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Program-Target Mechanisms to Ensure the Fiscal Balance of the Federal Constituent

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Abstract

The purpose of this research is to study the possible impact of program costs associated with the development of the real sector of the regional economy on the fiscal balances of the constituent entities of the Russian Federation based on the wavelet analysis method. To achieve this purpose, we conducted a correlation analysis of the time-frequency dependence between the variables of the empirical model: the shares of program costs, the shares of non-repayable receipts, and the share of business taxes in the revenues of the consolidated budgets of constituent entities of the Russian Federation such as the Republic of Mordovia, the Udmurt Republic, Trans-Baikal Territory, and Kaliningrad Region for the period from 2001 to 2021. The research results indicate a significant impact exerted by the program costs of the regional budgets on the development of the real sector to ensure fiscal balance in the Republic of Mordovia, the Udmurt Republic, and the Trans-Baikal Territory on certain time scales. The novelty of this research lies in demonstrating the wavelet analysis effectiveness applied when conducting correlation analysis in cases where the relationships between the analyzed variables follow different patterns at different time horizons, and precisely wavelet analysis makes it possible to reveal the most significant characteristics of the relationship of variables. Earlier studies based on traditional methods ignored the time-frequency dependence between the variables of the empirical model. The practical significance of the research results lies in the fact that they determine the time scale on which the most effective measures and budgetary policy instruments applied within the framework of program-target mechanisms are provided to ensure fiscal balances in the regions.

Keywords:

Federal Constituent Entity Budget;
Fiscal Balance;
Non-repayable Receipts;
Business Taxes;
Correlation Analysis;
Discrete Wavelet Transform.

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1- Introduction

Regional authorities are characterized by their ability to provide public goods (administrative capacity) and increase tax revenue (fiscal capacity) [1]. At the same time, the continuing subsidization of most budgets of federal constituent entities and the highly subsidized dependence of a certain group of regions cause a significant problem negatively affecting both the regional economic development of Russia and the stability of the national budget system [2–8]. In many federalized countries, revenue collection powers are largely vested in the central government, with spending responsibilities disproportionately vested in regional and local governments [9–14]. Due to this asymmetry, known as "vertical fiscal imbalance" the tax and non-tax revenues of regional and local budgets do not match their expenditures, and the gap is filled by intergovernmental transfers from the central government and borrowing by regional and local authorities [15–17].

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Russia is also characterized by a high degree of centralization of fiscal responsibilities, as a result of which federal interbudgetary transfers serve as the main source of co-financing of a significant part of the costs of state regional development programs [18, 19]. However, as follows from the results of numerous studies, interbudgetary transfers do not significantly impact regional development. They revealed the low efficiency of the transfer policies of the federal center [20] and the need to support the regions with the help of federal targeted programs [21, 22], and no statistically significant effect of interbudgetary transfers on the degree of socioeconomic potential realization in the regions was determined [23, 24]. It should be considered that the large-scale and rapid growth of public investments provided under program-targeted mechanisms often leads to inefficient results due to the limitations in the ability of regional authorities to absorb infrastructure investments [25–28].

In this regard, some publications substantiate the need to improve program-targeted mechanisms, including the provision of subsidies within the framework of state programs and national projects, to ensure sustainable socio-economic development of the regions [29] and the transformation of the inter-budgetary transfer system for ensuring fiscal balances of federal constituent entities [30]. As it was rightly highlighted by Braginsky et al. [31], on the one hand, spending on social projects is a necessary budget expenditure item; on the other hand, achieving the necessary balance by simultaneously increasing the number and improving the quality of commercial projects is hindered by limited budgetary funds, a formal approach to the procedure of tendering commercial projects applying for inclusion in state programs, and problems with assessing the socio-economic efficiency of state programs.

An essential step in the search for a solution to the problem of balancing regional budgets was made in the studies by Grebennikov & Magomedov [32] and Grebennikov et al. [33]. These publications indicate that budget expenditures within program-target mechanisms (program costs), focused on the implementation of social and commercial projects, qualitatively differ in the degree of influence on the balance of regional budgets. This is determined by the fact that financing of social projects through program costs generates secondary annually reproducible budget expenditures for maintaining social infrastructure and providing free public services; while the program costs that finance commercial projects, if successfully implemented, lead to enhanced tax revenues to budgets, growing employment, and increased gross regional product, contributing to the fiscal balance of the federal constituent entity by increasing the financial capabilities of the region. The positive tax effects from the implementation of commercial projects should cover the regularly reproducible secondary costs generated by social projects for a positive impact of the program costs on the implementation of social and commercial projects while ensuring the balance of regional budgets. Grebennikov & Magomedov [32] developed and proved the following hypotheses:

negative inverse correlation between the share of program costs for the implementation of commercial projects (development of the real sector) in the expenditures of the consolidated budgets of federal constituent entities (variable {X1}) and the share of non-repayable receipts in the revenues of their consolidated budgets (variable {Y1});

positive inverse correlation between the share of program costs for the implementation of commercial projects (development of the real sector) in the expenditures of the consolidated budgets of federal constituent entities (variable {X1}) and the share of business taxes in the revenues of their consolidated budgets (variable {Y2}).

The data of the Russian Treasury on the execution of the consolidated budgets of the subjects of the North Caucasus Federal District (NCFD) in 2001–2017 in the context of budget classification codes formed the information and analytical basis of the study in Grebennikov & Magomedov [32]. Regarding the change in the structure of the budget classification for the analyzed period, data were collected to ensure the comparability of the corresponding codes.

To determine the values of the variable {X1} in the "National Economy" section of the budget expenditure classification, data were used for the following subsections: "General economic issues", "Fuel and Energy Complex", "Agriculture and fisheries". "Transport", "Road facilities (road funds)", "Other Issues in the Field of the National Economy". Then, for these subsections, the following types of expenses of the consolidated budgets of the constituent entities of the North Caucasus Federal District for the period of 2001–2017 were selected: budget investments for the acquisition of real estate objects in state (municipal) ownership, budget investments to other legal entities, except budget investments in capital construction projects, and subsidies to producers of goods, works, and services.

The following types of business taxes were accounted for to determine the values of the variable {Y2}: sales tax, corporate profit tax, harmonized tax, unified tax on imputed income for particular types of activity, and unified agricultural tax.

The validity of the developed hypotheses was tested using correlation analysis (Spearman's rank correlation coefficients were calculated), of which the constituent entities of the North Caucasus Federal District were ranked based on the correlation analysis results. It should also be noted that Grebennikov et al. [33] conducted a similar study for each of the eight federal districts for the period of 2000–2018. For this purpose, test indicators were calculated to determine to what extent the annual dynamics of the actual distribution of the volumes of interbudgetary transfers between the constituent entities of the Russian Federation for each of the eight federal districts over the period 2000–2018 meets the criterion: the negative value of the Spearman's rank-order correlation coefficient between the variables "the share of

non-repayable receipts" and "fiscal self-sufficiency potential". The research established a correlation relationship between the calculated values of these indicators and socio-economic characteristics of federal districts and concluded that for a correct assessment of the impact of program-targeted management on regional development, it is necessary to consider the program parameters at all levels of the budget system of the Russian Federation in terms of a separate territory, a constituent entity of the Russian Federation or their group.

Considering the importance of this approach [32] based on the impact of the investment cost structure of the region's consolidated budget on the balance of regional budgets, the *purpose* of this study is to analyze the impact of program costs associated with the development of the real sector of the regional economy on the fiscal balance of the federal constituent entities, regarding the impact of time-frequency dependence. To achieve this purpose, this study tested the truth of three *hypotheses* about the presence:

(H1) *negative* inverse correlation between the variable {X1}, which characterizes the share of program costs for developing the real sector in the expenditures of the consolidated budgets of federal constituent entities, and the variable {Y1}, which characterizes the share of non-repayable receipts in the revenues of the consolidated budgets of federal constituent entities;

(H2) *positive* inverse correlation between the variable {X1}, which characterizes the share of program costs for developing the real sector in the expenditures of the consolidated budgets of federal constituent entities, and the variable {Y2}, which characterizes the share of business taxes in the revenues of the consolidated budgets of federal constituent entities;

(H3) *negative* inverse correlation between variable {Y1}, which characterizes the share of non-repayable receipts in the revenues of the consolidated budgets of federal constituent entities, and variable {Y2}, which characterizes the share of business taxes in the revenues of the consolidated budgets of federal constituent entities.

2- Research Methodology

Unlike Grebennikov & Magomedov [32], Grebennikov et al. [33], in this study, correlation analysis between variables in pairs ({X1}, {Y1}), ({X1}, {Y2}), ({Y1}, {Y2}) was conducted using wavelet analysis (numerical evaluation of cross-wavelet correlations), regarding the multidirectionality and different intensity of their correlations on different time scales (i.e., time-frequency correlations) to test the validity of the formulated hypotheses.

In cases where correlations between variables change over time and over different investment horizons, wavelet analysis allows simultaneous correlation analysis in the time and frequency domains [34-36]. It should be noted that methods such as DCC GARCH, enabling us to analyze in the time domain, do not allow for analysis in the frequency domain and therefore only allow the study of the covariance matrix in the time domain [37, 38].

When using a purely frequency approach based on the Fourier transform, information about all frequency components can be obtained, but since the amplitude is fixed throughout the period under consideration, information about the temporal dynamics is completely lost. Thus, with sharp changes in economic relations or the presence of discontinuities during the study period, it is impossible to establish exactly where this change occurs [39]. In addition, due to non-stationarity caused by structural discontinuities, estimates based on the Fourier transform may be inaccurate. Therefore, the wavelet transform has significant advantages over the Fourier transform when the time series is nonstationary or only locally stationary [40].

The decomposition of the economic dependence between variables into time-frequency components is an important feature of wavelet analysis. Wavelet analysis often uses a scale base instead of a frequency since certain scales usually characterize frequency bands. The set of wavelet scales can be further interpreted as time horizons over which economic relations can be studied separately. Thus, each scale describes the development of economic relations with a certain frequency while maintaining the temporal dynamics. Therefore, the wavelet decomposition usually gives a more complex picture compared to the time domain approach, in which all time horizons are aggregated. Therefore, if economic relations are expected to follow different patterns over different time horizons, wavelet analysis can reveal the most interesting characteristics of time data that would otherwise remain hidden [41-43].

In this article, a numerical assessment of the wavelet correlation of the analyzed variables was carried out on the basis of the method and approach considered in Percival [44], Percival and Walden [45], Whitcher [46], Whitcher et al. [47], from which it follows that the wavelet covariance within a specific time scale λ_j, $\gamma_{XY}(\lambda_j) = \mathrm{cov}\{W_{j,t}^X, W_{j,t}^Y\}$ indicates the contribution of the covariance between the two stochastic variables $\{X_t\}$ and $\{Y_t\}$ within this scale, and the numerical estimate of the wavelet correlation can be expressed as:

$$\rho_{XY}(\lambda_j) = \frac{\gamma_{XY}(\lambda_j)}{\sqrt{\sigma_X(\lambda_j) * \sigma_Y(\lambda_j)}} = \frac{\mathrm{cov}\{W_{j,t}^X, W_{j,t}^Y\}}{\sqrt{\mathrm{var}\{W_{j,t}^X\} * \mathrm{var}\{W_{j,t}^Y\}}} \quad (1)$$

where $\sigma_l(\lambda_j) = \mathrm{var}\{W_{j,t}^l\}$, $l = X, Y$ – wavelet variance of a stochastic process; $\{W_{j,t}^Y\}$ and $\{W_{j,t}^X\}$ – wavelet coefficients at the scale λ_j of time series $\{Y_t\}$ and $\{X_t\}$, respectively.

Figure 1 shows the sequence of the research stages. In the first stage, the region and the corresponding values of the time series of variables: {X1}; {Y1}; {Y2} are selected. In the second stage, the procedure of time series decomposition by Daubechies discrete wavelet transform, with decomposition level up to 4, and numerical evaluation of the correlation of wavelet coefficients of analyzed variables at all levels, from 1 to 4, are conducted. At the third stage, we compared the sign of the obtained correlation values of the wavelet coefficients of analyzed variables is compared with the sign of correlation of these variables in accordance with the developed hypothesis.

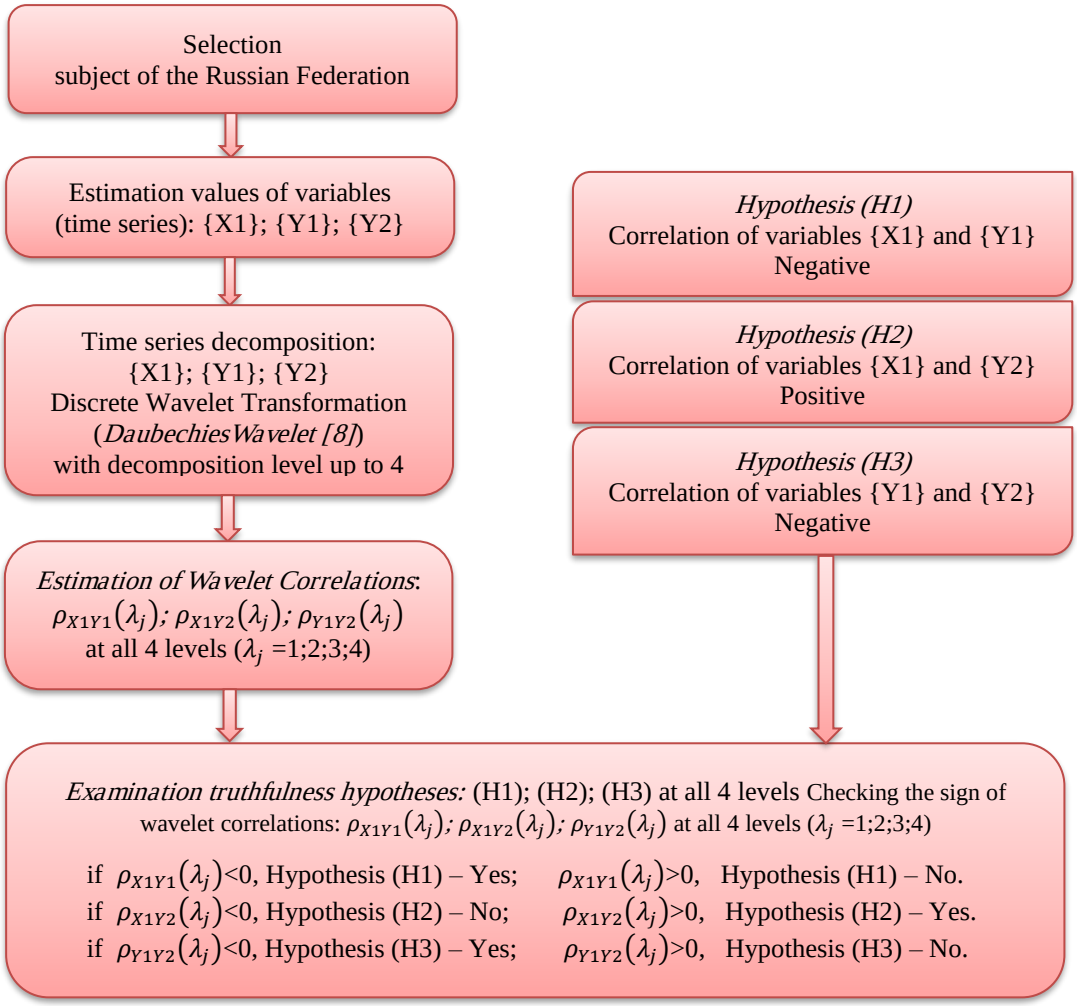

Figure 1. Simulation process flowchart

We should emphasize the following *data analysis peculiarities* – the numerical values of the variables: {X1}; {Y1}; {Y2}, lie in the range from 0 to 1 since by definition they are shared variables. The methodology for determining the variables of the empirical model coincides with the similar methodology discussed in Grebennikov & Magomedov, (2019) [32]. The substantiation of the choice of this particular set of parameters is explained in more detail in Grebennikov & Magomedov (2019) [32].

Annual data from 2001 to 2021 for variables {X1}, {Y1}, {Y2} are used as the initial data for the correlation analysis in this study for the constituent entities of the Russian Federation (the Republic of Mordovia, Udmurt Republic, Trans-Baikal Territory, and Kaliningrad Region[*]). These variables are used with index *m* ({X1m}, {Y1m}, {Y2m}) for the Republic of Mordovia, with index *u* ({X1u}, {Y1u}, {Y2u}) for the Udmurt Republic, with index *z* ({X1z}, {Y1z}, {Y2z}) for the Trans-Baikal Territory, with index *k* ({X1k}, {Y1k}, {Y2k}) for the Kaliningrad Region.

The initial data for the analysis were selected from the statistical database of the Treasury of Russia [48] and are presented in Table 1.

[*] The choice of these regions of Russia was initiated by the customer in whose interests the research was conducted: the Kaliningrad Region is the western constituent entity of the Russian Federation; the Trans-Baikal Territory is a region from the eastern part of Russia; and the Udmurt Republic and the Republic of Mordovia are regions of the Volga Federal District in the central part of Russia.

Table 1. Numerical values of variables for the constituent entities of the Russian Federation (the Republic of Mordovia, Udmurt Republic, Trans-Baikal Territory, Kaliningrad Region) for the period from 2001 to 2021: X1, a share of program costs for developing the real sector in the expenditures of the consolidated budget of the region, %; Y1, a share of non-repayable receipts in the consolidated budget revenues of the region, %; Y2, a share of business taxes in the revenues of the consolidated budget of the region, % (Source: compiled by the authors of the Russian Treasury data [48]).

X1: The share of program costs for developing the real sector in the expenditures of the consolidated budget of the constituent entity of the Russian Federation %											
RF constituent entity	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**
RM*	33.91	38.58	30.66	13.11	27.09	35.87	43.49	43.68	57.36	55.73	53.62
UR†	12.10	18.30	13.33	10.04	15.79	16.01	19.05	21.81	30.48	26.05	29.64
TBT‡	47.61	48.65	36.91	36.97	39.21	26.84	41.99	42.00	49.18	40.63	37.16
KR§	20.86	23.20	19.59	20.29	23.62	24.10	26.62	30.62	47.95	31.27	39.17
RF constituent entity	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**	**2019**	**2020**	**2021**	
RM	55.55	44.47	29.88	35.11	33.60	31.71	30.15	37.15	46.58	45.36	
UR	24.29	21.47	19.90	19.89	16.03	19.59	21.42	24.65	36.57	31.27	
TBT	37.77	40.77	37.27	37.01	31.95	30.92	37.60	45.08	47.33	46.44	
KR	31.94	26.23	35.27	33.17	51.41	60.17	60.04	58.02	57.22	49.23	
Y1: The share of non-repayable receipts in the revenues of the consolidated budget of the constituent entity of the Russian Federation, %											
RF constituent entity	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**
RM	33.91	38.58	30.66	13.11	27.09	35.87	43.49	43.68	57.36	55.73	53.62
UR	12.10	18.30	13.33	10.04	15.79	16.01	19.05	21.81	30.48	26.05	29.64
TBT	47.61	48.65	36.91	36.97	39.21	26.84	41.99	42.00	49.18	40.63	37.16
KR	20.86	23.20	19.59	20.29	23.62	24.10	26.62	30.62	47.95	31.27	39.17
RF constituent entity	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**	**2019**	**2020**	**2021**	
RM	55.55	44.47	29.88	35.11	33.60	31.71	30.15	37.15	46.58	45.36	
UR	24.29	21.47	19.90	19.89	16.03	19.59	21.42	24.65	36.57	31.27	
TBT	37.77	40.77	37.27	37.01	31.95	30.92	37.60	45.08	47.33	46.44	
KR	31.94	26.23	35.27	33.17	51.41	60.17	60.04	58.02	57.22	49.23	
Y2: The share of business taxes in the revenues of the consolidated budget of the constituent entity of the Russian Federation, %											
RF constituent entity	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**
RM	33.91	38.58	30.66	13.11	27.09	35.87	43.49	43.68	57.36	55.73	53.62
UR	12.10	18.30	13.33	10.04	15.79	16.01	19.05	21.81	30.48	26.05	29.64
TBT	47.61	48.65	36.91	36.97	39.21	26.84	41.99	42.00	49.18	40.63	37.16
KR	20.86	23.20	19.59	20.29	23.62	24.10	26.62	30.62	47.95	31.27	39.17
RF constituent entity	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**	**2019**	**2020**	**2021**	
RM	55.55	44.47	29.88	35.11	33.60	31.71	30.15	37.15	46.58	45.36	
UR	24.29	21.47	19.90	19.89	16.03	19.59	21.42	24.65	36.57	31.27	
TBT	37.77	40.77	37.27	37.01	31.95	30.92	37.60	45.08	47.33	46.44	
KR	31.94	26.23	35.27	33.17	51.41	60.17	60.04	58.02	57.22	49.23	

For correlation analysis using the method of calculating cross-wavelet correlations on different time scales, the initial data of the variables {X1}, {Y1}, {Y2} (time series) were previously subjected to a decomposition operation based on the Daubechies' discrete wavelet transform [49] with a decomposition level of up to 4 to test the validity of the developed hypotheses (H1-H3) in this research. Table 2 shows the correspondence between the level (iteration number) of the decomposition and the duration of the time interval.

* RM – the Republic of Mordovia
† UR – the Udmurt Republic
‡ TBT: the Trans-Baikal Territory
§ KR – the Kaliningrad Region

Table 2. Compliance of the iteration index of the time series decomposition with the duration of the time interval [50]

Iteration index (Wavelet Scale)	Time interval
1	1 – 2 years (2^1)
2	2 – 4 years (2^2)
3	4 – 8 years (2^3)
4	8 –16 years (2^4)

3- Results and Discussion

The results of testing the validity of the proposed hypotheses obtained in this research are presented in Table 3 and Figures 2-13, which reflect the numerical assessment results of the cross-wavelet correlation of variables in pairs ({X1}, {Y1}), ({X1}, {Y2}), ({Y1, {Y2}) at different time scales (**1** – from 1 year to 2 years; **2** – from 2 to 4 years; **3** – from 4 to 8years; **4** – from 8 to 16 years) for the constituent entities of the Russian Federation (the Republic of Mordovia, Udmurt Republic, Trans-Baikal Territory, and Kaliningrad Region over the period from 2001 to 2021.

Table 3. Results of verification of the validity of the formulated hypotheses and numerical values of the coefficients of cross-wavelet correlations of the analyzed variables

Validity verification	Wavelet correlation of variables in pairs	Wavelet scale (time interval, years)	Wavelet correlation coefficients			
			RM	UR	TBT	KR
Hypothesis 1	{X1}, {Y1} Negative	**1** (1 – 2 years)	0.709 (No)	0.303 (No)	–0.067 (Yes)	0.633 (No)
		2 (2 – 4 years)	–0.562 (Yes)	–0.868 (Yes)	–0.164 (Yes)	0.338 (No)
		3 (4 – 8 years)	–0.567 (Yes)	–0.182 (Yes)	0.283 (No)	0.880 (No)
		4 (8 – 16 years)	0.104 (No)	–0.347 (Yes)	0.475 (No)	0.941 (No)
Hypothesis 2	{X1}, {Y2} Positive	**1** (1 – 2 years)	–0.633 (No)	–0.002 (No)	0.166 (Yes)	–0.053 (No)
		2 (2 – 4 years)	–0.305 (No)	0.356 (Yes)	0.449 (Yes)	–0.168 (No)
		3 (4 – 8 years)	0.631 (Yes)	–0.716 (No)	0.847 (Yes)	–0.700 (No)
		4 (8 – 16 years)	0.855 (Yes)	–0.956 (No)	0.889 (Yes)	–0.833 (No)
Hypothesis 3	{Y1}, {Y2} Negative	**1** (1 – 2 years)	–0.830 (Yes)	–0.517 (Yes)	–0.867 (Yes)	–0.473 (Yes)
		2 (2 – 4 years)	–0.444 (Yes)	–0.481 (Yes)	–0.855 (Yes)	–0.687 (Yes)
		3 (4 – 8 years)	–0.844 (Yes)	–0.539 (Yes)	–0.101 (Yes)	–0.937 (Yes)
		4 (8 – 16 years)	–0.351 (Yes)	0.143 (No)	0.531 (No)	–0.966 (Yes)

In Figures 2 to 13, the predictive curve (in blue) with the confidence interval ($\pm\sigma$) (in grey) is calculated by the neural network machine learning method. The presence of the predictive curve in Figures 2 to 13 makes it possible to present the correlation relationship more clearly on scales of less than 1 year (Wavelet Scale =0) and more than 16 years (Wavelet Scale =5).

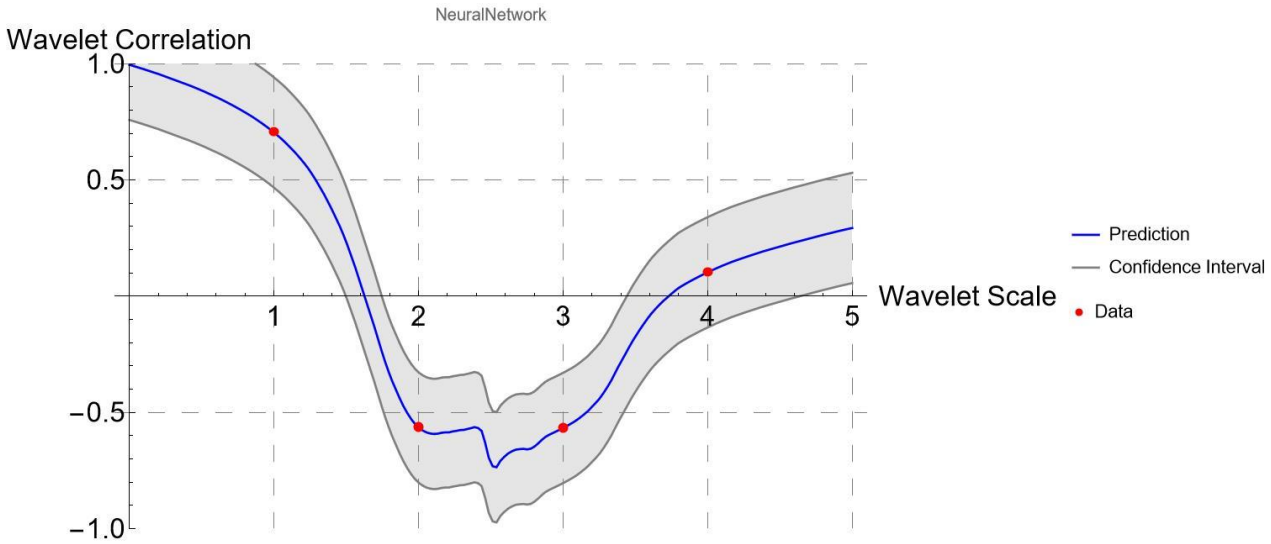

Figure 2. Dynamics of the wavelet correlation coefficient in a pair of variables ({X1m}, {Y1m}) at different time scales (the Republic of Mordovia, 2001-2021)

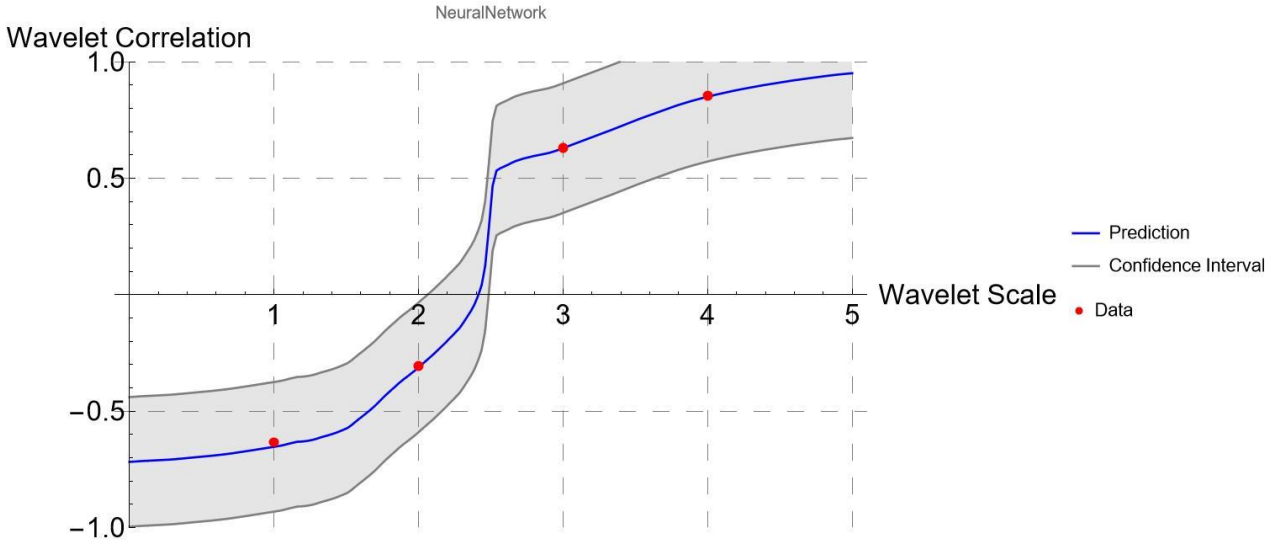

Figure 3. Dynamics of the wavelet correlation coefficient in a pair of variables ({X1m}, {Y2m}) at different time scales (the Republic of Mordovia, 2001-2021)

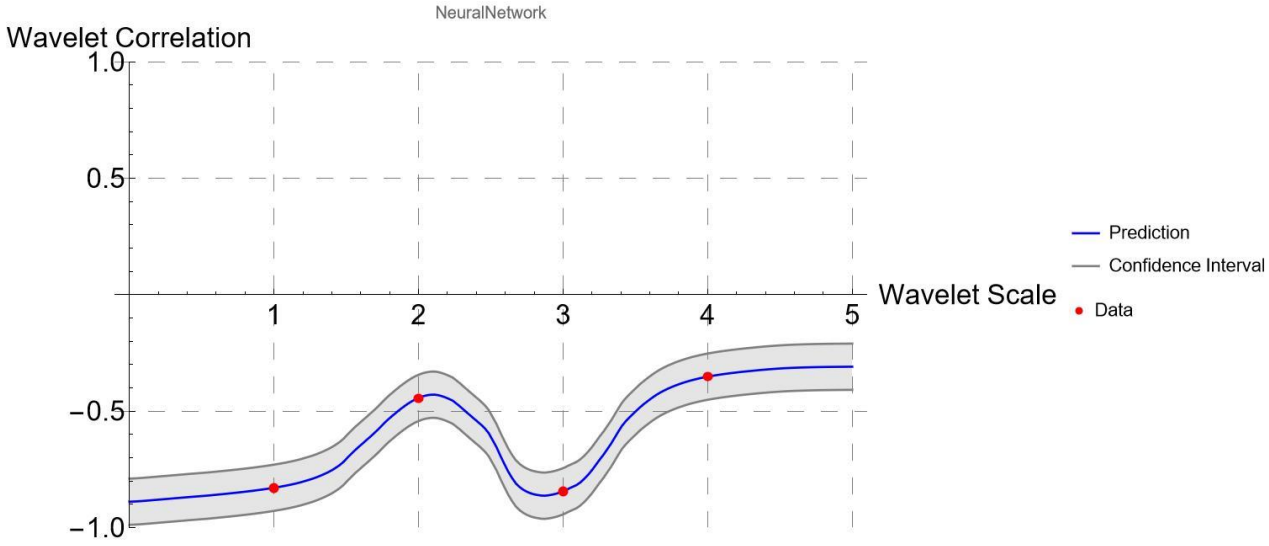

Figure 4. Dynamics of the wavelet correlation coefficient in a pair of variables ({Y1m}, {Y2m}) at different time scales (the Republic of Mordovia, 2001-2021)

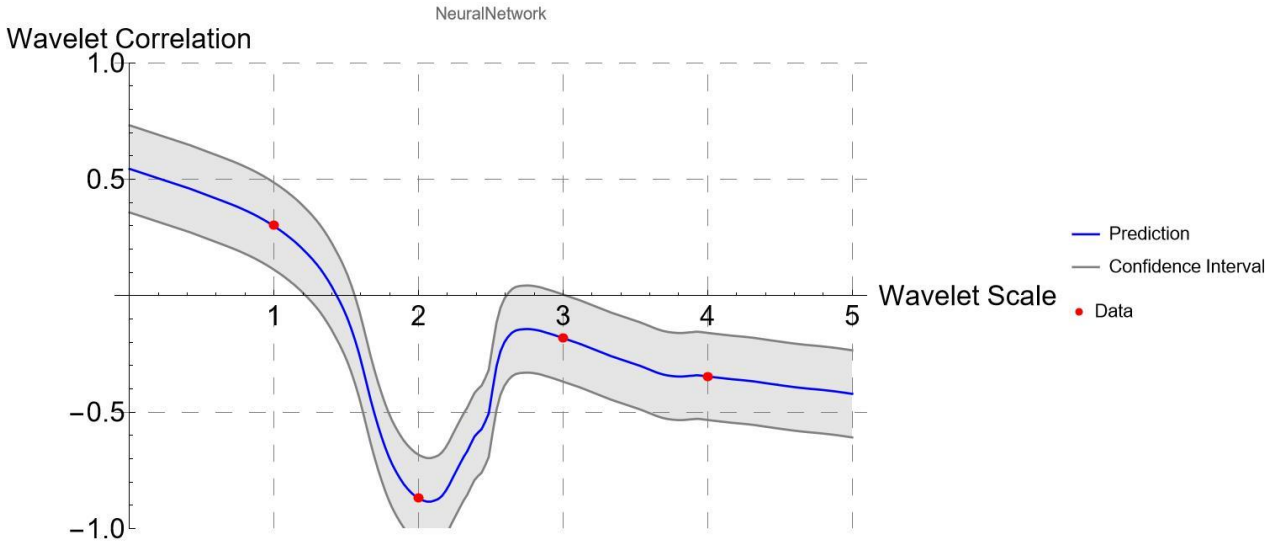

Figure 5. Dynamics of the wavelet correlation coefficient in a pair of variables ({X1u}, {Y1u}) at different time scales (the Udmurt Republic, 2001-2021)

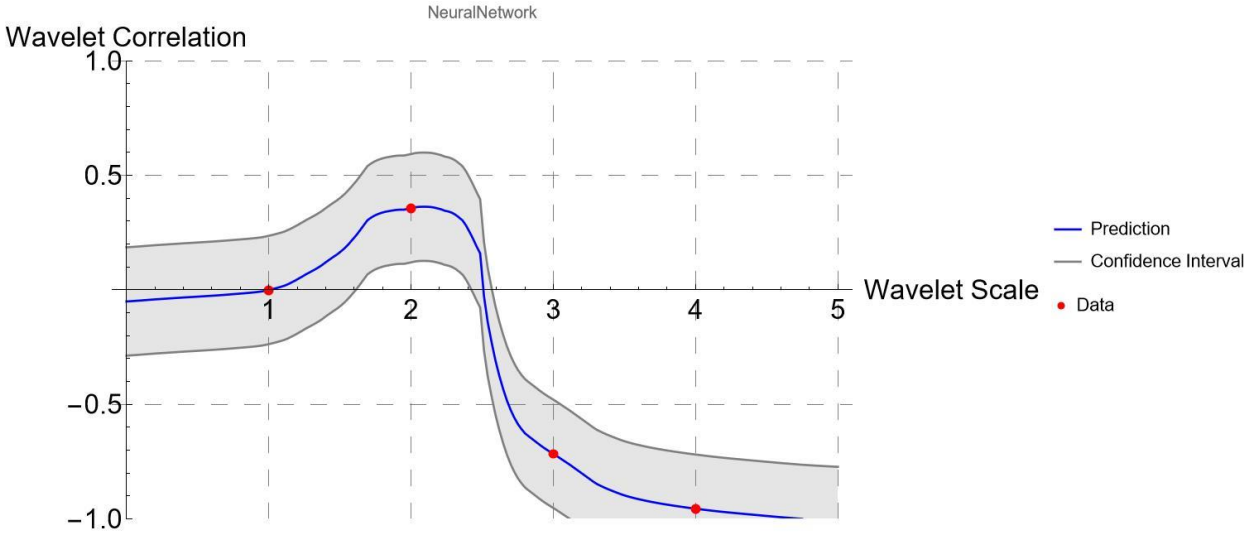

Figure 6. **Dynamics of the wavelet correlation coefficient in a pair of variables ({X1u}, {Y2u}) at different time scales (the Udmurt Republic, 2001-2021)**

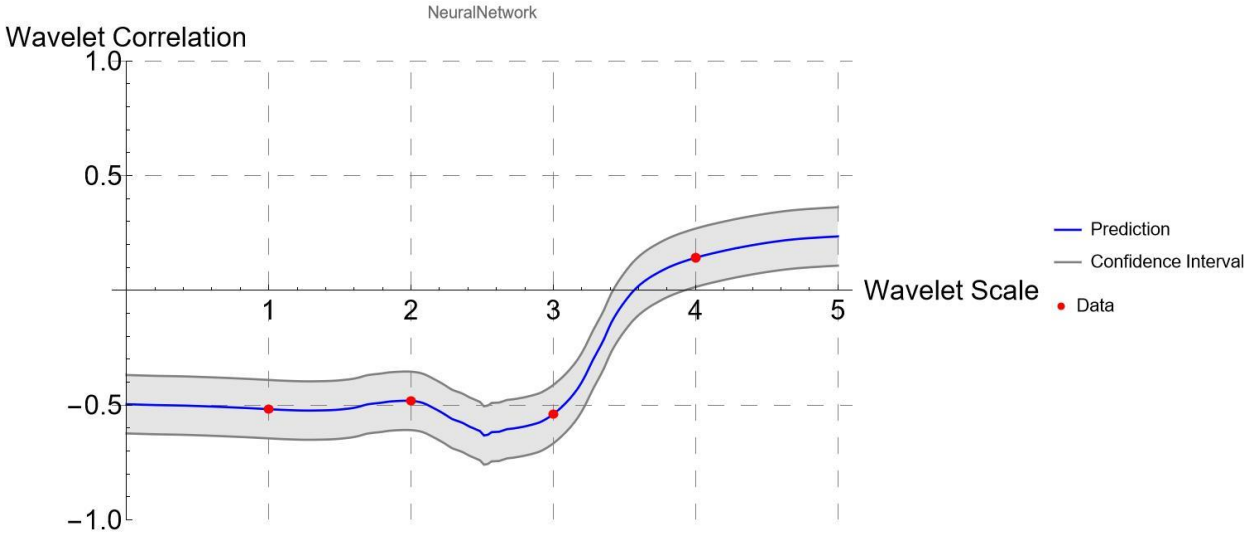

Figure 7. **Dynamics of the wavelet correlation coefficient in a pair of variables ({Y1u}, {Y2u}) at different time scales (the Udmurt Republic, 2001-2021)**

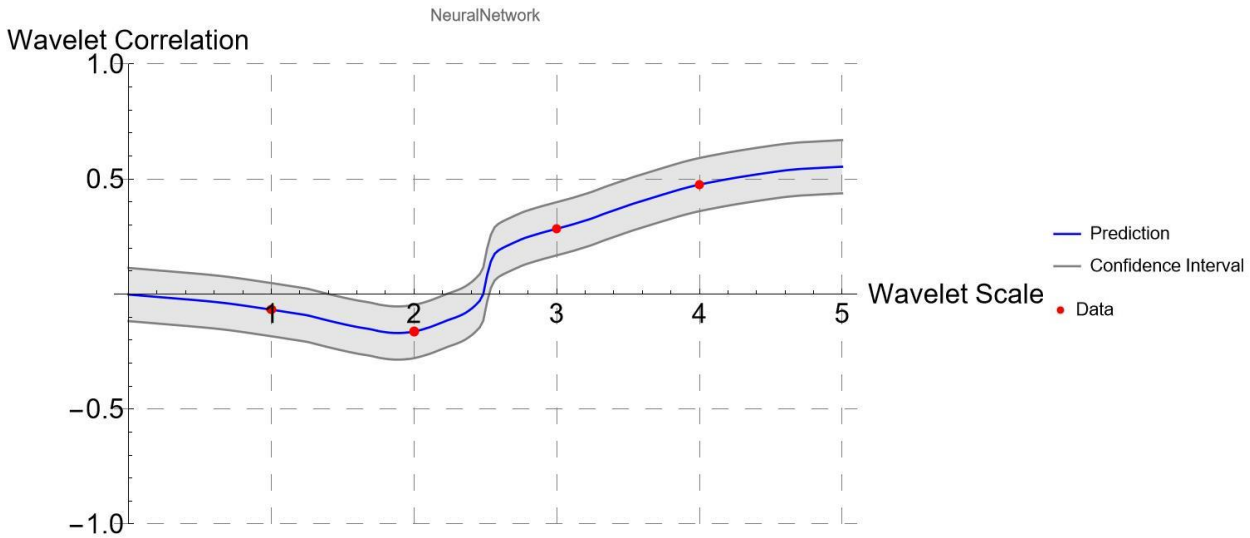

Figure 8. **Dynamics of the wavelet correlation coefficient in a pair of variables ({X1z}, {Y1z}) at different time scales (the Trans-Baikal Territory, 2001-2021)**

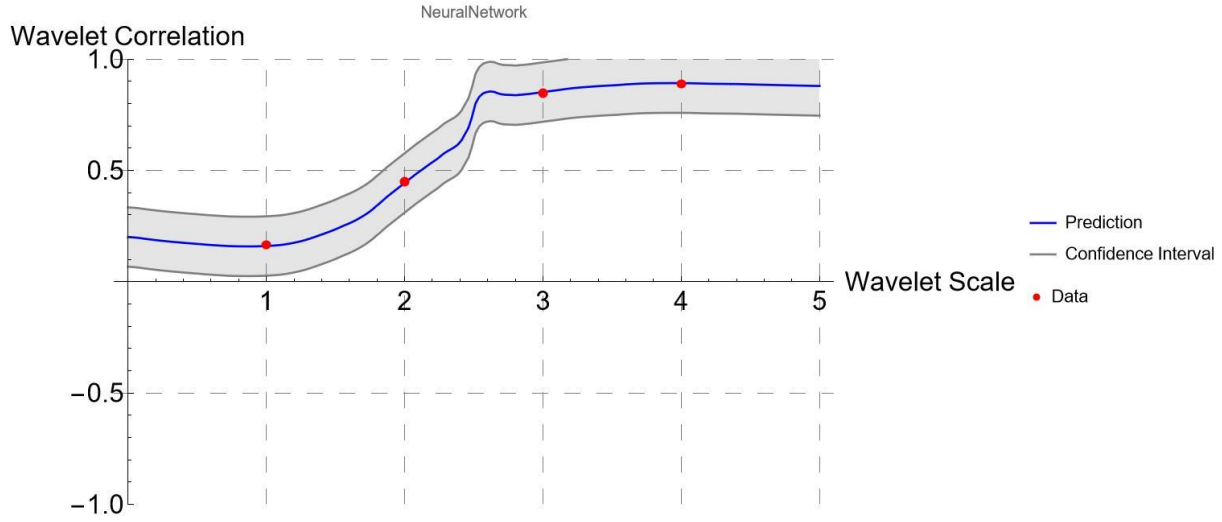

Figure 9. Dynamics of the wavelet correlation coefficient in a pair of variables ({X1z}, {Y2z}) at different time scales (the Trans-Baikal Territory, 2001-2021)

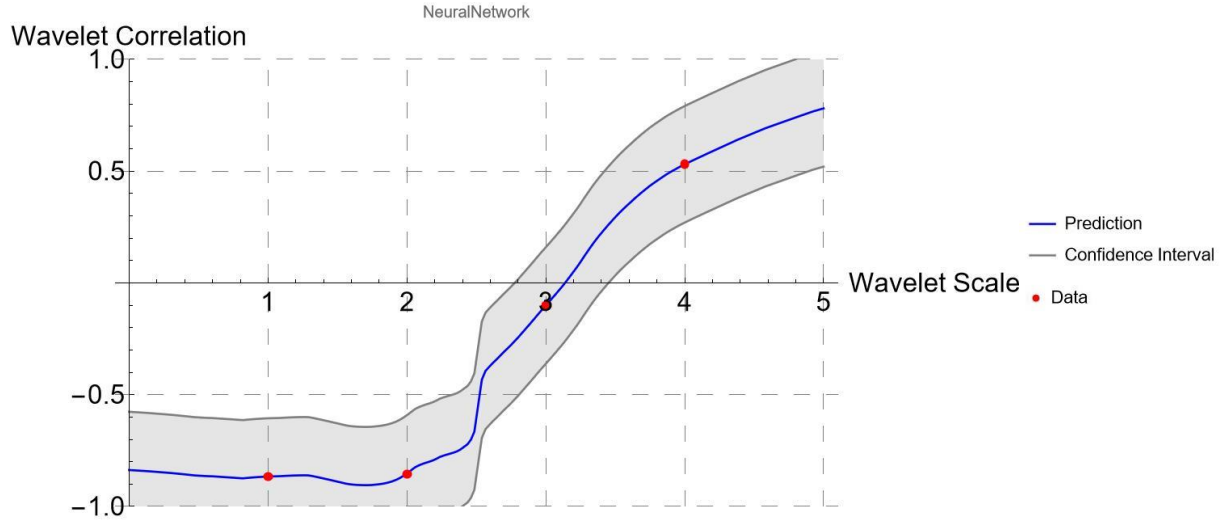

Figure 10. Dynamics of the wavelet correlation coefficient in a pair of variables ({Y1z}, {Y2z}) at different time scales (the Trans-Baikal Territory, 2001-2021)

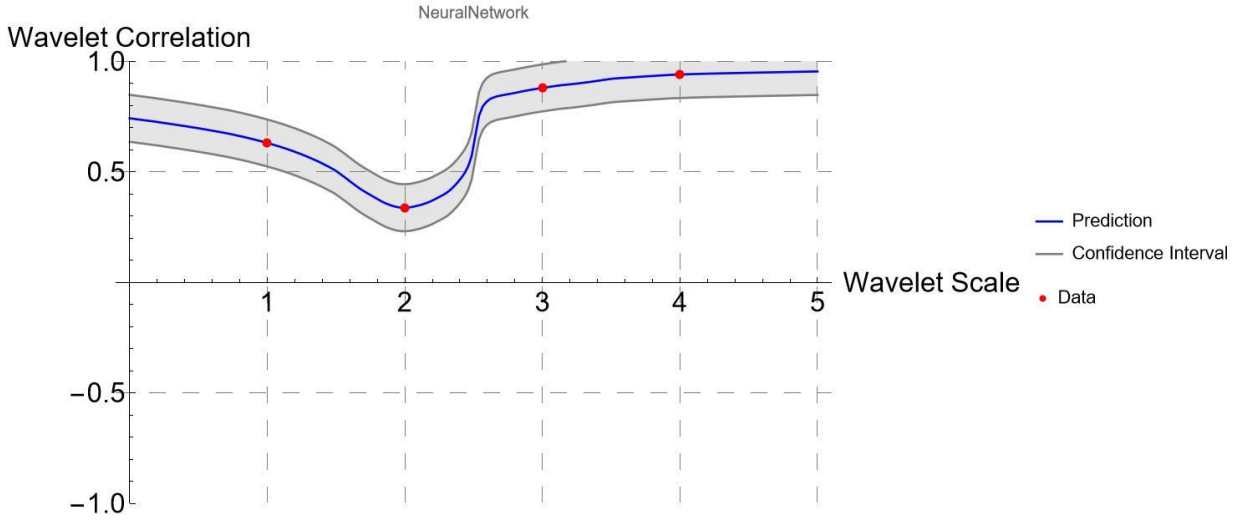

Figure 11. Dynamics of the wavelet correlation coefficient in a pair of variables ({X1k}, {Y1k}) at different time scales (the Kaliningrad Region, 2001-2021)

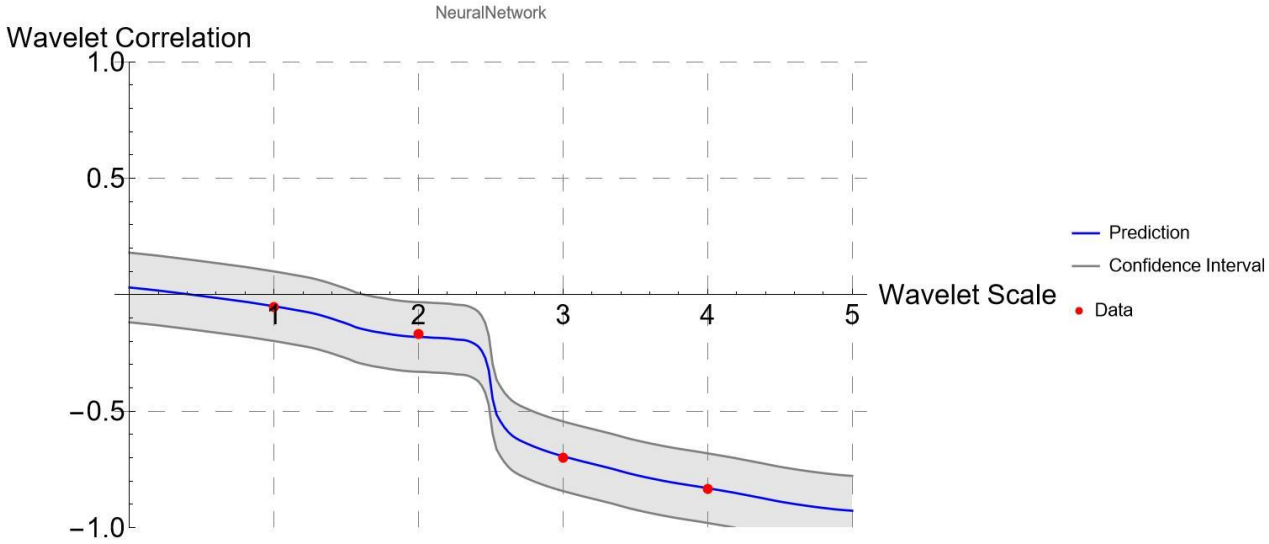

Figure 12. Dynamics of the wavelet correlation coefficient in a pair of variables ({X1k}, {Y2k}) at different time scales (the Kaliningrad Region, 2001-2021)

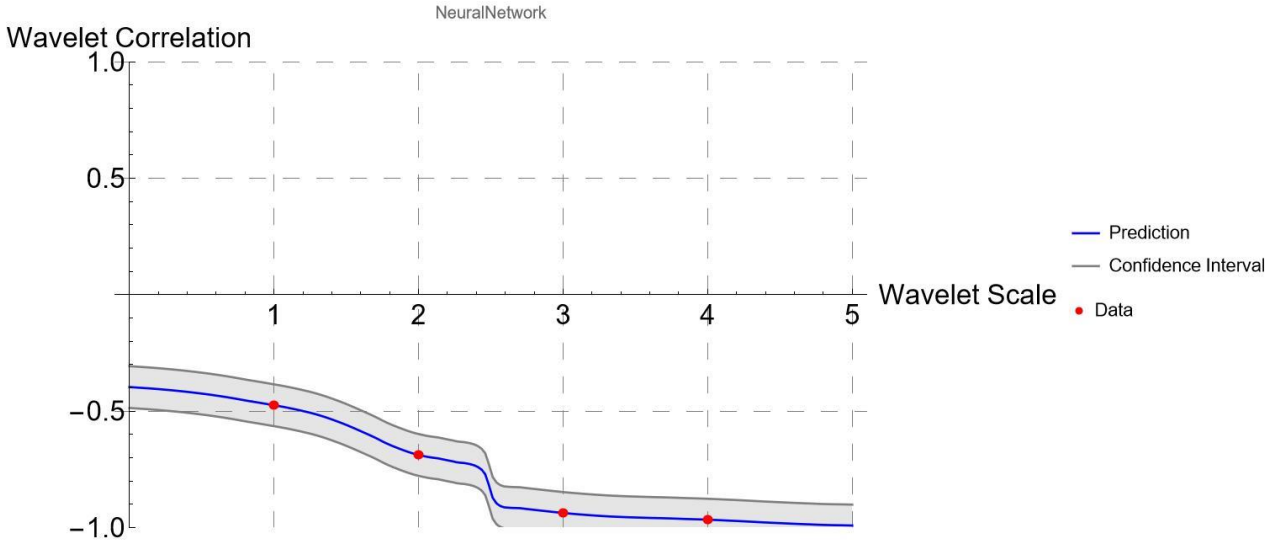

Figure 13. Dynamics of the wavelet correlation coefficient in a pair of variables ({Y1k}, {Y2k}) at different time scales (the Kaliningrad Region, 2001-2021)

In Figures 2 to 13: the vertical axis reflects the numerical values of the correlation of the wavelet coefficients of the analyzed variables, and the horizontal axis characterizes the values of the timescale. Let us consider in more detail the results of testing the validity of the proposed hypotheses for the selected regions.

3-1- The Republic of Mordovia

3-1-1- An Analysis of the Correlation Dependence between the Variables {X1m} and {Y1m}

Figure 2 shows the numerical values of the wavelet correlation coefficient between variables {X1m} and {Y1m} at different time scales.

The analysis of the numerical values of the cross-wavelet correlation coefficient of variables {X1m} and {Y1m} (Figure 2, Table 3) suggests that only at the second- and third-time levels, the correlation of these variables is negative and significant: (–0.562) and (–0.567), respectively. The correlation of variables {X1m} and {Y1m} at the first- and fourth-time scales has positive values: (0.709) and (0.104), respectively.

The result obtained confirms the validity of the H1 hypothesis about the *negative* relationship between the variables {X1m} and {Y1m} only at time scales: **2** – from 2 to 4 years and **3** – from 4 to 8 years.

3-1-2- An Analysis of the Correlation Dependence between Variables {X1m} and {Y2m}

Figure 3 presents the numerical values of the wavelet correlation coefficient between variables {X1m} and {Y2m} at different time scales.

As follows from the analysis of the numerical values of the cross-wavelet correlation coefficient of the variables {X1m} and {Y2m} presented in Figure 3 and Table 3, at the third scale time level, the correlation of these variables is positive and significant (0.631); at the fourth scale time level, their correlation is also positive and even more significant (0.855). The correlations of variables {X1m} and {Y2m} at the first- and second-time scales are negative: (–0.633) and (–0.305), respectively.

The presented result confirms the H2 validity of the *positive* relationship between the variables{X1m} and {Y2m} only at time scales: **3** – from 4 to 8 years; **4** – from 8 to 16 years.

3-1-3- An Analysis of the Correlation Dependence between Variables {Y1m} and {Y2m}

Figure 4 presents the numerical values of the wavelet correlation coefficient between variables {Y1m} and {Y2m} at different time scales.

As follows from the analysis of the numerical values of the cross-wavelet correlation coefficient of variables {Y1m} and {Y2m} (Figure 4, Table 3), the correlation of these variables is negative at all time scales but is most significant at the first- and third-time levels: (–0.830) and (–0.844), respectively. The correlations of variables {Y1m} and {Y2m} at the second- and fourth-time scales are (–0.444) and (–0.351), respectively.

The analysis result confirms the validity of H3 regarding the *negative* relationship between variables {Y1m} and {Y2m} at all time scales: **1** - from 1 year to 2 years; **2** - from 2 to 4 years; **3** - from 4 to 8 years; **4** - from 8 to 16 years.

3-1-4- Conclusion

The results of this study for the Republic of Mordovia confirm the H1-H3 hypotheses only at certain time intervals and indicate:

- *negative* inverse correlation between the share of program costs for developing the real sector in the expenditures of the consolidated budget of the Republic of Mordovia and the share of non-repayable receipts in the revenues of its consolidated budget over time intervals from 2 to 4 years and from 4 to 8 years;
- *positive* inverse correlation between the share of program costs for developing the real sector in the expenditures of the consolidated budget of the Republic of Mordovia and the share of business taxes in the revenues of the consolidated budget of this region on time scales from 4 to 8 years and from 8 to 16 years;
- *negative* inverse correlation between the share of non-repayable receipts in the revenues of the consolidated budget of the Republic of Mordovia and the share of business taxes in the revenues of its consolidated budget at all time intervals.

At the same time, all three dependencies are observed simultaneously only during the third time interval. This indicates that the *greatest* effectiveness of the measures and instruments of budget policy used within the framework of program-target mechanisms to ensure the fiscal balance of the Republic of Mordovia is manifested only in the time interval from 4 to 8 years.

3-2- The Udmurt Republic

3-2-1- An Analysis of the Correlation Dependence between Variables {X1u} and {Y1u}

Figure 5 presents the numerical values of the wavelet correlation coefficient between variables {X1u} and {Y1u} at different time scales.

As follows from the analysis of the numerical values of the cross-wavelet correlation coefficient between correlation variables {X1u} and {Y1u} (Figure 5, Table 3), at the second, third-, and fourth-time levels, the correlation of these variables is negative, but most significant at the second time level. The numerical values of the wavelet correlation coefficient at the indicated levels are: (–0.868), (–0.182), and (–0.347), respectively. The correlation between variables {X1u} and {Y1u} at the first-time level takes a positive value (0.303).

The result obtained confirms the validity of H1 regarding the *negative* relationship between variables {X1u} and {Y1u} only at time scales: **2** – from 2 to 4 years; **3** – from 4 to 8 years; and **4** – from 8 to 16 years.

3-2-2 An Analysis of the Correlation Dependence between Variables {X1u} and {Y2u}

Figure 6 presents the numerical values of the wavelet correlation coefficient between variables {X1u} and {Y2u} at different time scales.

As follows from the analysis of the numerical values of the cross-wavelet correlation coefficient between correlation variables {X1u} and {Y2u} (Figure 6, Table 3), only at the second time level, the correlation of these variables is positive

(0.356). At the first-time level, their correlation is practically absent (–0.002); at the third- and fourth-time levels, the correlations of variables {X1u} and {Y2u} are negative and take the values of (–0.716) and (–0.956), respectively.

The presented result confirms the validity of H2 regarding the *positive* relationship between variables {X1u} and {Y2u} only at the time scale **2** – from 2 to 4 years.

3-2-3 An Analysis of the Correlation Dependence between Variables {Y1u} and {Y2u}

Figure 7 presents the numerical values of the wavelet correlation coefficient between variables {Y1u} and {Y1u} at different time scales.

As follows from the analysis of the numerical values of the cross-wavelet correlation coefficient of the variables {Y1u} and {Y2u} (Figure 7, Table 3) at all time scales, except for the fourth, the correlations of these variables are negative and take the values (–0.517), (– 0.481), (–0.539) at the first-, second-, and third-time scales, respectively. The correlation between variables {Y1u} and {Y2u} at the fourth time level takes a positive value (0.143).

The analysis results confirm the H3 about the *negative* relationship between the variables {Y1u} and {Y2u} only at time scales: **1** – from 1 year to 2 years; **2** – from 2 to 4 years; and **3** – from 4 to 8 years.

3-2-4- Conclusion

The research results for the Udmurt Republic confirm the H1-H3 hypotheses only at certain time intervals and indicate:

- *negative* inverse correlation between the share of program costs for developing the real sector in the expenditures of the consolidated budget of the Udmurt Republic and the share of non-repayable receipts in the revenues of its consolidated budget over time intervals from 2 to 4 years, from 4 to 8 years, and from 8 to 16 years;
- *positive* inverse correlation between the share of program costs for developing the real sector in the expenditures of the consolidated budget of the Udmurt Republic and the share of business taxes in the revenues of this consolidated budget at a time scale from 2 to 4 years;
- *negative* inverse correlation between the share of non-repayable receipts in the revenues of the consolidated budget of the Udmurt Republic and the share of business taxes in the revenues of its consolidated budget at time scales from 1 year to 2 years, from 2 to 4 years, and from 4 to 8 years.

At the same time, all three dependences are observed simultaneously only during a time interval from 2 to 4 years. This result indicates that the *greatest* effectiveness of the measures and instruments of budgetary policy used within the framework of program-target mechanisms to ensure the fiscal balance of the Udmurt Republic is manifested only in the time interval from 2 to 4 years.

3-3- The Trans-Baikal Territory

3-3-1- An Analysis of the Correlation Dependence between Variables {X1z} and {Y1z}

Figure 8 presents the numerical values of the wavelet correlation coefficient between variables {X1z} and {Y1z} at different time scales.

As follows from the analysis of the numerical values of the cross-wavelet correlation coefficient of the variables {X1z} and {Y1z} (Figure 8, Table 3) at the first- and second-time levels, the correlation of these variables is negative, and has the values of (–0.067) and (–0.164), respectively. The correlations of the variables {X1z} and {Y1z} at the third- and fourth-time scales take positive values: (0.283) and (0.475), respectively.

The presented result confirms the validity of the H1 about the *negative* relationship between the variables {X1z} and {Y1z} only at time scales: **1** – from 1 to 2 years; **2** – from 2 to 4 years.

3-3-2- An Analysis of the Correlation Dependence between Variables {X1z} and {Y2z}

Figure 9 presents the numerical values of the wavelet correlation coefficient between variables {X1z} and {Y2z} at different time scales.

As follows from the analysis of the numerical values of the cross-wavelet correlation coefficient of the variables {X1z} and {Y2z} (Figure 9, Table 3), at all-time levels, the correlations of these variables are positive and take the values: (0.166) at the first-time level, (0.449) at the second time scale, (0.847) at the third time scale, and (0.889) at the fourth time level.

The result obtained confirms the validity of H2 regarding the *positive* relationship between the variables {X1z} and {Y2z} at all time scales: **1** – from 1 to 2 years; **2** – from 2 to 4 years.; **3** – from 4 to 8 years; **4** – from 8 to 16 years.

3-3-3- An Analysis of the Correlation Dependence between Variables {Y1z} and {Y2z}

Figure 10 presents the numerical values of the wavelet correlation coefficient between variables {X1u} and {Y2u} at different time scales.

Analysis of the numerical values of the cross-wavelet correlation coefficient of the variables {Y1z} and {Y2z} (Figure 10, Table 3) shows that at all time scales, except for the fourth, the correlations of these variables are negative, having the values: (–0.867), (– 0.855), (–0.101) at the first-, second- and third-time levels, respectively. At the fourth time scale, the correlation of the variables {Y1z} and {Y2z} takes a positive value (0.531).

The analysis results confirm the validity of H3 of the *negative* relationship between the variables {Y1z} and {Y2z} only at time scales: **1** – from 1 year to 2 years; **2** – from 2 to 4 years; and **3** – from 4 to 8 years.

3-3-4-Conclusion

The research results for the Trans-Baikal Territory confirm the H1-H3 hypotheses only at certain time intervals and indicate:

- *negative* inverse correlation between the share of program costs for developing the real sector in the expenditures of the consolidated budget of the Trans-Baikal Territory and the share of non-repayable receipts in the revenues of its consolidated budget over time intervals from 1 to 2 years and from 2 to 4 years;
- *positive* inverse correlation between the share of program costs for developing the real sector in the expenditures of the consolidated budget of the Trans-Baikal Territory and the share of business taxes in the revenues of this consolidated budget at all time scales;
- *negative* inverse correlation between the share of non-repayable receipts in the revenues of the consolidated budget of the Trans-Baikal Territory and the share of business taxes in the revenues of its consolidated budget at time scales from 1 year to 2 years; 2 to 4 years; and 4 to 8 years.

Simultaneously, all three dependencies are observed only during the time scales from 1 to 2 years and from 2 to 4 years. This indicates that the *greatest* effectiveness of the measures and instruments of budgetary policy applied within the framework of program-target mechanisms to ensure the fiscal balance of the Trans-Baikal Territory is manifested only in the time interval from 1 to 4 years.

3-4- The Kaliningrad Region

3-4-1- An Analysis of the Correlation Dependence between Variables {X1k} and {Y1k}

Figure 11 presents the numerical values of the wavelet correlation coefficient between variables {X1k} and {Y1k} at different time scales.

As follows from the analysis of the numerical values of the cross-wavelet correlation coefficient of the variables {Y1k} and {X1k} (Figure 11, Table 3), at all-time levels, the correlations of these variables are positive, while the values of the wavelet correlation coefficient at the first, second, third- and fourth-time scales make (0.633), (0.338), (0.880) and (0.941), respectively.

The result obtained does not confirm the validity of H1 regarding the *negative* relationship between the variables {X1k} and {Y1k} at all time levels: **1** – from 1 year to 2 years; **2** – from 2 to 4 years; **3** – from 4 to 8 years; 4 years; and **4** – from 8 to 16 years.

3-4-2- An Analysis of the Correlation Dependence between Variables {X1k} and {Y2k}

Figure 12 presents the numerical values of the wavelet correlation coefficient between variables {X1k} and {Y2k} at different time scales.

As follows from the analysis of the numerical values of the cross-wavelet correlation coefficient of the variables {X1k} and {Y2k} (Figure 12, Table 3) at all time levels, the correlations of these variables take negative values: (–0.053) at the first-time level, (–0.168) at the second time scale, (–0.700) at the third time scale, and (–0.833) at the fourth time level.

The presented result does not confirm the truth of H2 about the *positive* relationship between the variables {X1k} and {Y2k} at all time scales: **1** – from 1 year to 2 years; **2** – from 2 to 4 years; **3** – from 4 to 8 years; and **4** – from 8 to 16 years.

3-4-3- An Analysis of the Correlation Dependence between Variables {Y1k} and {Y2k}

Figure 13 presents the numerical values of the wavelet correlation coefficient between variables {Y1k} and {Y2k} at different time scales.

As follows from the analysis of the numerical values of the cross-wavelet correlation coefficient of the variables {Y1k} and {Y2k} (Figure 13, Table 3), at all-time scales, the correlations of these variables are negative, taking the values: (–0.473), (–0.687), (–0.937), (–0.966) at the first, second, third-, and fourth-time scales, respectively.

The analysis results confirm the validity of H3 regarding the *negative* relationship between the variables {Y1k} and {Y2k} at all time scales: **1** – from 1 year to 2 years; **2** – from 2 to 4 years; **3** – from 4 to 8 years;4 years; and **4** – from 8 to 16 years.

3-4-4- Conclusion

The research results for the Kaliningrad Region do not confirm the validity of hypotheses H1 and H2 at all time intervals concerning the presence of:

- *negative* inverse correlation between the share of program costs for developing the real sector in the expenditures of the consolidated budget of the Kaliningrad Region and the share of non-repayable receipts in the revenues of its consolidated budget;
- *positive* inverse correlation between the share of program costs for developing the real sector in the expenditures of the consolidated budget of the Kaliningrad Region and the share of business taxes in the revenues of the consolidated budget of this region.

The results of the analysis only confirm the validity of H3 regarding the presence of a *negative* inverse correlation between the share of non-repayable receipts in the revenues of the consolidated budget of the Kaliningrad Region and the share of business taxes in the revenues of its consolidated budget at all scale levels.

Thus, as applicable to the Kaliningrad Region, there is no time period in which all three considered correlations would be observed, which indicates the ineffectiveness of the measures and budgetary policy instruments used within the framework of program-target mechanisms to ensure the fiscal balance of the Kaliningrad Region.

The research results for constituent entities of the Russian Federation such as the Republic of Mordovia, the Udmurt Republic, and the Trans-Baikal Territory show that the ratio of spending on the development of the real sector of the economy and other expenses (for example, social), implemented within the framework of state programs is one of the most important factors influencing fiscal balancing. A similar result was obtained in Grebennikov & Magomedov, (2019) [32] for the constituent entities of the North Caucasian Federal District: Stavropol Territory and the Republic of North Ossetia-Alania.

The research found that the program structure of the Kaliningrad Region, same as the program structure of the Republics of Dagestan and Ingushetia [32], with the prevalence of spending on social activities plays the role of a kind of “budget deficit trap”, making it impossible to solve the problem of the region reaching a sustainable trajectory of socioeconomic development without regular non-repayable receipts from the federal budget.

4- Conclusions

The research results indicate a significant impact of program costs of the regions’ consolidated budgets associated with the development of the real sector to ensure fiscal balancing of the Republic of Mordovia, the Udmurt Republic, and the Trans-Baikal Territory considering the time-frequency nature of the impact. It was established that the highest efficiency of fiscal policy measures and tools applied in the framework of program-targeted mechanisms to balance the budgets of these regions is revealed: for the Republic of Mordovia – on the time scale of 4 to 8 years; for the Udmurt Republic – on the time scale of 2 to 4 years; and for the Trans-Baikal Territory – on the time scale of 1 to 4 years.

At the same time, as follows from the research results, it is rather problematic to solve the problem of balancing the regional budget at the expense of program costs for real sector development for the Kaliningrad region, since the predominance of expenditures on social activities makes it impossible to solve the problem of the region achieving a sustainable trajectory of socio-economic development without regular budget revenues from the higher budget. The elimination of this problem could contribute to improving the efficiency of joint work of federal and regional executive authorities aimed at improving the quality of territorial development in Russia.

The novelty and theoretical significance of this research lies in demonstrating the effectiveness of applying wavelet analysis in correlation analysis in cases where the relationships between the analyzed variables follow different patterns on different time horizons, and precisely the wavelet analysis reveals the most significant characteristics of the relationships of variables. Earlier studies based on traditional methods, ignore the time-frequency dependence between the variables of the empirical model.

The practical significance of the research results lies in the fact that they make it possible to determine the time scale providing the most effective measures and instruments of budgetary policy, applied within the framework of program-target mechanisms to ensure the fiscal balances of the regions.

4-1- Limitations and Study Forward

Despite the significant results obtained, some limitations of the study should be noted in addition to its important conclusions.

First of all, they concern the short depth of the analyzed time series (from 2001 to 2021) – there are four wavelet scales in total: **1** – from 1 to 2 years; **2** – from 2 to 4 years; **3** – from 4 to 8 years; and **4** – from 8 to 16 years.

In addition, in this study, at the stage of time series decomposition, the mother wavelet functions of the Daubechies family were used. In future studies, it is planned to expand the range of mother wavelet functions from other families, which can further improve the accuracy of the analysis results.

5- Declarations

5-1- Author Contributions

Conceptualization, A.K.K. and V.V.P.; methodology, A.K.K. and V.V.P.; software, A.I.M.; validation, V.V.P.; formal analysis, O.S.G. and M.L.V.; investigation, O.S.G., M.L.S., and M.L.V.; resources, M.L.S.; data curation, V.V.P.; writing—original draft preparation, O.S.G., A.I.M., and M.L.V.; writing—review and editing, A.K.K. and V.V.P.; visualization, A.I.M.; supervision, A.K.K. and V.V.P.; project administration, V.V.P.; funding acquisition, V.V.P. All authors have read and agreed to the published version of the manuscript.

5-2- Data Availability Statement

The data presented in this study are available in the article.

5-3- Funding

The article was prepared on the basis of the research results conducted at the expense of budgetary funds under the state assignment of the Financial University under the Government of the Russian Federation.

5-4- Institutional Review Board Statement

Not applicable.

5-5- Informed Consent Statement

Not applicable.

5-6- Conflicts of Interest

The authors declare that there is no conflict of interest regarding the publication of this manuscript. In addition, the ethical issues, including plagiarism, informed consent, misconduct, data fabrication and/or falsification, double publication and/or submission, and redundancies have been completely observed by the authors.

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