Imported products in construction activities: quantitative analysis of relationship (case of the Russian Far East)

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Abstract. The article is devoted to assessing the dependence of the volume of construction work carried out in the region on products imported and used in construction. Econometric modeling is used as the main research method: dynamic models with distributed lag. For the case of the Russian Far East, estimates of the multipliers of imported products for regional construction are obtained. Multipliers show a low rate of decrease in the impact of imports on the dynamics of the volume of construction work: less than 1.7% per year. Therefore, for example, during the first eight years after the purchase of imported equipment, only 12.52% of its total long-term impact on the volume of construction is sold. The results can be used to determine the forecast dynamics of the volume of construction work depending on the actual and target indicators of imports of machinery and equipment.

1. Introduction
The growth in the volume of construction work is one of the factors of positive regional economic dynamics. The construction process itself depends on many parameters: the volume of investment, the number and qualifications of workers, technical equipment, and the resource base. In addition, due to the openness of the region’s economy [1,2], the construction activity, by default, is affected by changes in the external environment [3]. World financial crises, trade sanctions, a pandemic directly or indirectly reduce the predictability of construction dynamics, thereby increasing the risks of a regional recession. As a result, the issue of developing and evaluating models to determine potential volumes of construction in the region depending on changes in exogenous factors is of particular scientific relevance.

2. The purpose of the study and the theoretical basis
The purpose of the study is to estimate the impact of imports of machinery and equipment on the volume of construction work. The object of the study is the Far Eastern Federal District (Far East). It includes 9 subjects of the Russian Federation: the Republic of Sakha (Yakutia), the Amur Region, the Jewish Autonomous Region, Magadan Region, Sakhalin Region, Kamchatka Territory, Primorsky Territory, Khabarovsk Territory, Chukotka Autonomous Okrug.

The study is based on classical and modern scientific experience. The used provisions of the theory of economic growth and the methodology of general economic and regional analysis with economic and mathematical models are taken from the works of such authors as: W. Isard [4], N. Glikman [5],
P.A. Minakir [6], N.N. Mikheeva [7], A.V. Belousova [8] and others; principles for studying exogenous risks for an open economy - from the works of Corden W., Neary J. [9]; Buiter W., Purvis D. [10]; Calvo G., Reinhart C. [11]; Frankel J. [12]; Blank A., Gurvich E., Ulyukaev A. [13], Dyumulen I.I. [14] et al.; ways to account for regional economic growth, international interactions in the economy of the eastern regions of the Russian Federation - from works: E.I. Devaeva [15], P.A. Minakira [16], V.I. Syrkina [17] and others.

3. Research methodology
The progress of the research process is represented by the following sequence of steps: 1) identifying the features of the specifications of the dependencies between the parameters of the import of goods used in regional construction and its volumes; 2) fixing the identified features using the methods of economic and mathematical analysis; 3) assessment of constructed structures; 4) obtaining predictive estimates of dependent and independent variables in the constructed dependencies. The first two of the above steps, which determine the course of the research process, are "universal" in terms of "application objects". In other words, their implementation does not depend on the scale, administrative status and other characteristics of the region being the object of the study.

The commodity items of Far Eastern imports of machinery and equipment are: liquid pumps; fluid lifts; pumps, compressors, fans; exhaust hoods or cabinets; air conditioning units; bulldozers, graders, planners, scrapers, mechanical shovels, excavators, single-bucket loaders, ramming machines and road rollers, self-propelled; prefabricated constructions.

The main research method is econometric modeling. Given the relatively long service life of construction products, the study uses a dynamic model (a model with an infinite $(t \to \infty)$ distributed lag) [18]. A general view of the model is presented in (1).

$$y_t = a + b_1 x_{t-1} + b_2 x_{t-2} + b_3 x_{t-3} + \ldots$$

where $y$ is the volume of construction work; $x$ - imports of machinery and equipment; $t$– time.

The economic meaning of coefficient $a$ is to estimate the influence of other factors not present in the model on the construction process in the region.

The value of the coefficient $b_i$ is interpreted as a change in the volume of construction work with a change in the volume of imports of machinery and equipment at the $i$-th point in time by $\$ 1 million. The tendency of the coefficient $b_i$ to zero determines the period of use of imported products in the construction process.

A quantitative analysis of the coefficients $a$ and $b_i$ is based on retrospective data in 2007-2019. Since the time range is insufficient to obtain statistically reliable estimates of the coefficients, the study uses panel data (information on 9 subjects of the Russian Federation, which are part of the Far East, for 13 years).

The simultaneous presence in model (1) of values of the same variable, presented relative to equidistant points in time, causes the problem of multicollinearity. This circumstance makes it impossible to estimate the coefficients of the model traditionally - using the least squares method - without preliminary carrying out special transformations. One of the latter is the Koyck transformation based on the geometric progression method.

To limit the infinite lag in model (1), the Koyck method [19] is used. The application of this method is considered in detail in [20]. The economic meaning of the transformation used lies in the assumption that the influence of imports on the volume of construction work in the region decreases with the increase in the prescription of foreign economic transactions. The process of reducing the influence of imports of goods used in construction is described by a geometric progression (2).

$$b_i = b_0 \lambda^i, \quad i = 0, \infty$$
In this case, $0 < \lambda < 1$ is interpreted as the rate at which the scale of the impact of imports on regional construction activity decreases as the time lag from the moment of purchasing goods abroad increases. Substituting the values $b_i$ (2) into (1), we obtain equation (3):

$$y_t = a + b_0 x_t + b_0 \lambda x_{t-1} + b_0 \lambda^2 x_{t-2} + b_0 \lambda^3 x_{t-3} + \ldots$$  \hspace{1cm} (3)

Subtracting from (3) a similar equation constructed for the previous moment in time and multiplied by the parameter $\lambda$, we pass to the autoregressive model (4):

$$y_t = a(1 - \lambda) + b_0 x_t + \lambda y_{t-1} \hspace{1cm} (4)$$

Using the reverse course of the transformations carried out, obtain numerical expressions for the coefficients of the model (1).

The decision regarding the limitation of the number of lags that will be taken into account in the study is made by an expert based on the analysis of the values $b_i$, $i = 0..\infty$ and the speed of their approach to the zero limit.

It is obvious that the substitution of the estimate of the coefficient $a$ obtained from model (4) into model (1) when using a finite number of lags causes discrepancies between the actual and calculated values of the volume of construction activity. The degree of the corresponding discrepancies increases with increasing deviation of the number of lags from infinity.

As a method for quantifying model (1), we use the generalized least-squares method [21], which makes it possible to eliminate heteroskedasticity of errors under conditions of autoregression.

All used cost indicators are translated into comparable prices in 2019.

To estimate the extent of the impact of imports of construction products and equipment on the volume of construction work, formula (5) is used.

$$k_i = \frac{b_i}{\sum_{i=0}^{t} b_i} \hspace{1cm} \text{(5)}$$

Index $t$ is determined by the length of the studied time interval. If $t = 0$, then the sum of $b_i$ coefficients is a short-term multiplier of imports of machinery and equipment for construction. If $0 < t < \infty$, then the sums of the coefficients $b_i$ are interpreted as intermediate multipliers. If $t = \infty$, then the sum of the coefficients is a long-term multiplier.

The sums of $b_i$ and $k_i$ for successive points in time estimate the cumulative effects of the impact of imports on the dynamics of regional construction.

Identification of the numerical values of the coefficients of the model (1) is a sufficient condition for constructing the import function of building materials (7).

$$x_t = y_t - a - b_0 x_{t-1} - b_1 x_{t-2} - b_2 x_{t-3} - \ldots \hspace{1cm} \text{divisor}$$  \hspace{1cm} (7)

Setting the current values of the results of construction activities in the region and knowing the scale of the corresponding import flows for previous periods allow an iterative calculation of the volume of foreign economic transactions, which must be achieved in order to achieve the target indicators of regional construction. The latter are introduced into the model variably: according to the inertial and innovative scenarios. In the first case, the determination of prospective construction values is based on the approximation of its retrospective dynamics and the prolongation of the trend trajectory for the forecast period. The second case involves taking into account the target growth rates set in government policy documents.
4. The results of the study
A quantitative analysis of model (1) made it possible to obtain the following estimates of coefficients (8).

\[ y_t = 15,571 + 0,090x_t + 0,089x_{t-1} + 0,087x_{t-2} + 0,086x_{t-3} + \ldots \]  

(8)

The estimates of the autoregressive coefficients (4) used to estimate the model (1) are shown in Table 1.

| Coefficient | Value   | t-statistic |
|-------------|---------|-------------|
| \( b_0 \)   | 0,090   | 4,33        |
| \( \lambda \) | 0,983   | 6,72        |
| \( a(1-\lambda) \) | 0,258   | 2,87        |

The value of the short-term multiplier shows that imports of machinery and equipment of $1 million provide a year of purchase of an increase in the volume of construction work in the Far Eastern Federal District by 0.090 billion rubles. The long-term multiplier (the limit of the converging time series, estimated by the Koyk method) shows that the total growth in the volume of construction work (over \( n \) years) provided by the purchase of construction products by $1 million abroad will amount to 5.44 billion rubles.

The use of formula (5) for the coefficients of model (8) shows a rather low rate of decreasing the influence of imported equipment on the dynamics of construction in the Far Eastern regions of the Russian Federation (Figure 1).

5. Conclusions
The results obtained in the article allow predicting the dynamics of construction in the region depending on the inertia (obtained using the trend models) and target (planned) indicators of imports...
of machinery and equipment. So, according to the estimates obtained, in 2020, for example, for the Khabarovsk Territory, the "effect" on the overall results of regional construction activities, due to the three-year import of building materials (with an increase in its volume in the indicated year by 8% in relation to the previous year) will amount to 12.2 billion rubles.

On the other hand, the estimates obtained by the author allow us to solve the inverse problem: to determine the volume of imported equipment necessary to ensure the planned volume of construction work. For this, a transformation of formula (8) is carried out: expressed as a dependent variable \(x_t\) (7). So, for the same Khabarovsk Territory, in order to achieve in 2020 a three-year effect for the volume of construction work in 13 billion rubles, it is necessary, according to dependence (6), to increase the value of imports by 27% in relation to 2019.

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