for the variable. The study showed that the strongest significance of the indicator goes with a lag of one year. As the lag increases, the significance of the data reduces. Accordingly, the endogenous variable with a one-year lag is taken in the model.

The next step in the analysis is construction of a correlation matrix with the variables of the model. According to the matrix, the gross regional product (Y_{t-1}^{21}) exerts the greatest impact on the regional exports (Y_t^{31}). The impact of other indicators is not that high. In order to make up a model, only the variables with correlation coefficient of 0.6 and above were selected. Therefore, the variables Y_{t-1}^{22} , Y_{t-1}^{24} , X_{t-1}^{11} will also be selected as influencing factors (see Tab. 3).

Next, the appropriate lags are selected for the influencing factors. The selection is carried out with the correlation coefficients. According to the calculations, the variables Y_{t-1}^{21} and Y_{t-1}^{22} have a stronger influence on the endogenous variable with a one-year lag, while the other two influencing factors show the best results for the zero-lag. Hence, the first equation of the model in the structural form can be represented as follows:

$$Y_t^{31} = a_0 + a_1 Y_{t-1}^{31} + a_2 Y_{t-1}^{21} + a_3 Y_{t-1}^{22} + a_4 Y_t^{24} + a_5 X_t^{11}.$$

The coefficients of the regression equation are calculated in the SPSS software (see Tab. 4).

² Ofitsial'nyi internet-resurs Minekonomrazvitiia RF. URL: <http://orv.gov.ru/regions/details/58>; Statisticheskaiia informatsiia po NAO. URL: <http://knoema.ru/atlas/Russian-Federation/Nenets-Autonomous-District>

³ S.K. Antipov, Statistika. Metody analiza problem mirovoi ekonomiki: ucheb. posobie, St. Petersburg, Izd-vo Politekhn. un-ta, 2012.

Table 4

Coefficients for the equation of the first model equation

	<i>Coefficients</i>	<i>Std.error</i>	<i>t-statistics</i>	<i>P-value</i>	<i>Low 95 %</i>	<i>Upper 95 %</i>
Y-intercept.	11938,53	10121,7	1,179499	0,303561	-16163,8	40040,87
Variable 1	-0,72049	0,606047	-1,18884	0,300256	-2,40315	0,962164
Variable 2	0,077421	0,036235	2,136651	0,099461	-0,02318	0,178025
Variable 3	-40,1828	55,47822	-0,7243	0,508978	-194,215	113,8494
Variable 4	-0,15433	0,085177	-1,81185	0,144237	-0,39082	0,082162
Variable 5	-30,959	30,31	-1,021	0,36	-115	53,21

Source: our calculations.

Table 5

The variance analysis of the first equation

	<i>df</i>	<i>SS</i>	<i>MS</i>	<i>F</i>	<i>Significance F</i>
Regression	5	8841998	1768400	3,052374	0,15106
Residual	4	2317409	579352,2		
Total	9	11159407			

Source: the data we have compiled.

After the performed calculations it is possible to make up the equation:

$$Y_t^{31} = 11938.53 - 0.72Y_{t-1}^{31} + 0.07Y_{t-1}^{21} - 40.18Y_{t-1}^{22} - 0.15Y_t^{24} - 30.96X_t^{11}.$$

According to the obtained equation, all the variables except GRP affect the regional exports negatively. The impact of the selected factors seems to be insignificant, which may be due to the fact that NAD exports are mainly influenced by factors not related to the regional infrastructure.

The analysis also involves checking the first equation for significance using the Fisher test (see Tab. 5).

The significance of the equation is confirmed by the Fisher criterion, according to the table, $F > \text{Significance } F$, which confirms that the model is accurate.

The second and third equations of the model are obtained in a similar manner, with the same methods. According to the correlation matrix, the indicator of imports of goods and services of the NAD (Y_t^{32}) is influenced by X_{t-i}^{11} which is the thermal energy sold to consumers and X_{t-i}^{13} which is the investments in fixed assets made by organizations with participation of foreign capital.

After carrying out of the correlation analysis, we get the equation in the structural form:

$$Y_t^{32} = a_0 + a_1Y_{t-1}^{32} + a_2X_{t-1}^{11} + a_3X_{t-1}^{13}.$$

After the calculations, we obtain the second equation:

$$Y_t^{32} = -16.13 - 0.78Y_{t-1}^{32} + 0.05X_{t-1}^{11} + 0.0002X_{t-1}^{13}.$$

Now we consider the third equation of the model. According to the correlation matrix, the variable Y_t^{33} is influenced by the following exogenous factors:

Y_{t-i}^{22} is the R&D expenditures, mln RUR, for the period $t - i$;

Y_{t-i}^{24} is the income of the population per capita (RUR per month) for the period $t - i$;

X_{t-i}^{25} is the internal waterways during the period $t - i$;

X_{t-i}^{26} is the length of the roads for the period $t - i$;

X_{t-i}^{29} is the communication services rendered to the population, per capita, RUR, for the period $t - i$;

X_{t-i}^{12} is the cargo turnover, mln tons per km for the period $t - i$;

After evaluating the correlation matrix and choosing the lags for the ADL-model, we obtain the structural form of the third equation:

$$Y_t^{33} = a_0 + a_1Y_{t-1}^{33} + a_2Y_{t-2}^{22} + a_3X_{t-1}^{25} + a_4X_{t-2}^{26} + a_5X_{t-2}^{29}.$$

After the calculation of the coefficients we get the third equation of the model:

$$Y_t^{33} = -3072151 + 0.6Y_{t-1}^{33} + 14.73Y_{t-2}^{22} + 7783.9X_{t-1}^{25} - 386.25X_{t-2}^{26} - 972.9X_{t-2}^{29}.$$

As a result, the model of the infrastructural influence on the external economic activities of the NAD can be represented as follows:

$$\begin{cases} Y_t^{31} = 11938.53 - 0.72Y_{t-1}^{31} + 0.07Y_{t-1}^{21} - \\ - 40.18Y_{t-1}^{22} - 0.15Y_t^{24} - 30.96X_t^{11}, \\ Y_t^{32} = -16.13 - 0.78Y_{t-1}^{32} + 0.05X_{t-1}^{11} + 0.0002X_{t-1}^{13}, \\ Y_t^{33} = -3072151 + 0.6Y_{t-1}^{33} + 14.73Y_{t-2}^{22} + \\ + 7783.9X_{t-1}^{25} - 386.25X_{t-2}^{26} - 972.9X_{t-2}^{29}. \end{cases}$$

The results and discussion. The obtained system of equations allows finding the dependence of external economic activity on the factors of regional infrastructure. Low import figures for the region can explain the obtained equation. In general, we can conclude that regional imports are not subject to significant influence of the infrastructural factors. The flows of foreign direct investment are much more dependent on the infrastructure than the export-import ones. The main stimulating effect for the FDI is provided by the R&D expenditures and by internal waterways. Because of road infrastructure of the region is isolated from the Russian road network, a negative coefficient was obtained for X_{t-2}^{26} .

The scientific novelty of the study is in clarification of the current trends in the dynamics of external economic activity of the

Nenets Autonomous District. The results of these studies can be used for creating a strategy for the regional development, as well as for the medium-term forecasting purposes.

Conclusions. In the course of the study, the external economic activity of the Nenets Autonomous District was analyzed and the main problematic aspects of the regional infrastructure were identified.

The main infrastructural factors influencing and determining the regional foreign trade activities were considered. Indicators characterizing the development of foreign economic activity were chosen, namely, they are the volume of exports, imports and direct foreign investments in the region.

A system of three equations, each of them modeling the dependence of foreign economic activity on the influencing factors, was obtained. The infrastructural factors primarily impact investment flows. The influence of the factors on the export-import flows has turned out to be insignificant. It is likely that external trade is primarily determined by non-infrastructural variables that were not considered in the study.

The obtained dependencies can be used not only in forecasting of macroeconomic processes for the region for the next decade up to 2030, but also for the development of the regional economic strategy.

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