Journal of Physics: Conference Series

PAPER • OPEN ACCESS

The dynamic simulation model of calculating equipment purchase with the bond loan

To cite this article: A A Boyko *et al* 2019 *J. Phys.: Conf. Ser.* **1399** 033120

The dynamic simulation model of calculating equipment purchase with the bond loan

A A Boyko[1,2], **V V Kukartsev**[1,2], **D V Eremeev**[1], **A S Bondarev**[1], **V S Tynchenko**[1,2], **V A Kukartsev**[2] **and K A Bashmur**[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: vadimond@mail.ru

Abstract. In this article, the dynamic simulation model of calculating equipment purchase on account of a bond loan is presented. The model has been developed on the basis of system dynamic method using Powersim Studio tools. In the constructed model, calculations were conducted in two ways to determine the cost of capital raising through a bond loan and to issuing company and bond profitability for the investor. To determine the capital cost in the model there was used the optimization mechanism, as a tool to determine an optimal value there was applied an optimizer built into Powersim Studio and based on the genetic algorithm. As a result of calculations, it has been obtained next values: the raising capital cost on account of a bond loan, the bond profitability for an investor, etc. Performed calculations can allow summing up that the developed dynamic simulation model is a quiet universal model and on its basis different researches associated to varied aspects of equipment purchase account on issuance bonds are able to perform.

1. Introduction

The production of machines and equipment is the leading sector of the global industry, the state of which determines the economic development of a country. Nowadays, in Russia the production of machines and equipment has been faced to several problems. Main problems are the unsatisfactory condition of basic funds, the increasing cost of the production, the reduction in its quality and profitability. All these problems lead to deteriorating the main state of enterprises [1].

The main problem of uncompetitive production of machines and equipment in Russia is outmoded basic funds with high physical and moral deterioration.

The state of basic funds does not allow absorbing knowledge-intensive and high-tech production, does not allow improving its quality.

The one of main reasons of the problem is, according most experts, the lack of investment resources in the industry generally and in the production of machines and equipment [2], [3]. To solve the problem, it needs to use different types of bond loan for purchase of equipment by enterprises [4]. In the second article of the Federal Law “In the securities market”, a bond is issue-grade security enshrined the right of its owner to purchase of the bond issuer in the specified period of its face value or another property equivalent. A bond might envisage the right of its owner to purchase of fixed percent of bond face value or other property rights. A bond income is a percent and/or discount [5].

Today investment managers of industrial enterprises face to the necessary of determining the cost of capital rising with the bond issue, the type of issued bonds, the schedule and the method of accounting coupon percent and other factors influenced to the efficiency of a bond loan.

The complication of accounting the influence of these factors foreordains the necessary of using instrumental management methods such as the economic mathematical modeling (EMM) producing the increasing the efficiency of making solutions of calculating equipment purchase with the bond issue. Today the one of these modern and widely used ways is the dynamic simulation modelling, the system dynamics method [1].

2. The model of accounting payment of a bond loan

The model of accounting an issue of a bond loan is in figure1.

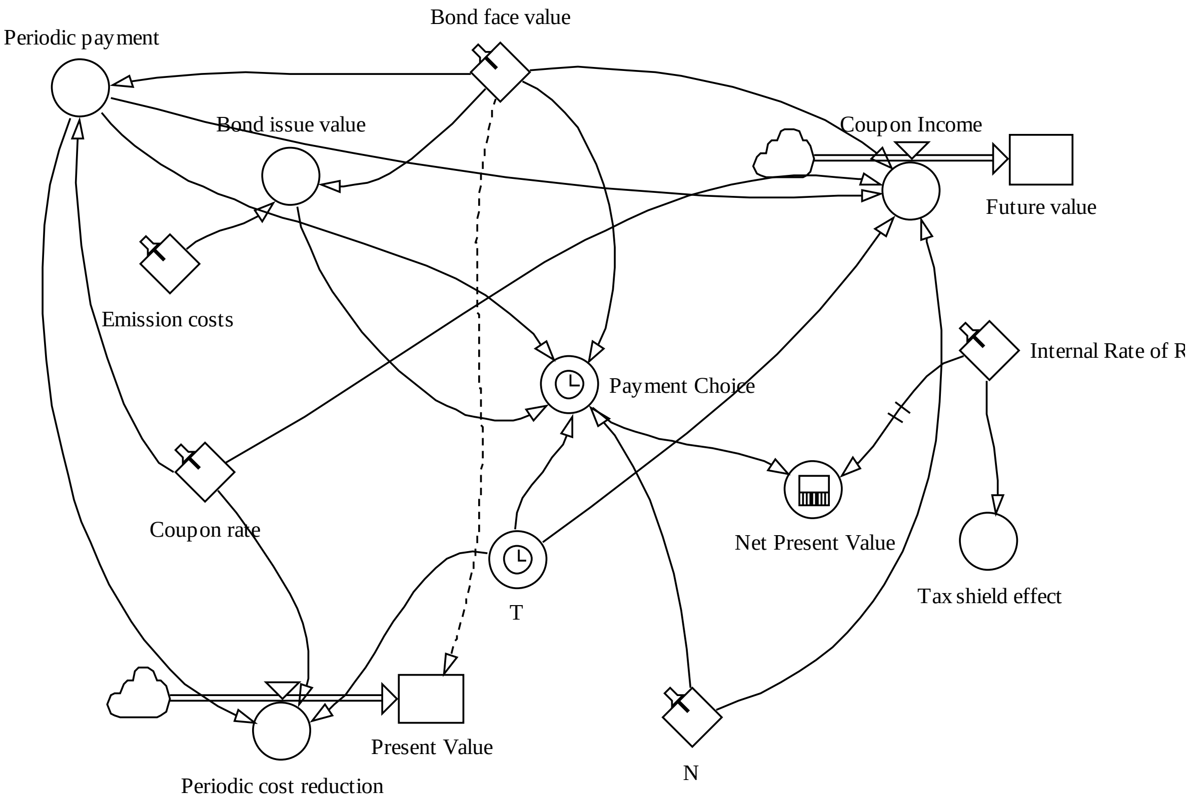

Figure 1. The diagram of flows and levels of calculating bonded loan payments.

The model of bond payment includes two levels (reservoir):

- Future value.
- Present value.

Also, there are presented two flows in the diagram:

- Coupon Income.
- Periodic cost reduction.

Except these flows and levels, there are helper variables on the scheme. An explanation of variables used in the diagram is presented in table 1. There is considering the accounting bond payment algorithm [6].

Types of bonds according to a form of the percent income payment are divided into a coupon (percent) and discount bonds. In the model, there is considering the most prevalent type of coupon bonds.

Table 1. Used variables in the diagram of flows and levels of calculating bonded loan payments.

Name	Documentation
Bond face value	Bond face value
Bond issue value	Bond issue value
Coupon Income	Coupon income on a bond
Coupon rate	Coupon rate
Emission costs	Emission costs
Future value	Investment future value
Internal Rate of Return	Bond internal rate of return
N	Bond issuance period
Net Present Value	Net present value
Payment Choice	Payment choice
Periodic cost reduction	Bond periodic cost reduction
Periodic payment	Coupon payment
Present Value	Bond presented cost
T	Current payment period
Tax shield effect	Tax shield effect

Payments with coupon bonds are divided into two money flows: the first flow determines the cost of capital rising with placing a bond loan for an issuer enterprise; the second determines the profitability of a bond for an investor.

The cost of capital rising with the placement of a bond loan is determined by the internal rate of return of an investigating project. The internal rate of return is an interest rate at which the cost of all money flows of an investigational project (NPV) is a zero. The internal rate of return is determined by formula 1 in the model:

$$NPV=-C_0+\sum_{t=1}^{T}\frac{C_t}{(1+IRR)^t} \tag{1}$$

where T – duration (a number of periods) of an investigational project;

C_0 – value of initial investments;

C_t – forecasting of net money receipts (the difference between money receipts and outflows) in the period $t = 1,\dots,T$.

The investor income of obtained bonds may be consisted of two components: periodic payments in the agreed amount (coupon profitability) and the difference between the cost of bond purchase and the cost of repayment (discount profitability). The coupon profitability on a bond is determined on the concept basis of the money cost over time based on interest rate and the current cost (the future value) in the model. The future value of money is summing currently invested money in which it will turn in a certain period with the determined interest rate, it calculates on formula 2:

$$FV=PV\times(1+i)^t \tag{2}$$

where PV – current cost (summing to invest at the moment);

i – interest rate for a period of the percent payments (for example, if percent is accrued once year, it will be annual; if percent is accrued monthly, it will be for a month)*;*

t – number of periods during which percent is accrued.

3. The interface of the accounting bound payment model control

On figure 2 there is an interface of the accounting bond payments model control.

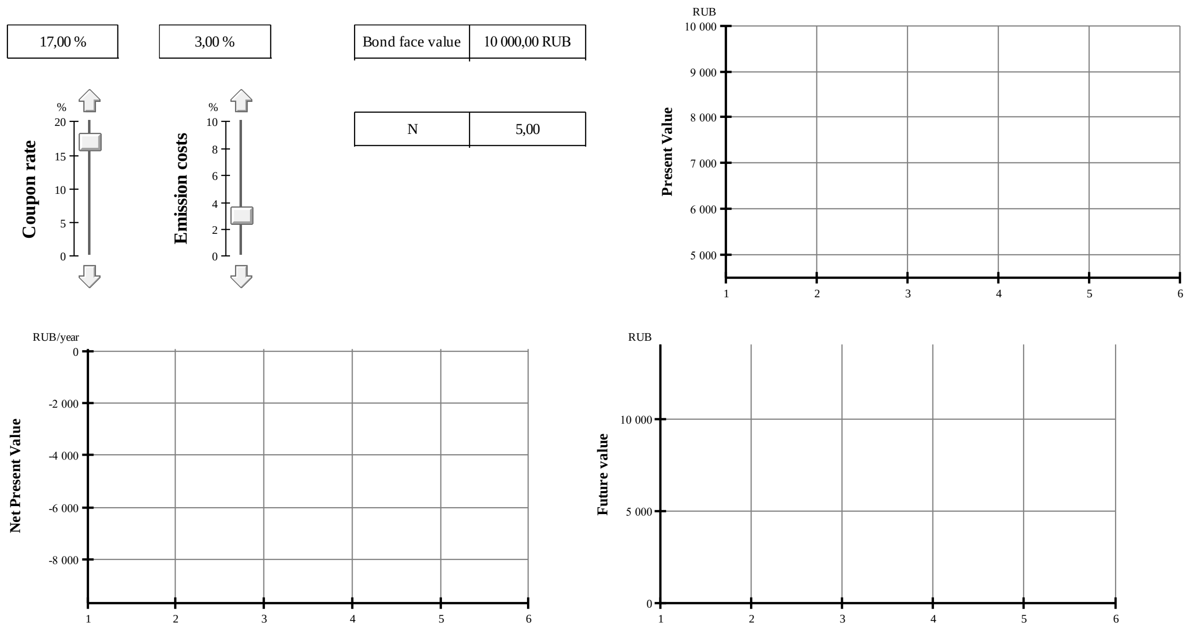

Figure 2. The control panel of the calculating bond payments model.

The structure of the interface is consisted of two parts: the entering of input data and the monitoring calculation result. Before the beginning of accounting there is entering the next data:

- Bond face value.
- Issuance bond.
- Coupon rate.
- Bond issue costs.

In the second part of the interface accounting results are displayed in the graphic form:

- Present (the current moment) bond value.
- Future value of investment.
- Schedule of changing net present value.

4. Results

In the research, the best value for money of rising capital is determined and accounting bond payment is performed according the next initial data:

- Bond face value: 10000 rub.
- Issuance bonds: 5 years.
- Coupon rate: 17 % a year.

- Issue costs: 3%.

Before the accounting bond payment, it needs to determine the best value for money of capital, to do it, there was used the optimizer built into Powersim Studio. A sought-for value is the internal rate of return of the capital (IRR). The target function of optimization is net present value (NPV). The best value of the internal rate of return is a discount rate at which NPV vanishes.

In the Decisions form (figure 3), it is setting an interval of changing IRR from 0 to 100%.

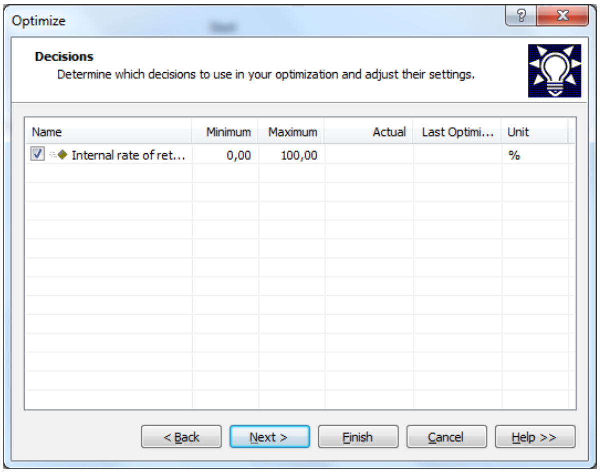

Figure 3. Decisions form.

In the Objectives form (figure 4), there is setting the target value: NPV=0.

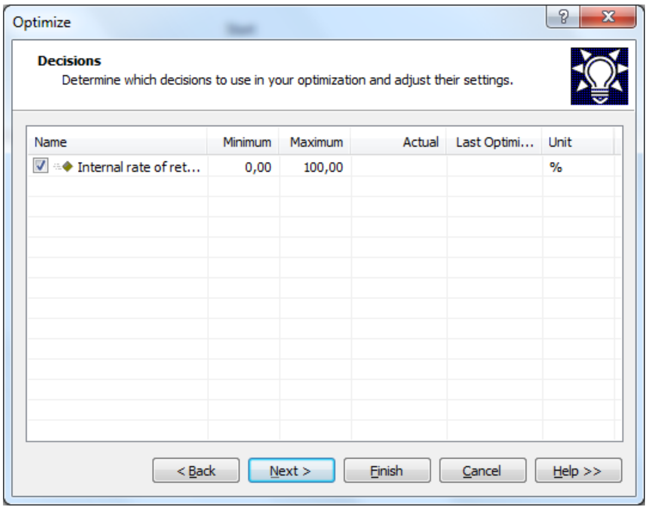

Figure 4. Objectives form.

After setting initial data, the optimizer is launched (figure 5).

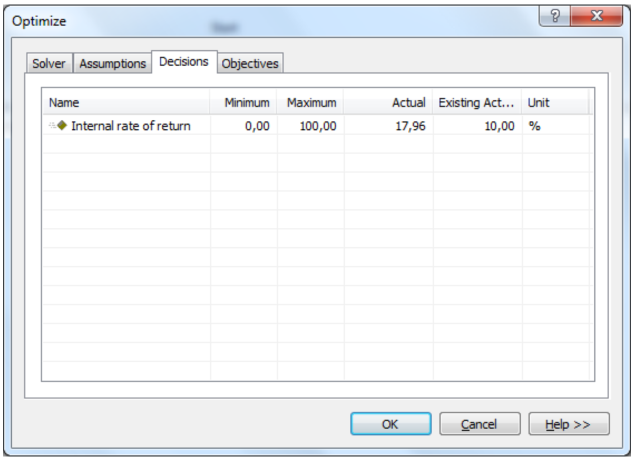

Figure 5. Results of optimization.

After defining the best value of the internal rate of return, bond payment is accounted (figure 6).

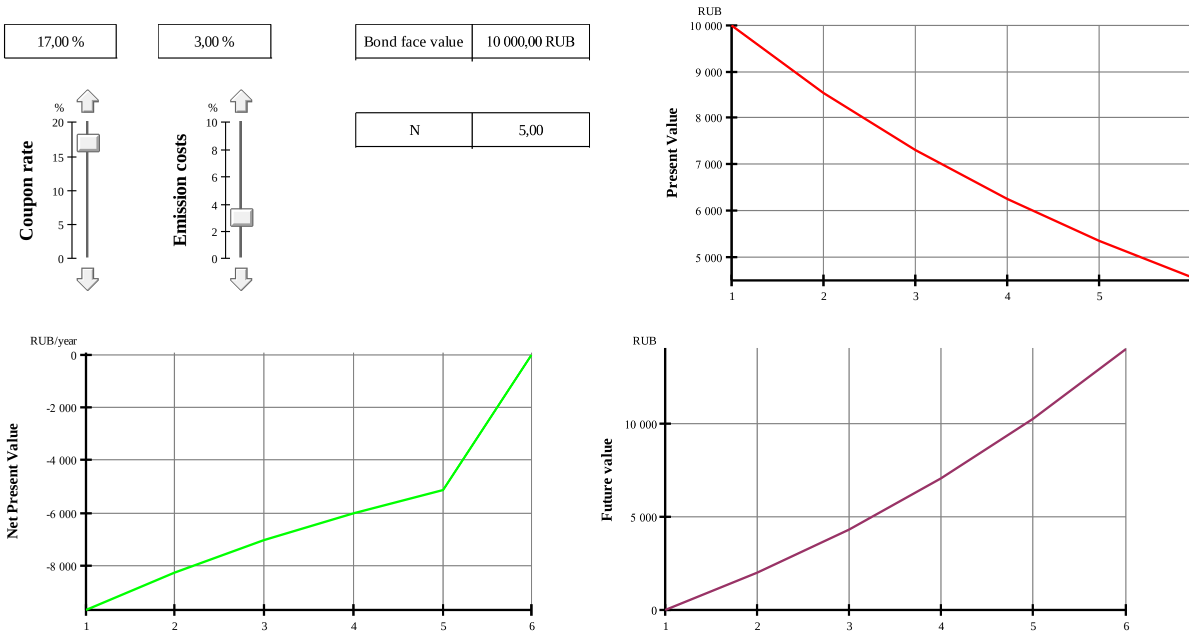

Figure 6. Result of calculating bond payments.

It can be seen from graphs (figure 6) that the current bond face value will be reduced in five years more than two times, also it is clearly revealed how net present value vanishes at the best value of the internal rate of return but the investor gets the profitability of the bond purchase.

5. Conclusion

In the result, based on performed calculations there is summing up that the placement of the bond loan is the benefit project because of the internal rate of return (17.96%) is higher than the coupon return (17%).

Also, it must notice that the constructed simulation model of bond payment of equipment purchase may be used to account state and corporate bonds, coupon and discount bonds, different types of coupon return due to the model may be considered as a multipurpose.

References

[1] Boyko A A, Kukartsev V V, Lobkov K Y and Stupina A A 2018 Strategic planning toolset for reproduction of machine building engines and equipment *J. of Phys.: Conf. Series* **1015** 042006
[2] Boyko A A, Kukartsev V V, Tynchenko V S, Chzhan E A and Stupina A A 2018 Algorithm for managing investment resources for enterprises' fixed assets reproduction *Adv. in Econ., Business and Man. Res.* **61** 188-93
[3] Kevesh A L 2017 *Investments in Russia. 2017* (Moscow, Rosstat)
[4] Kreb A, Eierle B and Tsalavoutas I 2019 Development costs capitalization and debt financing *J. of Business Fin. & Accounting* **46(5-6)** 636-85
[5] Maci J and Hovorkova V V 2017 Loan versus bond financing of Czech companies and the influence of the global recession *J. of Competitiveness* **9(1)** 72-88
[6] Bratton W W 2016 Bond and loan covenants, theory and practice *J. of Capital Markets Law* **11(4)** 461-85