The methodology for calculating lease payments for construction companies based on the parametric model

A S Nechaev¹ and T V Romanova²

¹Irkutsk National Research Technical University, 664074, 83 Lermontov str., Irkutsk, Russia

²Ezhevsky Irkutsk State Agrarian University, Institute of Economics, Management and Applied Informatics

E-mail: n-a-s@mail.ru

Abstract: The article analyzes problems of leasing planning in order to improve its efficiency. The technique of optimization of lease payments taking into account the reduction factor is described. An example of construction and implementation of the parametric model for optimizing the structure of lease payments is provided. The scheme of construction and implementation of the parametric model for optimizing the structure of lease payments is presented. The article presents a methodology for calculating lease payments based on the parametric model and using the reduction factor, which improves the efficiency of the process of updating fixed assets of construction organizations. The results of lease payment modeling are presented taking into account the payment dynamics. The article describes the dynamics of lease payments whose result is a decreasing function described by the exponential equation. To optimize lease payments, two models can be applied: the parametric model that takes into account the amount paid to the leasing company for the previous period, and the model based on the lease payment reduction coefficient.

The construction industry is one of the most labor-intensive and capital-intensive sectors of the economy. At present, Russian construction companies lack own funds for technical re-equipment. During the transition of the economy to market conditions, one of the important tasks is to develop the construction industry. The problem can be solved by re-equipping the industry and strengthening its potential [3].

Fixed assets can be renewed by implementing the tools of financial leasing; therefore, one of the main forms of state support is construction equipment leasing [5]. The investment leasing mechanism is a powerful lever in accelerating the technical re-equipment of the industry, equipping construction organizations with modern technology.

An analysis of the problems of leasing planning revealed that their efficiency can be improved by applying mathematical modeling methods. The model of optimizing the structure of monthly lease payments should take into account economic interests of lessors and lessees [1].

Let us analyze the methodology for optimizing lease payments, taking into account the lease payment reduction coefficient based on the example of acquisition of construction equipment.

The parametric model for optimizing the structure of lease payments can be analyzed on the following example (Fig. 1).

The bank granted a loan in the amount of RUB 2,300 thousand to Pars LLC.
Pars LLC purchased a dump truck and leased it to Abris LLC, which subleased this dump truck to Sunvent + for 24 months.

Figure 1. The scheme of the leasing example.

Once a month, the subcontractor makes lease payments to the construction company in favor of the leasing company, and upon completion of the lease agreement, it acquires the leased asset at the residual value [2].

The leasing company pays off the bank loan and taxes [4].

The moments $T_i$ (the first day of each month) are set. They indicate the end date of the $i$-th period (month) from the beginning of the contract. It is assumed that all financial transactions occur during $T_i$: the subcontractor makes the lease payment, and the leasing company returns part of the loan and pays loan interests and taxes. The annual loan interest rate is 20%.

The amount of taxes depends on the lease payments which are controlled parameters of the process under consideration. The wrong choice of lease payments leads to an unjustified increase in tax deductions.

During the first year, funds in the amount of 1,150 thousand rubles invested in the leased asset are paid back [12; 7].

It is assumed that in each period the leasing company receives a certain amount of lease payments as a reward for services provided by the subcontractor. The lessor's remuneration rate is 10% of the leased property value. The subcontractor also uses the service of insurance of the leasing property (50 thousand rubles) [6].

The task is to plan lease payments in order to
1. ensure the feasibility of all the required payments of the lessor at every moment $T_i$ ($i = 1, \ldots, n$).
2. ensure the required level $v$ of the total remuneration of the lessor;
3. to achieve minimum leasing payments.
Let \( x_i \) be a leasing payment during the \( i \)-th period (once a month); \( a_i \) – payment for loan resources used for purchasing the equipment; \( d_i \) - depreciation charges accrued by the lessor in the accounting year; \( b_i \) – amount paid to the lessor for the previous period, including funds previously repaid by the lessee; \( p_i \) – profit for the \( i \)-th period; \( y_i \) – lessor's income for the \( i \)-th period; \( B \) – book value of the leased asset; \( K_n \) – residual value of the leased asset; \( t \) – VAT rate (\( 0 < t < 1 \)) for the \( i \)-th period, \( n \) - number of \( i \)-periods equal to 12 months (one year).

Taking into account that the depreciation rate as a percentage of the original (replacement) value of the depreciable property is 2.7%, and the loan rate per annum is 20%, we have:

\[
d_i = 0.027 \cdot B; \quad a_i = 0.2 \cdot ((B + K_n) / 2). \tag{1}
\]

The lessor’s remuneration for the equipment under the lease agreement taking into account the commission rate as 10% of the average annual residual value of the equipment can be written as

\[
v = 0.1 \cdot ((B + K_n) / 2) \tag{2}
\]

Profit for the \( i \)-th period is calculated by formula:

\[
P_i = x_i - a_i - d_i. \tag{3}
\]

Lessor’s income \( y_i \) for the \( i \)-th period can be calculated as

\[
y_i = x_i - a_i - t \cdot P_i. \tag{4}
\]

In addition, the following conditions must be met:

- the total income of the lessor for the entire period must be greater than the remuneration for the provision of equipment under the lease agreement:

\[
\sum_{i=1}^{n} y_i \geq v; \tag{5}
\]

- the total income of the lessor is more than 0:

\[
\sum_{i=1}^{n} y_i \geq 0. \tag{6}
\]

To simulate lease payments, the parametric model can be applied. Parameter \( b_i \) - the amount paid to the lessor for the previous period (including the funds previously repaid by the lessee) - increases every month by the amount of monthly payments (\( x_i \)). Otherwise,

\[
b_{i+1} = b_i + b'(x_i). \tag{7}
\]

Parameter \( b_i \), characterizes the residual value of the equipment \( K_n \), which is described by formula:

\[
K_n = B - \sum_{i=1}^{n} b_i + b'(x_i). \tag{8}
\]

Thus, the mathematical model for optimizing monthly lease payments is as follows.

The optimality criterion minimizes the total lease payment:

\[
\sum_{i=1}^{n} c_i x_i \rightarrow \min, \tag{9}
\]

where \( c_i = e^{-vT_i} \) - the discount factor that takes into account that if \( x_i \) is a sum of the leasing payment at moment \( T_i \), it is equal to \( x_i e^{-vT_i} \), paid by the lessee at the initial moment \( T_0 = 0 \), \( v \) — continuous risk-free interest rate applied by the lessor.

Subject to the conditions which have been described above:

\[
P_i = x_i - a_i - d_i; \tag{10}
\]

\[
y_i = x_i - a_i - t \cdot P_i. \tag{11}
\]
\[ K_n = B - \sum_{i=1}^{n} b_i + b'_i(x_i) \]
\[ b_{i+1} = b_i + b'_i(x_i); \]
\[ d_i = 0.027 \cdot B; \]
\[ a_i = 0.2 \cdot ((B + K_n)/2); \]
\[ v = 0.1 \cdot ((B + K_n)/2); \]
\[ \sum_{i=1}^{n} y_i \geq \nu; \]
\[ \sum_{i=1}^{n} y_i \geq 0; \]
\[ x_i, a_i, d_i, v_i \geq 0. \]

Table 1 shows the results of solving the parametric programming problem. It can be seen that if the optimal plan is observed and the differentiated method of lease payment calculation is used, the total lease payment can be reduced by 83,380 rubles or 15.4%.

**Table 1.** Results of modeling lease payments taking into account the dynamics of the amount paid to the lessor for the previous period, rubles.

| Period (month no.) | Lease payment | Deviations (+,-) |
|--------------------|---------------|------------------|
|                    | Without account the coefficient | Taking into account the coefficient | Lease payment to a leasing company | Without account the coefficient | Taking into account the coefficient |
| 1                  | 45145         | 34968            | 45144.5          | 0.5                       | -10176.5                      |
| 2                  | 44539         | 34545            | 45144.5          | -605.5                    | -10599.5                      |
| 3                  | 43941         | 34127            | 45144.5          | -1203.5                   | -11017.5                      |
| 4                  | 43352         | 33715            | 45144.5          | -1792.5                   | -11429.5                      |
| 5                  | 42770         | 33307            | 45144.5          | -2374.5                   | -11837.5                      |
| 6                  | 42197         | 32904            | 45144.5          | -2947.5                   | -12240.5                      |
| 7                  | 41631         | 32506            | 45144.5          | -3513.5                   | -12638.5                      |
| 8                  | 41072         | 32113            | 45144.5          | -4072.5                   | -13031.5                      |
| 9                  | 40521         | 31725            | 45144.5          | -4623.5                   | -13419.5                      |
| 10                 | 39978         | 31341            | 45144.5          | -5166.5                   | -13803.5                      |
| 11                 | 39441         | 30962            | 45144.5          | -5703.5                   | -14182.5                      |
| 12                 | 38912         | 30588            | 45144.5          | -6232.5                   | -14556.5                      |
| Amount of payments | 458354        | 357834           | 541734           | -83380                    | -183900                       |

Figure 2 shows that the result of problem solution is a continuously decreasing function, which can be described by an exponential equation \( y = 45758e^{-0.014x} \).

In this case, the monthly payment will decrease from 45145 rubles for the beginning of the period up to 38,912 rubles for the end of the year.
Figure 2. Dynamics of lease payments for the year taking into account the implementation of the parametric model.

Model (10)-(20) can be modified taking into account the coefficient of lease payment reduction. Let us designate the reduction coefficient as \( k \). This coefficient depends on the level of provision of the construction organization with fixed assets. Taking into account that for each organization there are different coefficients, let us calculate the coefficient:

\[
k = \frac{F}{F_i},
\]

where

\( F \) – update rate for the period under study;
\( F_i \) – update rate for the reporting period.

Parameter \( y_i \) of model (10)-(20) taking into account the lessors’ income for the \( i \)-th period and constraints (12) can be written as

\[
y_i = k \cdot (x_i - a_j - t \cdot P_i).
\]

Table 1 shows the results of modeling lease payments, taking into account the lease payment reduction coefficient.

According to the optimal plan and the lease payment reduction coefficient, it is possible to reduce the total payment for the year by 34%, which will reduce the burden on the lessee.

As shown in Figure 3, optimization of lease payments based on model (10)-(20) can reduce the monthly payment by the end of the billing period, thereby saving 15.4%.
As a result of the implementation of the model, taking into account additional constraints (21) - (22), a smoother decrease in lease payments was observed during the billing period. Figure 2 shows that the monthly payments were reduced by 34%.

Thus, to optimize lease payments, two models can be used: the parametric model that takes into account the amount paid to the leasing company for the previous period, and the model that takes into account the lease payment reduction factor.

The implementation of the first model made it possible to obtain the optimal plan for monthly lease payments in the form of a continuously decreasing function, which can be described by the exponential equation $y = 45758e^{-0.014x}$.

The second model can reduce the monthly payments and total loan payments by 34%.

The first model takes into account the timely repayment of loans by the lessee, which will make it possible to identify the optimal plan for monthly lease payments. As a result, when using this model, the lessee reduces the total amount of payments by 15.4%.

The second model is based on the lease payment reduction coefficient due to which the lease payment can be significantly reduced. Based on the example, the parametric programming problem was calculated using this coefficient, which made it possible to reduce the monthly amount of payments by 34%.

This method of optimization of lease payments is focused on the lessee. It can reduce the burden of lease payments, as well as to update the material and technical base of construction organizations.

The lease payment reduction coefficient is aimed at effective development of a construction organization. It depends on the fixed assets updating coefficient for the analyzed previous periods.

Since using this coefficient, the leasing company can suffer losses, subsidies for technical and technological modernization can be granted to regulate this process through a state leasing company, thereby providing assistance to organizations in need.

The previously proposed coefficient was not used to calculate lease payments; its application will allow for updating fixed assets, choosing more suitable conditions based on the equipment and financial and economic conditions of the construction organization. The developed mechanism of state support will allow for more targeted allocation of subsidies for modernization of construction organizations, thereby developing the construction industry.

In conclusion, it can be noted that the parametric analysis allows us to find out how the optimal value of the target function changes when its coefficients or constraints change. In this case, it is
assumed that the variable values depend on a certain parameter (e.g., time). It is necessary to determine the dependence of an optimal value of the target function on this parameter.

When assessing the economic feasibility of leasing models, it is necessary to improve the structure of lease payments, which ensures the repayment of the cost of an object. In this case, lease payments cannot be less than the return value of a leased object.

References
[1] Basova A V, Nechaev A S 2013 Taxation as an instrument of stimulation of innovation-active business entities World Applied Sciences Journal 22(11) pp 1544-1549
[2] Nechaev A S, Ognev D V and Antipina O V Analysis of risk management in innovation activity process Proceedings of the 2017 International Conference "Quality Management, Transport and Information Security, Information Technologies", IT and QM and IS pp 548-551
[3] Nechaev A S, Zakharov S V and Troshina A O Innovation risk minimization and neutralization methods Proceedings of the 2017 International Conference "Quality Management, Transport and Information Security, Information Technologies", IT and QM and IS 2017 pp 552-555
[4] Nechaev A S, Bovkun, A S and Zakharov S V Innovation management characteristics of industrial enterprises Proceedings of the 2017 International Conference "Quality Management, Transport and Information Security, Information Technologies", IT and QM and IS 2017 pp 556-559
[5] Nechaev A S, Zakharov S V, Barykina Y N, Vel'm M V and Kuznetsova O N 2020 Forming methodologies to improving the efficiency of innovative companies based on leasing tools Journal of Sustainable Finance and Investment
[6] Barykina Y 2019 Analysis of information support for innovation development IOP Conference Series: Materials Science and Engineering 667 012012
[7] Barykina Y 2019 Risks of long-term leasing transactions for construction industry development. IOP Conference Series: Materials Science and Engineering 667 012011
[8] Kretova N V, Khokhlova G I, Kretova A A and Khokhlova Yu 2020 Specificity assessment and management of financial stability of construction companies IOP Conference Series: Materials Science and Engineering 880 012096
[9] Nikityuk L G 2019 Innovation incentive mechanism in the construction industry. IOP Conference Series: Materials Science and Engineering 667 012067
[10] Ryabchuk P, Baev I, Zubkova O, Korneev D 2018 The supply chain process management methodology within the strategic space and considering the leasing for market development International Journal of Supply Chain Management 9 pp 536-543
[11] Cao Y 2020 Research on application of the Internet of things technology in financial leasing of intelligent manufacturing enterprises International Journal of Advanced Manufacturing Technology 107(3-4) pp 1061-1070
[12] Bunkovskiy V I and Samarukha A V 2015 Production process management with consideration of risk component Actual Problems of Economics 166(4) pp 8-14
[13] Zakharov S V, Bovkun A S and Vasiliev K O 2017 The functioning of small innovative enterprises created in partnership with state universities and natural persons Proceedings of the 2017 International Conference "Quality Management, Transport and Information Security, Information Technologies" pp 32-33