Imitation-dynamic model of amortization reproductive effect with different methods of calculation

A A Boyko[1,2], **V V Kukartsev**[1,2], **E S Smolina**[1], **V S Tynchenko**[1,2], **Ya I Shamlitskiy**[1] and **N V Fedorova**[1,2]

[1] Reshetnev Siberian State University of Science and Technology, 31, Krasnoyarsky Rabochy Av., Krasnoyarsk, 660037, Russian Federation
[2] Siberian Federal University, 79, Svobodny pr., Krasnoyarsk, 660041, Russian Federation

E-mail: boiko101961@yandex.ru

Abstract. This article presents an imitational-dynamic model for calculating the reproductive effect of amortization of fixed production assets with various accrual methods. The model was developed based on the system dynamics method using Powersim Studio tools. In the model, calculations were carried out for five amortization methods: linear; arithmetic-digressive (declining balance method); geometrically digressive; progressive and method of writing off the cost of the survival years sum. The model was used as a tool to study the impact of various amortization methods on the dynamics of its reproductive effect. As a result of experiments with variants, the most effective method was determined. The conducted study allows us to conclude that the constructed imitational-dynamic model is quite universal and on its basis, it is possible to conduct a variety of studies concerning various issues related to amortization deductions.

1. Introduction

Innovative development of the economy significantly depends on the development of strategies for the reproduction of basic production assets (BPA). The strategy development for the reproduction of BPA, in turn, requires a detailed study of amortization methods.

Amortization is the gradual transfer of value from the fixed assets to manufactured products in order to accumulate funds for their full restoration (renovation). In other words, amortization is the loss of the BPA value as a result of physical and moral depreciation [1].

If earlier depreciation charges consisted of two parts (full restoration and major repairs), now major repairs, like other types of repairs, are carried out at the expense of current production costs, and depreciation deductions go only to the renovation of fixed production assets.

In the present work, we investigated the influence of the choice of calculating depreciation various methods on the its reproductive effect dynamics, which consists in the possibility of realizing the BPA due expanded reproduction to the systematic use of wear out.

The need to take into account the influence of various factors while calculating amortization charges by different methods predetermines the use of instrumental management methods, such as economic and mathematical modeling (EMM), which provide an increase in the effectiveness of decisions made regarding the amortization method choice. One of such modern and widely used approaches today is imitational-dynamic modeling, the system dynamics method [2, 3].

2. Model of amortization deductions calculation

Model of amortization calculation is presented in Figure 1.

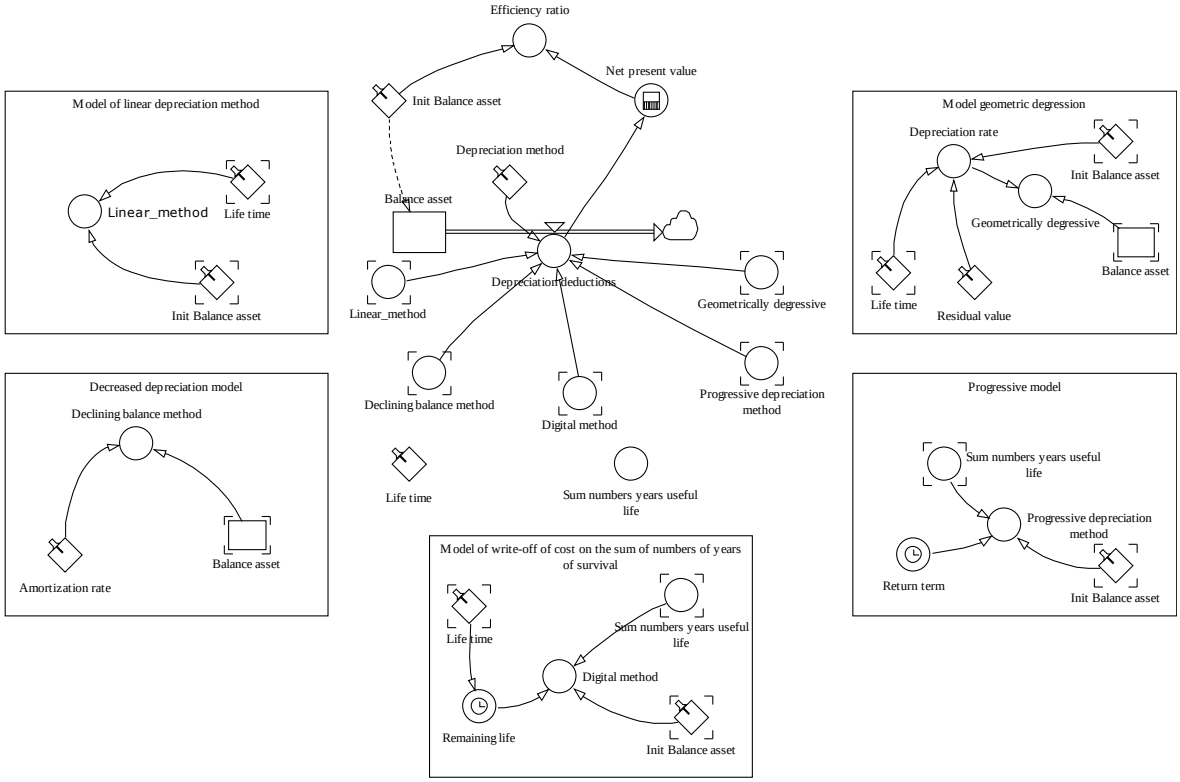

Figure 1. Flow diagram and amortization calculation levels.

The model includes one level (drive), that is balance asset. The diagram also shows one stream - amortization deductions.

In addition to the listed flows and levels, there are auxiliary variables in the diagram. Interpretation of the variables shown in the diagram is presented in Table 1.

Table 1. Used variables in the flow diagram and levels of amortization deductions calculation.

Name	**Documentation**
Balance asset	Book value of BPA
Declining balance method	Digressive (depreciation method) method of amortization
Depreciation deductions	Amortization flow
Depreciation method	Depreciation method identification number
Depreciation rate	Depreciation charge
Digital method	The method of amortization on the sum of the survival years
Efficiency ratio	The coefficient of amortization reproductive efficiency
Geometrically digressive	Digressive (geometric digression) method of amortization
Init Balance asset	Initialization of the BPA book value
Life time	The useful life of the BPA
Linear_method	Linear amortization method
Net present value	Net present value of amortization
Progressive depreciation method	Progressive amortization method
Remaining life	The remaining number of BPA operation years
Residual value	Residual value of BPA
Return term	The repayment period of amortization
Sum numbers years useful life	The sum of the BPA useful life years numbers

Currently, in accordance with the tax code of the Russian Federation [4] in Russian economic activity, the following methods of amortization are used: the linear method and the nonlinear method. However, in the economic literature and in the practice of some countries, other methods are known [1, 5]. So, digressive methods are based on the principle that the significant proportion of amortization occurs in the first years of the labor means. The law, which determines the annual amounts of deductions, can be using formulas of arithmetic or geometric progression. In progressive methods, the center of amortization gravity is, on the contrary, the last years of the BPA service life. In the formulas for these methods, as well as for digressive ones, the law can be used both arithmetically and geometrically.

Obviously, the reproduction effect of amortization also depends on the law of changing the amortization fund. In this study, this effect is characterized by a coefficient of efficiency calculated as the ratio of the net present value (NPV) of depreciation to the BPA book value.

In this work, the following methods were studied [1, 6]: linear method, digressive (diminishing residue method), digressive (geometric digression), progressive method, method of writing off the cost according to the sum of the years left to live.

Consider the algorithm for calculating amortization for each of the methods:

- The linear method implies amortization based on the BPA initial cost and the amortization rate calculated on the basis of the object's usefulness lifespan [4].
- In the case of a non-linear amortization method, digressive (diminishing residue method), the amount of accrued amortization during each calculation period is correlated with the average annual residual price of the BPA. The amortization rate is determined in accordance with article 259.2 of the Tax Code. The possibility of amortization under the accelerated scheme is also provided, with the use of a multiplying factor [4].
- In the case of geometrically digressive amortization, the same percentage is written off from the BPA annually, but not from the initial book value, as at linear amortization, but from the corresponding residual value. Therefore, the amortization rate for geometrically digressive amortization should be higher than for the linear, given the amortization period in both cases is the same [1].
- The method of writing off the cost according to the sum of the years left to live (the digital method). It involves the determination of the amortization annual amount on the basis of the initial value of fixed assets and the relationship, in which the numerator is the number of years remaining until the end of the object useful life, and in the denominator, is the sum of its usefulness lifespan [6].
- The calculation of the annual amortization amounts charges using the progressive amortization method is carried out similarly to the sum of the years left to live. The difference is that the lowest amortization rate occurs in the first year of the facility, and the greatest in the last year.

3. Management interface of amortization reports calculation model

Figure 2 presents the interface for managing the amortization calculation model. The interface structure consists of two parts: input of input data and monitoring of the calculation results.

Before starting the calculation, the following data is entered:

- Book value of the BPA.
- Amortization method (coefficient that ranges from 1 to 5).
- Useful life of the BPA and the amortization rate are established.

In the second interface part, the calculation results are displayed in graphical form:

- Amortization schedule for each method.
- Sum of NPV.
- Coefficient of effectiveness.

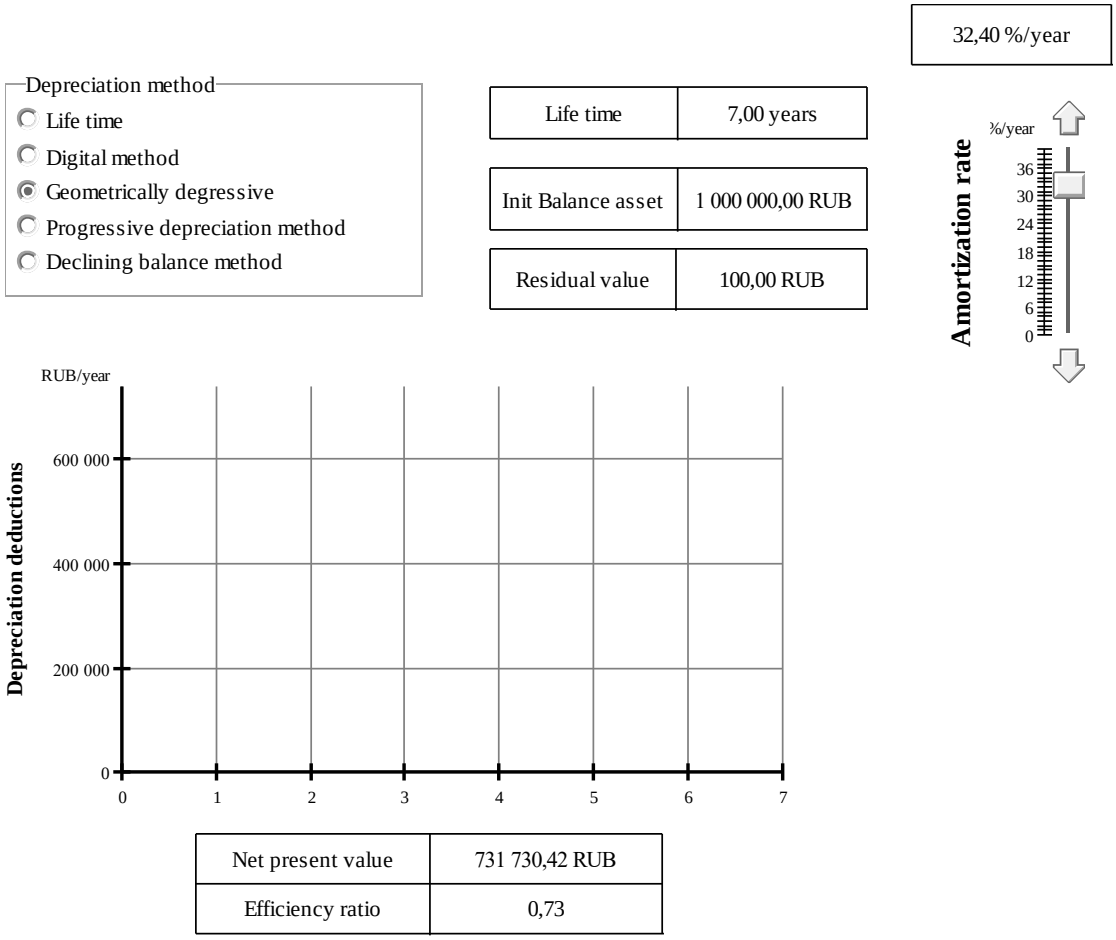

Figure 2. The depreciation charge calculation model control panel.

4. Results

During the experiment, amortization charges were calculated according to the following initial data:

- Book value of BPA - 1 million rubles.
- The useful life - 7 years.
- Amortization rate - 32.4% per year.
- Residual value - 100 rubles.

There were used five methods:

- Linear method (Figure 3a).
- Method of writing off the costs by the sum of the survival years (Figure 3b).
- Method of geometric destress (Figure 4a).
- Progressive method (Figure 4b).
- Declining balance method (Figure 5).

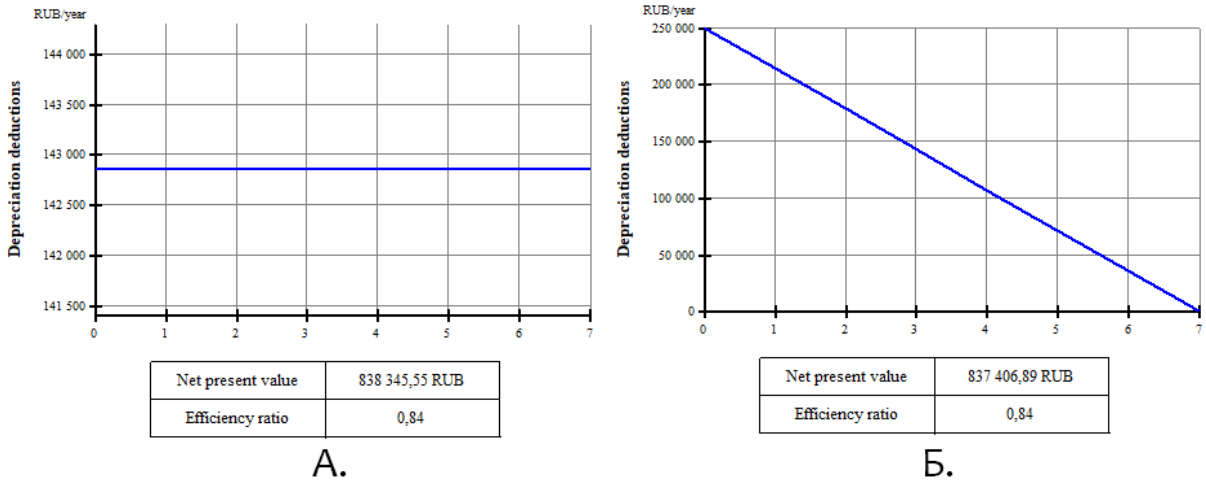

Figure 3. The amortization calculation results (A - the linear method, B - the method of writing off the costs by the sum of the survival years).

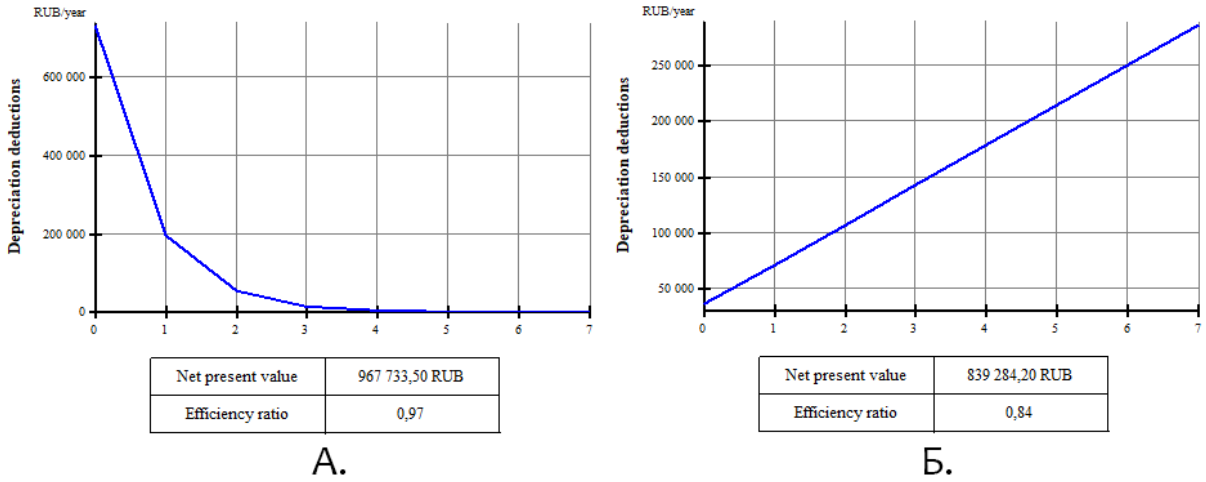

Figure 4. The amortization calculation results (A - by the method of geometric destress, B - by the progressive method).

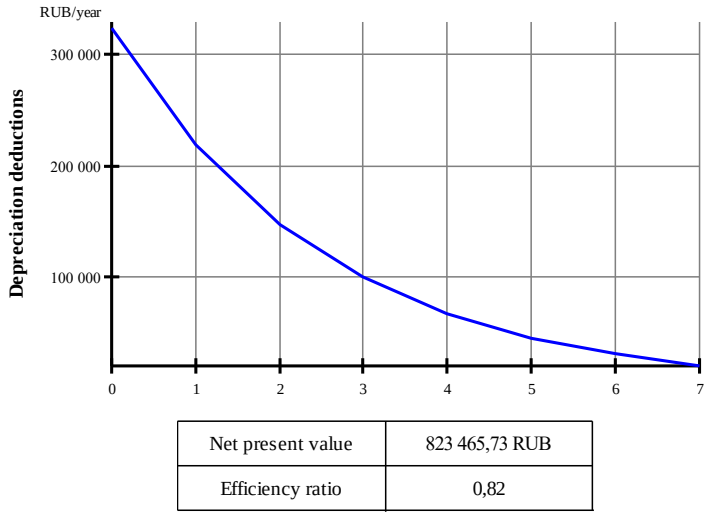

Figure 5. The amortization calculation results by the declining balance method.

5. Conclusion

As a result, based on the calculations, it can be concluded that the reproduction effect in terms of the net present value is maximal for the geometrically-digressive amortization method with the efficiency ratio of 0.97, and minimal for the declining balance method (arithmetic-digressive) with the efficiency ratio of 0.82.

The values obtained for the rectilinear and other methods, occupy an intermediate position between the values obtained by the geometrically-digressive and arithmetic-digressive methods. It follows from the above that it is advisable to use the geometrically-digressive method of amortization deductions instead of the rectilinear and other methods from the point of view that it is possible to achieve a significant expansion of the volume of TSPF only by choosing a method without attracting any other sources for this.

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