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Study of the Effectiveness of the Russian Regions Forestry Activities

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Abstract. The main purpose of the contribution is to study the effectiveness of forestry activities in the regions of Russia and develop measures to improve it. As a part of the implementation of this goal, the following tasks have been solved: assessment of the current efficiency of forestry activities in the regions of Russia by clustering, identification of factors affecting this indicator and the development of measures to improve it. The main research methods are cluster and factor analysis, literature analysis. As a result of the conducted research, clustering of data by regions in the field of the forest industry is carried out. Four clusters have been identified, differing in the values of the seven analyzed parameters. The ranges of variability, averages and deviations for these indicators are determined. Profitability is singled out as a key indicator of the efficiency of the forest industry in terms of resource provision. As a result of identifying significant deviations from the average values for clusters, the most successful regions are defined. According to the results of the study, indicators have been singled out whose deviations from the average values for clusters affect the final efficiency. For such indicators, using the Ishikawa diagram, the factors affecting the profitability of the forest industry in terms of resource provision are determined. In order to increase the efficiency of the industry and based on the results of the research, comprehensive measures are proposed, the implementation of which should be a priority in this subject area.

Keywords: forest industry, forestry, profitability, effectiveness, sustainable development, clustering, factor analysis.

Research area: Social Structure, Social Institutions and Processes; Economics.

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Исследование эффективности лесохозяйственной деятельности регионов России

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Аннотация. Основная цель работы – исследование эффективности лесохозяйственной деятельности регионов России и разработка мероприятий по ее повышению. В рамках реализации данной цели решались следующие задачи: оценка текущей эффективности лесохозяйственной деятельности по регионам России методом кластеризации, определение факторов, влияющих на данный показатель, и разработка мероприятий по его повышению. Основные методы исследования – кластерный и факторный анализ, анализ литературы. В результате исследования проведена кластеризация данных по регионам в сфере лесной отрасли. Выделены четыре кластера, отличающихся по значениям семи анализируемых параметров. Определены диапазоны изменчивости, средние и отклонения для данных показателей. В качестве ключевого показателя эффективности лесной отрасли в части ресурсного обеспечения выделена рентабельность. В результате выявления существенных отклонений от средних значений по кластерам определены наиболее успешные регионы. По результатам исследования выявлены показатели, отклонения которых от средних значений по кластерам сказываются на итоговой эффективности. Для таких показателей с использованием диаграммы Исикавы определены факторы, влияющие на рентабельность лесной отрасли в части ресурсного обеспечения. В целях повышения эффективности отрасли и, опираясь на результаты проведенного исследования, предложены комплексные мероприятия, реализация которых должна быть первоочередной в данной предметной области.

Ключевые слова: лесная отрасль, лесохозяйственная деятельность, рентабельность, эффективность, устойчивое развитие, кластеризация, факторный анализ.

Научная специальность: 5.4.4. Социальная структура, социальные институты и процессы (социологические науки); 5.2.3. Региональная и отраслевая экономика.

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Introduction

The modern forestry industry in the world practice is based on the use of wood raw materials with the use of advanced technologies and business principles. The dominant trends are orientation towards sustainable development, deep processing, circular economy, maximum use of all wood raw materials, etc. Many studies by both Russian and foreign authors have been devoted to the problems of the development of the forest industry (Buongiorno, 2014, Eikeland, 2004, McEwan, 2020, Pyzhev, 2022, Rivière, 2020). At the same time, the research touches on a wide variety of aspects: technology, management practices, ecology, equipment, logistics and much more. On many issues, domestic scientists are close to their foreign colleagues. The main task of most studies is directly or indirectly related to improving the efficiency of the industry or its individual aspects. This task is really relevant and is universally recognized as the most important (Barua, 2014, Brown, 2010, Korhonen, 2014).

It is interesting that in the Russian literature and practice there was a separation of two aspects related to forest resources: logging and reforestation (Romanov, 2003, Sosnin, 2018, Starikov, 2014). The first is attributed to industry and the area of responsibility of business, the second is ecology and/or forestry, for which the state is primarily responsible. At the same time, both in world science and in domestic science, until recently, such a division was considered incorrect. Given the emphasis in the global economy on sustainable development, such an approach is completely inappropriate. The use and restoration of forest resources is a single ongoing process involving many elements and institutions (Pokonov, 2017, Shirnin, 1991). In general, it can be called forestry activity (Khuazhev, 2016).

The use of forest resources (wood and its reforestation) occurs almost throughout Russia. The regions of the country differ both in volume and in the specifics of forestry activities. The effectiveness of this activity is also different. The domestic forest industry is inferior to the world leader in this indicator (Medvedev, 2022, Zykov, 2022). However, there are significant regional differences. According to the au-

thor's opinion, the regions of the country can be grouped according to individual indicators characterizing forestry activities. Based on the grouping, key factors affecting the effectiveness of the object under study can be identified. The results of the factor analysis should be measures aimed at improving the efficiency of forestry activities. The formation of this hypothesis determined the following goal of this work – the study of the effectiveness of forestry activities in the regions of Russia and the development of measures to improve it.

Methods

Data Mining techniques are used in the work. According to classical definitions, it is a technology of research and detection by means of artificial intelligence in the aggregate of disparate data of hidden information that can be used for various purposes (Andrushchak, 2019, Ruß, 2013). The clustering method was used directly in the study, which identifies similar objects among the data array.

The data set consisted of 197 observations. This is information about a number of indicators of forestry activity in the regions for the period from 2012 to 2021. The sample volume was determined based on the availability of the entire set of data on the studied parameters. An important criterion was the fullness of the database. In the absence of at least one of the studied parameters, the observation was excluded from the sample. The following indicators characterizing the activity of the forest industry in terms of logging were used for the study:

1. Net profit (loss) of large and medium-sized enterprises (from 15 personnel), million rubles (hereinafter, for simplification, the term “net profit” will be used). The use of data only for large and medium-sized enterprises is due to certain negative trends in the activities of small businesses, as well as their insignificant role in environmental issues.

2. Revenue (net) from the sale of goods, products, operations, services (minus value added tax, excise taxes and other similar mandatory payments) million rubles (hereinafter referred to as revenue) by the type of “logging” economic activity.

3. The volume of harvested wood, thousand m³ (hereinafter – the volume of logging).

4. The cost of goods sold, products, operations, services, million rubles by the type of “logging” economic activity (hereinafter – the cost).

5. The average monthly nominal accrued salary per one employee, roubles by the type of “logging” economic activity (hereinafter – the average salary).

6. Reforestation area, ha.

7. The level of profitability (unprofitability) of goods, products, operations, services sold, % (hereinafter referred to as profitability).

The information content of the database was carried out using official statistical information contained in the Unified Interdepartmental Information and Statistical System (EMISS).

Table 1 shows a fragment of the database:

As a result of filling the database, each observation is characterized by seven indicators for a separate region. At the same time, taking into account the wide time interval in the study (2012–2021), the regions meet several times.

The clustering method used makes it possible to better understand the nature of the analyzed data, while differentiating by several parameters. The K-means clustering algorithm was used in the work. Its features are described

in some detail in various literary sources (Shaposhnikova, 2017).

To process the data in terms of determining the factors influencing the indicators and the object of research, the analysis of scientific literature, factor analysis, as well as the compilation of the Ishikawa diagram were used.

Data processing was carried out using Microsoft Office and Statistica software products.

Results and discussion

As a result of the preliminary analysis, the main descriptive statistics of the database were formed (Table 2).

The data presented in the Table differ significantly in standard deviation, that is, they have different variability. For clustering purposes, it is extremely important to achieve a single value of this parameter. Using the standardization of the Statistica software package, the data are brought to uniformity. Next, clustering was performed by the K-means algorithm.

Four clusters were obtained (Table 3). Based on the analysis, a cluster with the most negative trends was identified – Cluster 3. The largest losses and negative profitability are observed here.

However, at the same time, there are large volumes of logging, with low (for example, in

Table 1. Database for the study

Region	Net profit, mln roubles	Revenue, mln roubles	Volume of harvested wood, thousand m ³	Cost, mln roubles	Average salary, roubles	Reforestation area, ha	Profitability, %
Vladimirskaya oblast	1.84	496.56	2160.20	305.08	11747.10	6036.0	0.92
Kaluzhskaya oblast	-0.01	26.70	1036.30	25.93	14587.40	2458.0	2.97
Kostromskaya oblast	-229.50	581.52	3923.12	711.58	12674.80	11752.0	-24.77
Tverskaya oblast	15.87	379.12	3357.77	262.67	12992.90	11700.0	15.74
Yaroslavl'skaya oblast	0.22	108.93	1195.84	69.23	11836.90	3388.0	2.06
Kareliya Republic	-779.80	4563.06	5411.97	3904.60	25527.20	18964.0	-1.23
Komi Republic	-318.08	2540.13	7426.63	2440.89	19994.80	40374.0	-9.33
Arhangelskaya oblast	-326.15	5314.10	11428.21	4540.87	19340.30	48546.0	-8.10
Vologodskaya oblast	-308.64	3545.02	12916.12	2659.99	16549.50	43250.0	-3.47
Leningradskaya oblast	-73.08	3272.71	7681.90	2880.69	13222.20	16546.0	-0.19
Novgorodskaya oblast	-24.62	225.48	3516.00	207.93	12804.20	10809.0	0.12

* Source: calculated according to Unified Interdepartmental Information and Statistical System (EMISS) [electronic resource]. URL: <https://www.fedstat.ru>

Table 2. Basic descriptive statistics

Variable	Number of observations	Mean	Minimum	Maximum	Standard deviation
Net profit, mln roubles	197	-75.63	-3523.49	3552.1	814.94
Revenue, mln roubles	197	2333.61	1.68	26851.7	3807.31
Volume of harvested wood, thousand m3	197	7550.23	210.80	35668.8	7727.20
Cost, mln roubles	197	2902.18	2.69	21037.6	4239.74
Average salary, roubles	197	24997.37	7699.30	68641.2	12958.23
Reforestation area, ha	197	31658.19	0.00	157247.4	31438.85
Profitability, %	197	3.18	-50.66	40.9	13.79

* Source: calculated by the authors

Table 3. Means in each cluster

Cluster	Region	Net profit, mln roubles	Revenue mln roubles	Volume of harvested wood, thousand m3	Cost, mln roubles	Average salary, roubles	Reforestation area, ha	Profitability, %	Number of observations	Observation percentage
1	Altajskiy Krai	1.877	589.527	3045.28	535.017	17263.77	11355.22	6.6513	87	44.16
2	Kareliya Pepublic	320.934	4118.566	5741.93	5034.651	35706.07	20170.58	9.7994	32	16.24
3	Permskiy Kray	-352.819	1303.692	7621.11	1289.526	18156.16	34563.52	-14.3027	37	18.78
4	Vologodskaya oblast	-299.48	5570.78	18456.88	7716.134	39223.44	81084.17	6.4383	41	20.81

* Source: calculated by the authors

comparison with Cluster 2) revenue. The most “successful” association of regions is Cluster 2. Here there is the greatest profitability, net profit. At the same time, the average revenue and salaries are high.

Next, an analysis was carried out to determine the significant factors. So, Fig. 1 shows a graph of continuous variables by clusters.

Based on the analysis of variance, it is clearly seen that all variables have an impact on the region’s belonging to the cluster. This becomes obvious due to the fact that the p-level for all parameters is below 0.05. Thus, all indicators are significant.

Further, the study analyzes categorical variables. So, Fig. 2 shows a graph of the frequencies of inclusion of individual regions in clusters.

The change in indicators for the studied clusters looks extremely interesting. Fig. 3

shows the boxplot diagrams for such indicators as net profit, volume of harvested woods, revenue and profitability.

Another important component of the study is the change in indicators, in particular profitability, depending on the volume of harvested wood in the region. The results of the analysis are shown in Fig. 4.

Clearly, the distribution of profitability depending on the volume of harvested wood, taking into account the distribution by clusters, can be seen in Fig. 5. It can be seen that the accepted profitability values largely have a fairly clear concentration in a certain area.

The next stage of the work was the study of the indicators of the regions that significantly deviate from the average values in the clusters of their presence. The procedure is as follows:

1. Data structuring for each region and finding of the average values of the studied in-

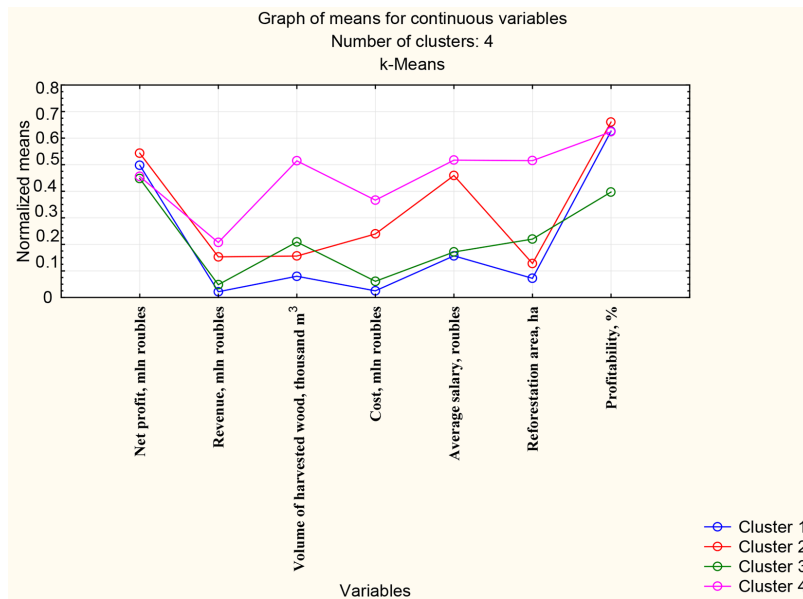


Fig. 1. Graph of normalized means of variables by clusters

Source: calculated by the authors

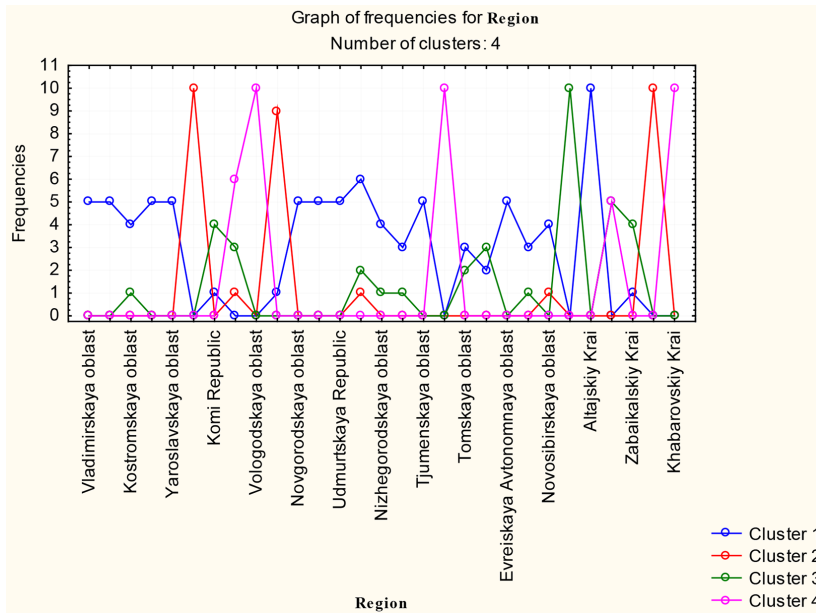


Fig. 2. A graph of frequencies for the regions

Source: calculated by the authors

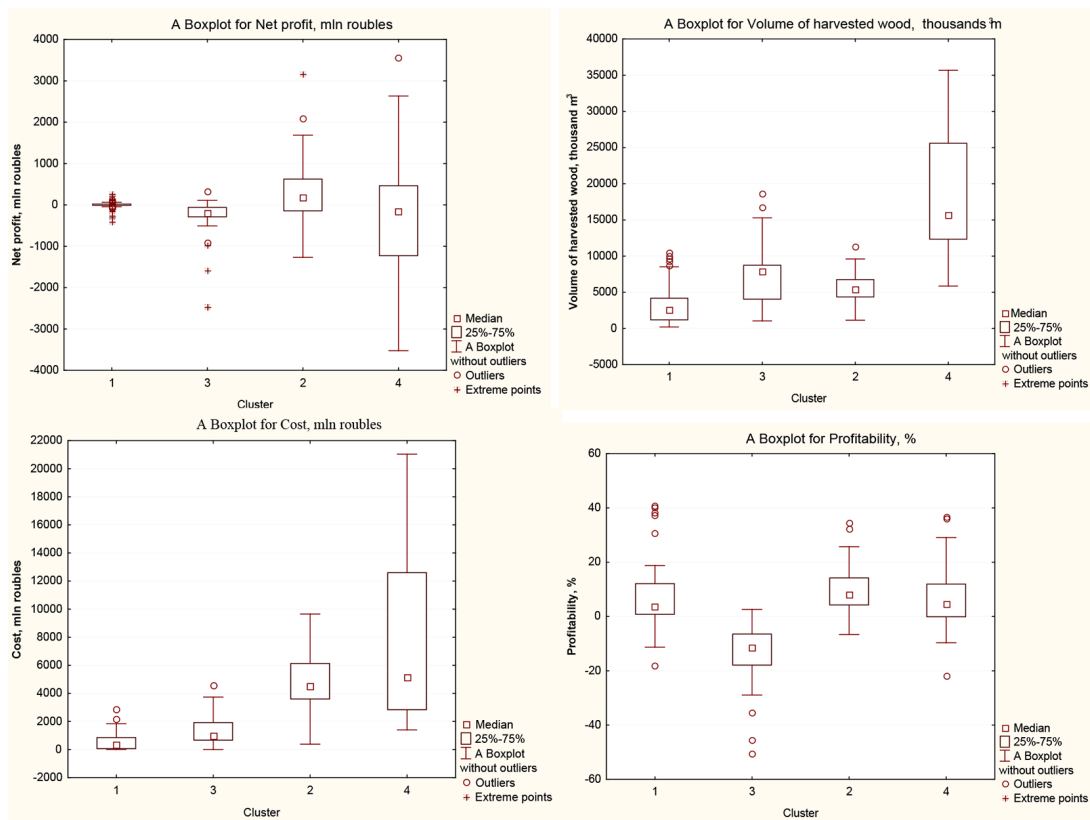


Fig. 3. Boxplot diagrams for the indicators “Net profit”, “Volume of harvested wood”, “Revenue” and “Profitability”

Source: calculated by the authors

dicators of each region in each of the clusters in where it is located. An example of the data obtained is presented in Table 4. It should be noted that some regions are included in only one cluster, some – in two or three.

2. Comparison of the average values of regional indicators with the average values for clusters. At the same time, in order to identify the leading regions and regions significantly inferior to the average values, cases of deviation of the average values of regions from the average values of clusters by more than 50 % were identified. An example of the results obtained is presented in Table 5.

The symbol “↑” means the excess of the regional average for the cluster by more than 50 %. The symbol “↓” is a deviation in the smaller direction by more than 50 %. An empty cell means that the regional indicator is with-

in the boundaries of the average values for the cluster ($\pm 50\%$).

3. Evaluation of the interrelationships between the indicator of the effectiveness of forestry activities in the regions (profitability) and other criteria under study.

According to the results of the analysis, it was revealed that the resulting efficiency indicator is largely influenced by a number of factors. In particular, regions with significantly different profitability from the cluster averages (50 % or more) are affected by the following factors: net profit, volume of harvested wood and reforestation area. The following dependence can be traced: if these indicators exceed the cluster average by more than 50 % in the region, the profitability of logging will also be higher by 50 % or more. The opposite is also true: with the values of these indicators at 50 %

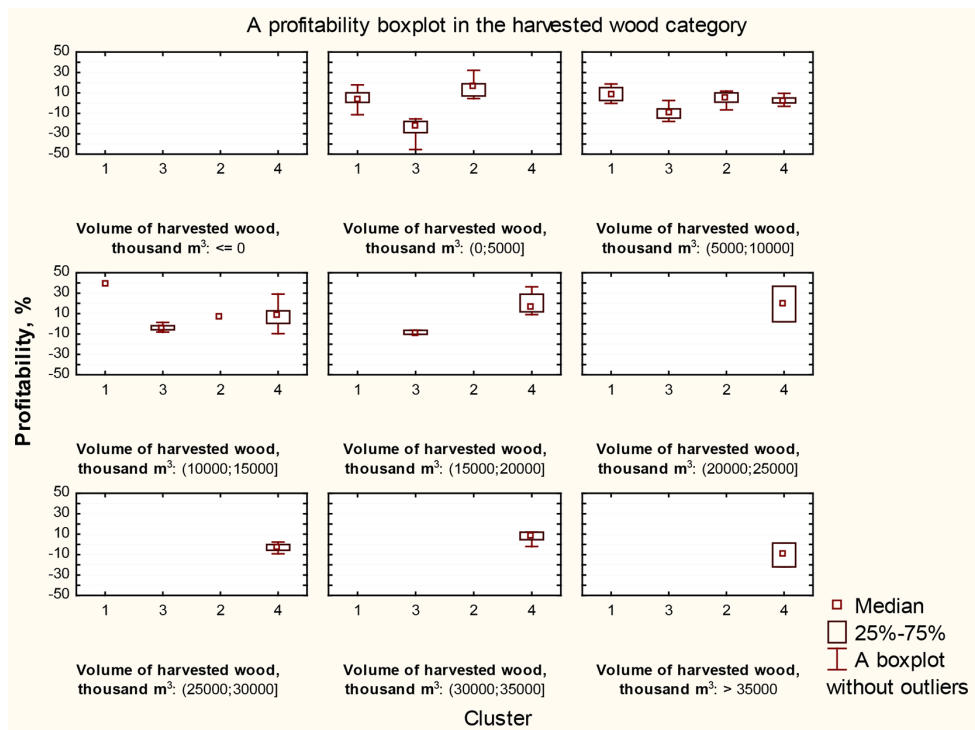


Fig. 4. A profitability boxplot depending on the volume of harvested wood

Source: calculated by the authors

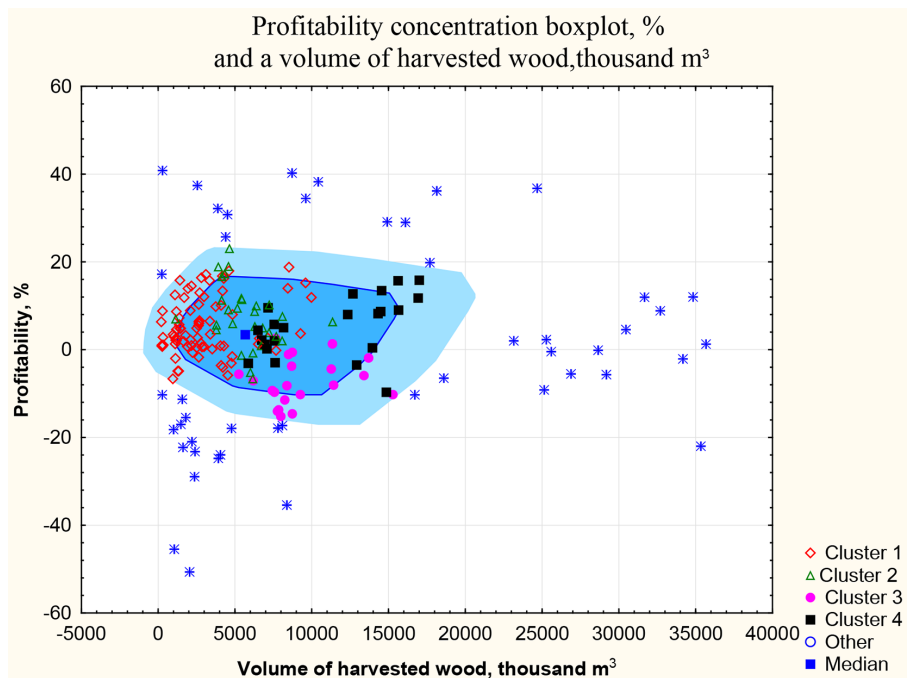


Fig. 5. Profitability concentration boxplot depending on the volume of harvested wood

Source: calculated by the authors

Table 4. Determination of the average values of the studied indicators of the regions in each of the clusters of their presence

Cluster	Region	Net profit, mln roubles	Revenue, mln roubles	Volume of harvested wood, thousand m ³	Cost, mln roubles	Average salary, roubles	Reforestation area, ha	Profitability, %
1	Altajskiy Krai	118.76	1501.29	2981.96	1275.23	13549.80	13699.0	12.09
1	Altajskiy Krai	17.10	370.11	2543.79	256.33	13444.80	13160.0	37.41
1	Altajskiy Krai	15.47	968.24	2512.88	813.82	13986.70	14074.6	4.91
1	Altajskiy Krai	-20.40	923.67	2501.48	802.00	15581.50	13530.9	0.49
1	Altajskiy Krai	13.22	1120.72	2639.99	895.76	16442.50	11856.0	6.37
1	Altajskiy Krai	108.23	175.32	2712.97	895.99	18367.10	11113.8	13.00
1	Altajskiy Krai	125.10	250.58	2811.60	863.31	21689.00	11646.6	16.38
1	Altajskiy Krai	72.65	331.45	2664.25	1270.06	23060.10	7980.9	5.97
1	Altajskiy Krai	63.85	274.06	2635.71	1136.61	25211.50	7733.3	5.51
1	Altajskiy Krai	131.36	417.29	2691.11	1509.59	29450.00	7993.6	6.60
1	Altajskiy Krai	64.53	633.27	2669.57	971.87	19078.30	11278.86	10.87
3	Amurskaya oblast	109.31	977.98	1804.08	668.44	19726.60	33646.0	-15.47
1	Amurskaya oblast	108.78	809.77	1469.01	374.46	21834.90	35513.0	4.84
1	Amurskaya oblast	29.11	639.02	1375.43	222.71	25881.00	37679.3	7.24
3	Amurskaya oblast	-137.76	349.18	1480.44	167.74	24519.30	28514.2	-17.03
3	Amurskaya oblast	-288.18	1022.92	1616.84	1046.26	28123.70	27682.0	-22.27
1	Amurskaya oblast	68.95	724.40	1422.22	298.58	23857.95	36596.15	6.04
3	Amurskaya oblast	-105.54	783.36	1633.79	627.48	24123.20	29947.38	-18.26

*Source: calculated by the authors

Table 5. Identification of significant deviations from the average values for clusters

Cluster	Region	Net profit, mln roubles	Revenue, mln roubles	Volume of harvested wood, thousand m ³	Cost, mln roubles	Average salary, roubles	Reforestation area, ha	Profitability, %
Cluster averages								
1		1.877	589.527	3045.28	535.017	17263.77	11355.22	6.65
2		320.934	4118.566	5741.93	5034.651	35706.07	20170.58	9.80
3		-352.819	1303.692	7621.11	1289.526	18156.16	34563.52	-14.30
4		-299.48	5570.78	18456.88	7716.134	39223.44	81084.17	6.44
Averages and the region analysis								
1	Altajskiy Krai	64.5329	633.2726	2669.57	971.869	19078.3	11278.86	10.874
Results of comparison		↑			↑			↑
3	Zabajkalskiy Krai	-43.2795	91.3095	2259.65	79.9015	12245.55	13535.58	-30.95
Results of comparison		↑	↓	↓	↓		↓	↓

*Source: calculated by the authors

or less of the average for the cluster, the profitability of logging in the region will also be 50 % or less of the average.

At the same time, if the direct dependence on net profit is quite logical and understandable (as well as in the case of volume of harvested wood), then the presence of a clear link between reforestation in the region and profitability is an extremely interesting result. It is obvious that with a proper approach to the organization of forestry activities in the region, including responsible environmental (reforestation) policy, the forest industry itself shows better results. And, conversely, with low attention to processes other than purely economic, lack of focus on sustainable development, the effectiveness of regional forest complexes significantly decreases.

The obtained relationship is confirmed by the fact that in 50 % of cases when the profitability level of the region exceeds the average value for the cluster, there is a simultaneous excess for all three identified criteria (net profit, volume of forested wood and reforestation area). In other words, there is a mutual influence and relationship between these indicators and the level of efficiency of the forest industry in the regions of Russia. From a practical point of view, it is important to identify the factors that affect these indicators. To do this, it is necessary to conduct a traditional factor analysis, as well as to identify specific regional features in those observations within the study for which significantly deviating values of indicators are observed.

One of the indicators is the average salary. According to the author, the use of a similar comparative base ($\pm 50\%$ of the average value for the cluster) is not entirely correct. Nevertheless, at the current time, the average industry income values do not differ significantly (compared, for example, with differences in the volumes of harvested wood or revenue of enterprises in the regions). At the same time, the conducted mitigation of the deviation level (up to $\pm 25\%$ of the average value for the cluster) did not show significant changes. This confirmed the fact that the average value of salaries across clusters is a fairly stable indicator and its role in significantly increasing (or de-

creasing) the efficiency of forestry activities is insignificant.

It is obvious that the impact on net profit and revenue is largely influenced by market factors – demand, competitors' activities, fluctuations in product prices, the macroeconomic situation, etc. In general, these are the aspects that a separate enterprise or region cannot have a significant impact on. At the same time, there is a group of factors that are adjusted at the local and regional levels (Chen, 2020). From the perspective of improving the efficiency of the forest industry, these factors should be identified and analyzed in detail. The author's team performed this work. Initially, a factor analysis had been carried out. The assessment of the enlarged factors influencing the indicators used in the study was carried out. An example of the results obtained is presented in Table 6.

Further, the factors influencing the efficiency of the objects under consideration were identified. Based on the results of cluster analysis and analysis of significant deviations from the average values of clusters, it was revealed that one of the most important thing for the leadership (significant lag) of the regions is net profit, the volume of harvested wood and the area of reforestation. For these indicators, the key factors influencing them were identified (Fig. 6).

Among the presented groups of factors, two large groups can be distinguished:

1. External factors. This is a group of factors that are practically not affected and changed by the regions and companies directly engaged in logging activities (Ivantsova, 2022). These include natural and climatic conditions, the volume of GDP from the industry, the general market situation, etc.

2. Internal factors. Here are the factors that are subject to regulation to a certain extent. Accordingly, the impact on them can affect the efficiency of the forest industry. They can be summarized in the following form:

- Company. The policy pursued in the organization, organizational and strategic decisions taken, financial and economic opportunities determine the features, volumes and effectiveness of the forest industry and forestry activities. To a certain extent, the specifics and

Table 6. A fragment of the database with a list of factors affecting the indicators used in the study for the analysis of forestry activities

Indicators	First level factors	Second level factors
Net profit	Revenue	Sales volume
		Product price
		Commodity structure
	Cost	Productivity of technology
		Natural and climatic conditions
		Company personnel
		Cost of fuel, spare parts and other materials
		Cost of raw materials (rent)
	Amount of tax deductions	Volume of GDP from the industry
Fiscal policy of the state		
Revenue	Sales volume	Production volume
		Natural and climatic conditions
		Productivity of technology
		Company personnel
	Product price	Company policy
		Market situation
		Product quality
	Commodity structure	Technological features
		Natural and climatic conditions
		Company policy
		Demand for products

*Source: Compiled by the authors

technological features also affect the efficiency of the enterprise and, as a result, all industries. With the widespread introduction of modern production technologies at the enterprises of the region, there should be an overall increase in productivity and efficiency.

An example is the widespread modernization of equipment involved in the logging process. Over the past 10–15 years, logging enterprises throughout the country have been actively switching to the use of felling complexes (harvesters, forwarders) Ponsse, John Deere, etc. This has significantly increased the volume, timing, cost and profitability of logging.

– Personnel, The qualification of personnel, as well as the specifics of its motivation,

working conditions significantly affect labor productivity, quality characteristics of products. The above example with the introduction of modern technology (harvesters, forwarders, etc.) has required significant professional development of the personnel of logging enterprises. At modern enterprises of the industry, people engaged in wood harvesting are operators who deal with complex equipment in fairly comfortable conditions. At the same time, the living conditions and the provision of all staff activities are also improving. At the same time, this is largely determined by the characteristics of enterprises – there are both positive and extremely negative examples of relationships and building a workflow between the staff and the management of organizations.

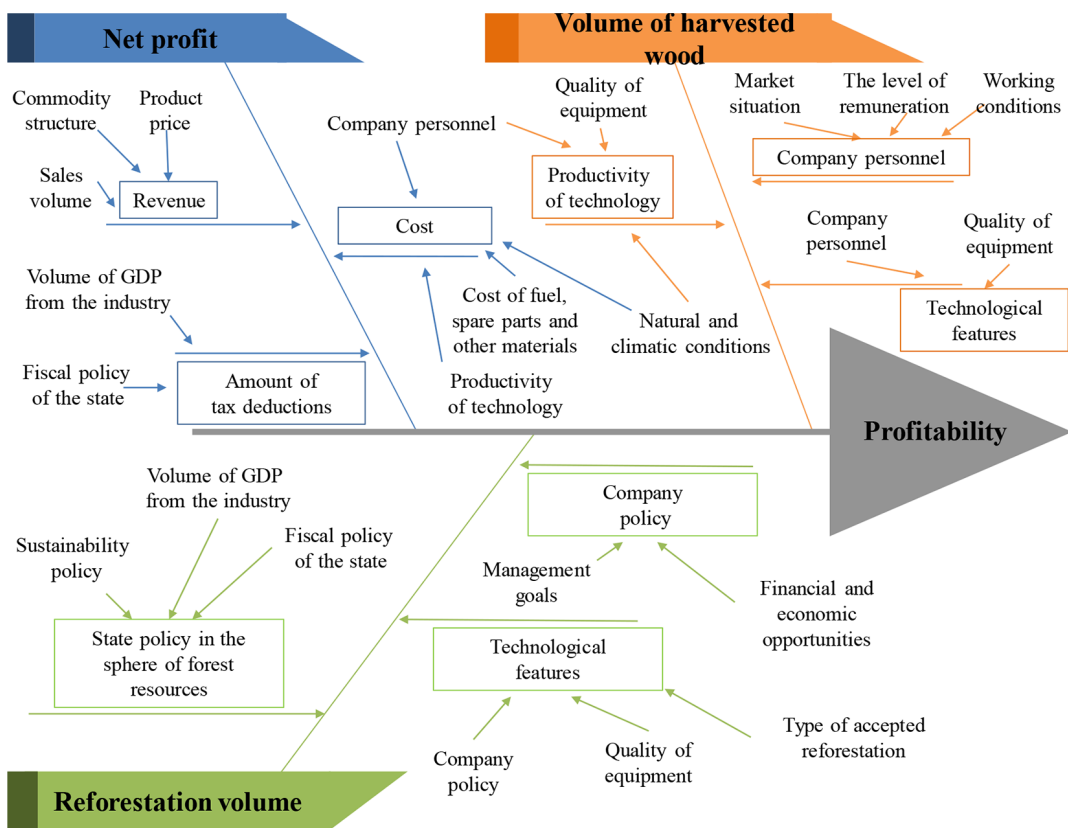


Fig. 6. Causal diagram of the profitability of the logging sector by regions of the country
Source: Compiled by the authors

– Technology. An undoubted factor in increasing the profitability of the forest industry is the machinery and production equipment used. In addition to logging machines, modern forest transportation (logging trucks), transshipment (for loading and unloading operations) and auxiliary (various tractors, cars and machine tools) equipment are actively used. At the same time, the operation of the equipment is affected not only by its productivity, the degree of “modernity”, but also by wear and tear, the qualifications of the personnel working on it, the conditions in which the work is carried out, etc.

– Products. The efficiency of the industry largely depends on what products are produced – its range, price, quality, production and sales volumes. The effectiveness is directly determined by these production results. At the same time, the price, quality, and production volumes depend on the characteristics of the

enterprise (organization of production processes), the machinery and equipment used, and the personnel involved in production.

Thus, all the mentioned factors have a mutual influence on each other. The overall profitability of the forest industry depends on their joint coordinated impact. Consequently, in order to increase the efficiency (profitability) of the industry, comprehensive measures should be developed aimed at a mutually influencing group of factors. Their main task is to have a systemic impact on several objects, affecting various aspects of the industry. During the study, the following activities have been selected:

1. Continuation of implementation and support of priority investment projects in the field of forest resources development. At the same time, attention to the problems of sustainable development should become an important focus. The projects proposed for implementa-

tion should proceed not only from economic goals, but also support modern trends in balanced development (Vos, 2023).

2. Intensification of the use of financial and tax instruments to support the forest industry (preferential taxation, subsidies and subventions, reimbursement of part of the costs of various expenses, tax preferences, etc.). In conditions of significant restrictions on the part of some foreign partners, it is important to support domestic producers. At the same time, it is important to develop criteria for the adoption of these support measures. According to the authors, the share of processed raw materials, compliance with the modern social and environmental agenda, the introduction of advanced technologies, etc. should be important aspects (Pietarinen, 2022). The implementation of modern principles and approaches by enterprises in their work should be a factor in obtaining substantial support from the state.

3. Information support of the industry. It is necessary to increase the information maintenance of forest industry enterprises. This thesis is being implemented through the increasing informatization of all processes in timber processing complex and logging in particular. Transparency and the availability of extensive databases on the availability, movement and use of wood resources should become the norm. Also, industry enterprises should have access to consulting services on various aspects of their activities, which will allow them to quickly solve many tasks. The latter can be implemented through the activities of unions of relevant organizations (both regional and federal).

4. Infrastructure support. The state should actively contribute to the development of forest infrastructure. At the moment, for a significant part of small and medium-sized businesses, the development of infrastructure (primarily the road network) is an impossible task. The form of implementation of such support is public-private partnership, as well as the provision of broad subsidies for the implementation of infrastructure projects. The implementation of this direction is justified, among other things, by the use of the infrastructure being created in the forest area not only for business purposes,

but also for environmental tasks, which are implemented primarily by the state (Halonen, 2022).

5. Continuation of work on the development of various forms of association of timber enterprises – industrial parks, clusters, integrated structures. Large organizational formations allow us to achieve the best results and solve complex tasks facing many market participants together. At the same time, the association itself should not be imposed by the state, but implemented by business units independently.

6. Development of the scientific and technological component in the forest industry. In particular, it is necessary to intensify scientific research in the field of effective use of wood resources and the development of the forest industry as such. For these purposes, new tenders for relevant research and development are required (including federal and regional level competitions). Additional support is needed for scientific organizations and universities engaged in research and training in the forest industry.

7. Intensification of efforts to improve the quality of training and retraining of personnel for the forest industry. This work should be carried out by the state, educational institutions and business.

8. Stricter requirements for production processes in the forest industry. The main goal is to improve the quality of products, maximize the involvement of all wood biomass resources in production, increase added value, and transition to the principles of sustainable development.

9. Introduction of an intensive forestry model. This aspect in the work of the forest industry is closely interrelated with the development of forest infrastructure, scientific direction, methods of financial support, etc. In the end, there should be a gradual departure from the extensive management model. Russia is a big country and there are still a lot of available resources for the forest industry, but intensification will increase the productivity and volume of harvested wood from 1 hectare of forest territory, increase the productivity of reforestation, reduce the risks of adverse situations in

the forest area and, in general, form a class of responsible forest users.

This list can be continued, however, according to the authors, these areas of development of the forest industry should become a priority.

Conclusion

As a result of the conducted research, based on the separation of data on forestry activities in the regions of the country, information was obtained on key factors affecting efficiency, and measures aimed at modernizing the industry were developed. The thesis is confirmed that the regions of the country can be grouped according to a number of indicators characterizing the forest industry in terms of resource provision – logging, reforestation, etc. The peculiarities of the variability of the indicators used in the study, including data clusters, are revealed. The identified factors of the first and second level, affecting profitability, allowed us to form measures, the ultimate goal of which is to modernize the in-

dustry and significantly increase its efficiency. At the same time, the impact on the groups of factors designated as “enterprise”, “personnel”, “equipment” and “products” is complex and affects various aspects of the functioning of the industry. Great importance should be attached to the principles of sustainable development, which are directly or indirectly taken into account in individual measures for the development of the industry.

The significance of the results lies in obtaining and testing an approach to assessing the effectiveness of forestry activities and the forest industry; assessing relevant key groups of factors affecting the efficiency of the industry; developing measures based on the current situation study aimed at improving the efficiency of the industry. Thus, the results obtained are both theoretical and applied. The prospects for continuing research are the complication of the models used and cluster analysis due to the consideration of a larger number of indicators characterizing the functioning of the forest industry.

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