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Is Timber Investment Actually the Driver of Logging Growth and Human Welfare?

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Abstract. Investment in the forest sector is one of the critical issues for the development of the forest industry in Russia. To form an effective sectoral investment policy, it is necessary to accurately understand the causes and consequences of key processes in the industry. In particular, it is important to establish how investments are reflected in timber harvesting, and whether there is a connection between these processes and the well-being of the population. The study is aimed at identifying causal relationships between investment in the forestry sector, logging, and the well-being of the population by identifying Granger causality in vector autoregressive models. After testing for stationarity of the series, we evaluated a five-equation vector autoregression model and performed zero-constraint F-tests to identify causality. The results show that there is a bi-directional positive causality between logging volume and investment in forestry and pulp and paper production. The causality between investment in forestry and investment in pulp and paper production is also bi-directional and positive. In addition, one Granger cause has been identified for the growth of GRP, which is investments in wood processing and the production of wood products. Thus, the results suggest that investments in forestry and the forestry industry are important determinants of logging volumes in the Russian forest sector, and vice versa. At the same time, for the welfare of the population, the causality was revealed only on the part of investments in wood processing, which is also a practically important result in the context of stimulating investment policy in the forestry sector.

Keywords: investment policy, forest industry, timber investment, Granger causality.

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Research area: economics.

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Действительно ли инвестиции в лесной комплекс являются драйвером роста лесозаготовок и благосостояния людей?

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Аннотация. Инвестиции в лесной сектор являются одной из критически важных проблем развития лесной промышленности в России. Чтобы сформировать эффективную отраслевую инвестиционную политику, необходимо точно понимать причины и следствия ключевых процессов в отрасли. В частности, важно установить, как отражаются инвестиции в заготовке древесины и существует ли связь этих процессов с благосостоянием населения. Исследование направлено на выявление причинно-следственных связей между инвестициями в лесном секторе, лесозаготовкой и благосостоянием населения с помощью выявления причинности по Гренджеру в моделях векторной авторегрессии. После проведения теста на стационарность рядов мы оценили модель векторной авторегрессии из пяти уравнений и провели F-тесты нулевых ограничений для выявления причинности. Полученные результаты показывают, что есть двусторонняя положительная причинность между объемом лесозаготовок и инвестициями в лесное хозяйство и в производство целлюлозно-бумажной продукции. Причинность между инвестициями в лесное хозяйство и инвестициями в производство целлюлозно-бумажной продукции также двусторонняя и положительная. Кроме того, для роста ВРП выявлена одна причина по Гренджеру – инвестиции в деревопереработку и производство древесной продукции. Результаты позволяют утверждать, что инвестиции в лесное хозяйство и лесную промышленность служат важными факторами, определяющими объемы лесозаготовок в лесном секторе России, и наоборот. Вместе с тем, для благосостояния населения причинность выявлена лишь со стороны инвестиций в деревопереработку, что также практически важный результат в контексте политики стимулирования инвестиций в лесной сектор.

Ключевые слова: инвестиционная политика, лесная промышленность, инвестиции в лесной комплекс, причинность по Гренджеру.

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Introduction

Russian forests represent a significant resource potential for the development of the timber industry. According to the Federal Forestry Agency, the total stock of standing timber in Russia is estimated at 82.5 billion m3, and the forest cover of the territory reaches 46.4 % in 2021. Against the backdrop of leadership in forest resources, Russia's performance on the world market of timber products is somewhat more restrained: Russia occupies a leading position only in the production of low-processed wood products. The development path of the forest industry in the country is associated with a number of structural problems that include the low degree of wood processing, the lack of transport infrastructure for logging, the low efficiency of reforestation measures, the depletion and dete-

rioration of the resource base quality (Pyzhev, 2019; Gordeev, 2020; Antonova, 2017). At the same time, the issue of the efficiency of sectoral investments seems to be relevant.

In general, Russia's share in the world production of forestry products to some extent reflects the structure of the country's forest products exports: the share in roundwood is quite large, somewhat less in the production of sawn timber and wood-based panels, and in the production of pulp and paper products, Russia does not occupy a leading position (FAO, 2020). The low degree of wood processing is indeed one of the problems in the development of the Russian forest industry, which is explained, among other things, by the insufficiency of processing capacities. We also note that the added value of products is extremely small: the total share of the forestry sector in the gross value added in recent years has not exceeded one percent. According to the RF Customs Service, the share of timber and pulp and paper products in the structure of Russian merchandise exports ranges from 3.5 % for non-CIS countries to 5 % for CIS countries in 2020.

Moreover, the nature of forest management and logging that has developed in Russia in recent years has led to a significant depletion of primary forests and, accordingly, a decrease in the quality of wood: the assortment structure of the forest stand is significantly deteriorating. Thus, timber processing industries are faced with the inability to provide themselves with high-quality wood, which leads to a decrease in the number of enterprises in the industry.

Another group of problems is related to the low efficiency of reforestation, which should be dealt with by both government agencies and logging companies. In the last two decades, the volume of reforestation in Russia has had a downward trend (Pyzhev et al., 2015). For a long period, extensive exploitation of coniferous forests was carried out, while the process of reforestation was not given the required attention. One of the consequences is the change in the species composition of the forest stand from a "quality" coniferous forest to mixed forests with a predominance of deciduous wood.

Finally, we note the problems associated with the low level of timber processing and, accordingly, the low value-added of timber products. Here it is also worth mentioning the problem of illegal logging associated with the export of unprocessed timber, which not only causes direct economic damage in the form of loss of forest resources and lost profits for the state, but also leads to serious consequences for the forestry itself (Pyzhev et al., 2015; Blam et al., 2011). In addition, illegal logging exacerbates the critical problem of inefficient reforestation.

Thus, for successful competition in the global forest products market, the development of the Russian forestry sector requires an integrated approach to solve the problems stated above. The measures applied to overcome the various constraints on the development of the forestry sector should be coordinated among themselves. Within that approach, improving Russia's position in the global market for forest products is possible only if we stimulate the creation and development of processing industries aimed at creating products with high added value, which requires attracting a significant amount of investment in the forest sector.

The purpose of this study is to investigate the causal relationships between timber investments and logging volume in Russia. To determine the causal relationships, we use vector autoregression (VAR) models and the Granger-causality testing method.

The rest of the paper is organized as follows. The article introduces the forestry sector development issues in Russia, focusing on sectoral investment; provides a literature review of the research on causal relationships; proceeds to explain the methodology and data; presents the results of empirical VAR modeling; and draws conclusions about causes and effects of investment and logging as well as welfare of population.

Literature review and theoretical framework

One of the serious restrictions on the development of the timber industry in Russia is weak investment activity. The industry is considered unattractive for investors due to high risks and low profitability. The quality of institutions is also an important factor in invest-

ment attractiveness and investment efficiency. That is why the problem of insufficient investment in the development of wood processing facilities is extremely urgent.

Some measures are being taken to stimulate the development of the forest industry and its infrastructure and to increase the processing of wood products. To transfer the industry from exporting round timber to deep processing, a ban on the export of unprocessed and roughly processed wood of coniferous and valuable deciduous species is introduced from 2022. The effectiveness of this measure is not yet clear. The export of minimally processed wood will still not be banned, and timber with a moisture level not exceeding 22 % will not be banned at all. Nevertheless, a positive economic effect from the development of wood processing industries is expected in any case, the only question is how great it will be.

To stimulate the development of wood processing industries, the mechanism of state support for investment projects in the field of forest development seems to be a promising tool. Such a mechanism involves the provision of a preferential rate for the lease of forest plots to investors and the provision of forest plots without an auction in exchange for an obligation to create or modernize timber processing infrastructure facilities.

This measure is considered very promising; however, its implementation is associated with several problems. Over the entire period of state support for such projects, almost a third of the projects were excluded from the priority list. The reasons for exclusion are most often related to non-fulfillment of obligations, the bankruptcy of the applicant enterprises, lack of investment, or non-payment for the lease of forest plots. Such precedents, among other things, cause enormous damage to forests: investors cut timber at very low rates of payment, and often do not carry out measures for reforestation and protection of forests from fires. Considering the losses from the support of projects of unscrupulous investors, we consider it relevant to study the parameters that could make it possible to predict the likelihood of successful implementation of an investment project at the stage of deciding on its support.

The literature is rich in analyses of topics related to timber investment. Relevant topics are investment returns (Cubbage et al., 2020; Pra et al., 2019; Wang et al., 2014), investment to innovation in the forest sector (Weiss et al., 2021; Bouriaud et al., 2011), or specifically foreign investment (Qiu et al., 2021; Lin et al., 2020). However, the literature in these fields does not generally consider evaluating the efficiency of specific measures taken. There is also a lack of research that would suggest decision-making models for state support of investment projects. Logistic regression was used to create a credit rating model for construction and timber industries in Vietnam using an artificial neural network (Hai et al., 2018), which can be considered as a decision-making model for development and investment.

To assess the effectiveness of timber investments in the form of returns the commonly used indicators are Investment Rate (Sujova et al., 2015), Internal Rate of Return (Evison, 2018), and Net Present Value (Restrepo, Orrego, 2015). In relation to research on the forestry sector, there can be also used such indicators as Land Expectation Value which is a function of the forest price, forest yield, interest rate, and the plantation forests development costs (Restrepo, Orrego, 2015). However, these consider the efficiency of specific investment projects and do not evaluate the performance of measures taken by the government in general.

Many papers deal with problems related to stimulating investment in the forest sector. Instruments used by the government to stimulate investment include tax incentives (Nery et al., 2019), government subsidies, and cost-sharing programs (Song et al., 2014; Ovaskainen et al., 2017). In our study on the analysis of global experience and its viability in Russia, we compiled a classification of best practices for stimulating investment in the forestry sector, considering country specifics (Ivantsova, 2020). We also found that the support measures which work in Canada are likely to be the most efficient ones under the national conditions because Canada runs similar forest land property rights. Canada practices R&D encouragement and public subsidies which could be imple-

mented in Russia as a type of public-private partnership or other types of joint investment of the projects in the forestry sector.

In order to develop an effective measure of stimulating investment in the timber industry, knowledge about the cause-effect relationships is crucially important. The further stages of the analysis include dataset description, unit root test, cointegration test, VAR modelling, and, finally, conclusions about Granger causality in selected variables.

Methodology and data

The sample data on 58 regions of Russia[1] covers the period 2013–2016 and contains annual observations for logging volume, fixed capital investment in forestry and logging, wood processing, and pulp and paper production. To investigate a relationship between investment and human welfare we also collect data on Physical Volume Indices of Gross Regional Product (GRP). We assume that GRP reflects the growth of the economy, which in turn is reflected in the welfare of the population.

The data were collected from the Federal State Statistics Service (2022) through Unified Interagency Information and Statistical System (EMISS). This period was chosen due to data availability and is limited to 2016, as sectoral statistics are provided under the new classification of economic activities starting in 2017.

The description of selected variables is presented in Table 1 while summary statistics is displayed in Table 2.

To understand the dynamics of the variables under consideration, we also calculated the average values for the objects, which are presented in Table 3 and Fig. 1.

Similar dynamics is observed for the volume of logging and investment in wood processing and production of wood products. At the same time, investment in pulp and paper production shows a decline in 2014 and 2016. Investment in forestry more than halved in 2014 compared to the previous year, but by 2016 recovered almost to its previous level. The dynamics of the GRP index is not pronounced, the changes are small, although it is worth noting that in 2015 the average growth took a value

Table 1. Set of variables

Variable	Description	Units
InvForestry	Fixed capital investment in forestry and logging	1 000 000 RUB
InvWoodPr	Fixed capital investment in wood processing	1 000 000 RUB
InvPaper	Fixed capital investment in pulp and paper production	1 000 000 RUB
Logging	Logging volume	1000 m^3
GRPGrowth	Physical volume indices of Gross Regional Product	%

Table 2. Summary statistics

	Mean	Median	Minimum	Maximum
InvForestry	203,02	12,050	0,000	3117,4
InvWoodPr	702,69	83,300	0,000	10118
InvPaper	738,75	101,95	0,000	14185
Logging	3446,4	1550,6	10,827	35337
GRPGrowth	100,85	101,10	82,500	109,20

[1] Some regions were excluded from the analysis due to lack of data.

Table 3. Mean values for variables

	2013	2014	2015	2016
InvForestry	282,878	135,478	149,405	244,328
InvWoodPr	481,998	629,369	734,231	965,148
InvPaper	708,529	564,141	850,419	831,905
Logging	3 263,642	3 430,900	3 468,606	3 622,369
GRPGrowth	101,510	101,666	99,981	100,240

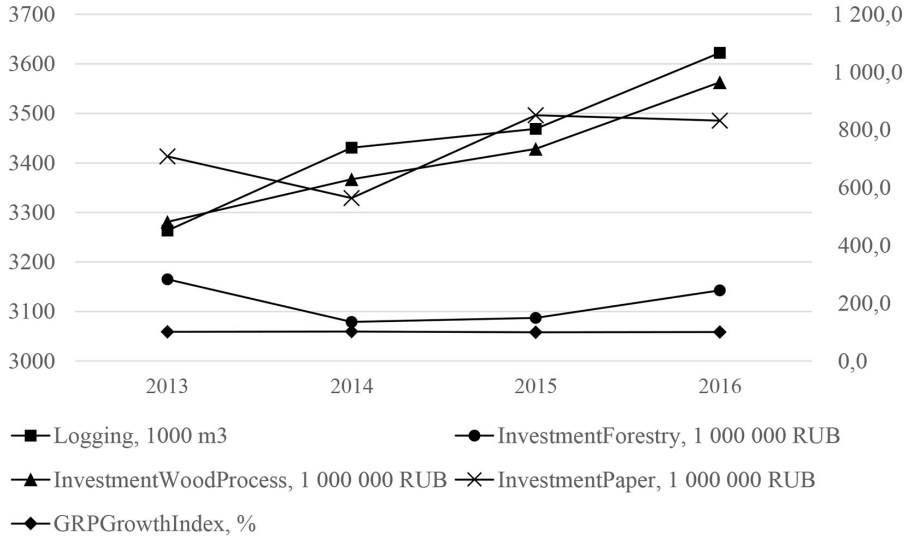

Fig. 1. Mean values of variables, 2013–2016

of less than 100, which means a slight decline in the economy.

Before exploring causal relationships with VAR modeling and Granger causality, we can consider the hypothesized relationships between the pairs of features under consideration. To do this, we present scatterplots for individual variables under study, which are presented in Fig. 2.

Scatterplot (a) reflects the relationship between investment in forestry and logging volume. We can see the positive nature of the dependence, with most of the values scattered at a low level of values of both variables. Scatterplot (b), reflecting the dependence between investment in wood processing and logging volume, and scatterplot (c), reflecting the dependence between investment in pulp and paper production and logging volume, show similar relationships, though the decline is slightly different. According to scatterplot (d), the relationship between the volume of logging and the growth of GRP was not revealed. There are some outliers in the right in terms of logging volume, however. Here we proceed to explain the methodology of VAR modeling and causality testing.

We use VAR models to test for causality between investment, logging, and GRP. We also assume that all variables considered in this study are endogenous. The assumptions of VAR models require that the variables be stationary and not cointegrated. The most common way to test stationarity is the Augmented Dickey-Fuller test (ADF-test) with the null hypothesis that the series has a unit root against the stationarity hypothesis. The ADF-test is based on the evaluation of two regressions –

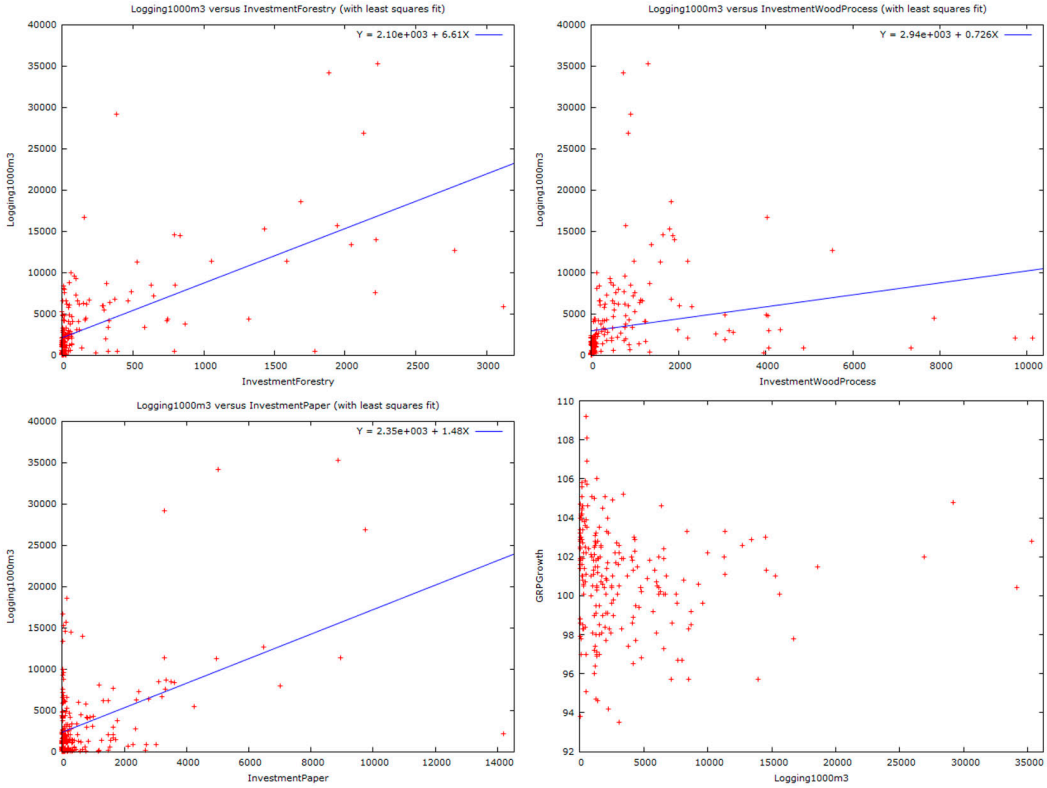

Fig. 2. Scatterplots for: (a) Investment in forestry and logging volume; (b) Investment in wood processing and logging volume; (c) Investment in pulp and paper production and logging volume; (d) Logging volume and GDP Growth

with a constant and with a constant and a trend, as further shown in equations (1) and (2) below:

$$\Delta Y_t = \beta_0 + \gamma Y_{t-1} + \varepsilon_t \quad (1)$$

$$\Delta Y_t = \beta_0 + \beta_1 t + \gamma Y_{t-1} + \varepsilon_t \quad (2)$$

where ΔY_t is the first difference of the series Y_t; γ, β_0 and β_1 are coefficients to be estimated, and ε_t is an error term.

Results

Stationarity (Unit Root Tests)

As already mentioned, the ADF test is employed to test the stationarity of the series. The ADF tests are performed on the level of initial observations by estimating the two models presented in equations (1) and (2).

The results of ADF-test are presented in Table 4. While the null hypothesis states that there is a unit root and the series is not stationary, we can conclude that the null hypothesis is rejected for all variables. Thus, the studied series are stationary and can be used for further analysis without additional transformations.

Since we have found that the series are stationary, no cointegration testing is required.

Granger causality (VAR)

To determine the optimal lag order in VAR model, we used Akaike's criterion (AIC), which indicated a lag order of 3. We estimated a system of five VAR equations for each of the variables.

To determine the causal relationships, we use F-tests of zero restrictions, where the null hypothesis states that the coefficients for all lags are zero. Thus, if the null hypothesis is rejected, we can assume that there is Granger causality for the variables indicated. The results of F-tests for each of the VAR equations

Table 4. ADF-test statistics

	Test with constant	Test with constant and trend
InvForestry	-4,90643***	-4,99681***
InvWoodPr	-9,26623***	-9,28564***
InvPaper	-4,03007***	-4,01304***
Logging	-3,62495***	-3,76726**
GRPGrowth	-13,9881***	-14,3738***

Notes: The optimal lag length was selected automatically using the Akaike criterion (AIC) for ADF test. *** Significant at 1 %; ** significant at 5 % level.

Table 5. Results of F-test for VAR

	(3) InvForestry	(4) InvWoodPr	(5) InvPaper	(6) Logging	(7) GRPGrowth
InvForestry	31.641 [0.0000]	0.19709 [0.8983]	4.3047 [0.0057]	6.6145 [0.0003]	1.7326 [0.1613]
InvWoodPr	0.18866 [0.9040]	17.044 [0.0000]	0.21266 [0.8876]	0.11505 [0.9512]	4.1505 [0.0070]
InvPaper	11.706 [0.0000]	1.6966 [0.1688]	5.5908 [0.0010]	6.8061 [0.0002]	0.98739 [0.3996]
Logging	8.5973 [0.0000]	0.98868 [0.3990]	4.9844 [0.0023]	82.059 [0.0000]	0.55135 [0.6478]
GRPGrowth	0.68619 [0.5614]	0.31467 [0.8148]	0.47776 [0.6981]	0.98489 [0.4008]	0.36206 [0.7805]
R^2	0.553	0.253	0.271	0.748	0.111

Notes: [] parenthesis denotes p-value for F-statistics; the optimal lag length was selected using the AIC for VAR.

are presented in Table 5, where the columns are dependent variables, and the rows are factor variables.

In terms of Granger causality, under the assumption of endogeneity of the input variables, we found that logging volumes are the cause for investment in forestry and investment in pulp and paper production, and vice versa. The investment in forestry is also the cause of investment in pulp and paper production and vice versa. The only significant effect on GDP growth is of investment in wood processing and production of wood products. All statistically significant cause-and-effect relationships have positive directions of dependence. R^2 denotes quite high explanatory power for the equations (3) and (6). The explanatory power for equation (7) is expectedly low as there is only one significant determinant.

Conclusion

In this study, we attempt to explore causal relationships between timber investments and logging volume in Russia. We estimated VAR model with five equations with an acceptable explanatory power. The main results show that: a) logging volume Granger causes investment in forestry and investment in pulp and paper production; b) investment in forestry and pulp and paper production Granger cause logging volume; c) investment in forestry Granger causes investment to pulp and paper production; d) investment in wood processing and production of wood products Granger causes the growth of GRP.

These results can be taken to suggest that investments in forestry and timber industry are important determinants of logging volume in the forest sector of Russia. And vice versa, the more the volume of logging is, the more investment in forestry and pulp and paper production flows. This conclusion is an extremely important practical result of the study in terms of stimulating investment in the creation of high value-added products in the timber industry.

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