Methods for operational risk's analysis of entrepreneurial structures in civil engineering

A B Kogan

1Innovations and Entrepreneurship Department, Novosibirsk State University of Economics and Management, 56, Kamenskaya, Novosibirsk 630099, Russia

E-mail: KogAnt@mail.ru

Abstract. The object of this research work is constructional business structures’ activity. The subject of the research is the connection between profit and work volume, taking into account a construction company’s tax and economic specifics. This research work’s goal is to develop formulas for calculating the break-even point (BEP) of a construction (contracting) company. In this case, the company can use three tax regimes. Firstly, it is the general taxation system (GTS), where the value added tax is paid. Secondly, it is a simplified taxation system (STS) with the object of taxation "income". Thirdly, it is the taxation object STS "income reduced by the amount of expenses." Methods of budgeting, methods of calculating tax liabilities, algebra, and general scientific methods are used to obtain the results. The approbation was carried out on the economic model of a construction firm, compiled with the use of data on the estimated cost of a building object in Novosibirsk. As a result, formulas have been developed for calculating the construction companies’ BEP, using STS, as well as BEP formulas of construction companies with the use of STS with various objects of taxation. These three BEPs values comparison is carried out, which proves the influence of the taxation system on the risks magnitude, the taxation system with the highest BEP is shown. The effect paradoxicality of STS on the tax liabilities amount, profits and operational risks is shown.

1. Introduction

Firms’ risk and profit management (and their investment projects) is a standard process for any business [1, 2]. Large companies often create goal-oriented positions to guide this process and use formal methods and documentation. Medium-sized firms can use formal methods, but their set will be smaller than that of large ones. Small businesses will use mostly intuitive approaches. However, the company's operational risks will be assessed by calculating the break-even point (BEP) at this level (and at all others).

Methods for BEP calculating have long been proposed in economic theory, but they are still being discussed by Chernyakov M.K., Chernyakova M.M., Akberov K.Ch. [3], Pyatnitsky D.V. [4], Ofileanu D. and Bumbescu S. S. [5], they still improve the mathematical foundations of BEP calculating. Daniel S. [6] associates BEP with real options. Dahan E. and Srinivasan V. [7] develop the theoretical basis for BEP calculating. Bychkova G.M. [8] describes the features of this method application for multi-product production. Many works are devoted to the reflection of industry-specific features, calculating BEP. So, Malyarevkaya L.A. [9] describes in general the influence of industry-specific features on BEP calculation. Kleinberg R.L., Paltsev S., Ebinger C.K.E., Hobbs D.A., Boersma T. [10] describe this method for the oil market, Iyer K. Ch. and Jain S. [11] for airport services, Seichiro K. and Ichimura S. [12] for energy transportation services, Dadashev A.Z. and Topchi Y.A. [13] for tourist services, and
Danilenko N.I., Zambrzhitskaya E.S., Mamaeva A.V. [14] for enterprises of ferrous metallurgy. This list can be continued, but we will note the articles, describing BEP calculation in construction industry for the purposes of this work. For example, these issues are considered by E.I. Shagikhametova and M.S. Serdarova [15] (production of building materials), as well as N.N. Khakhonova. [16] (activities of a contractor).

However, none of the materials, studied by the author of this work, clearly reflects the tax accounting procedure. Moreover, there is no description of BEP calculation for a company using a taxation system without value added tax, i.e. simplified taxation system (STS). At the same time, STS is a fairly common system, for example, it is used in Belarus (Chapter 32, Tax Code of the Belarus Republic), M.M. Nazhmiddinov and S.D. Nadezhda describe the simplified tax system application in Tajikistan [17]. We will further offer a formalized description of taxes, calculating BEP, focusing on the calculation of this indicator for firms that perform construction and installation work (CIW) under construction contracts.

BEP formula determining is based on the following considerations. A firm has fixed costs that are independent of output and variable costs, directly related to output. Fixed costs connect with time. In some cases it is convenient to calculate them for a month, in others for a week or a day. Asking the question “will the business bring losses?”, entrepreneur realizes that part of the funds, received from the sale of each goods’ unit will be paid to compensate the variable costs to create this unit (let's call them specific variable costs). The difference between the price and the specific variable costs forms the marginal profit (MP). Thus, it is necessary to divide the fixed costs by the profit margin to estimate the minimum sales volume that will cover the fixed costs. The following formulas for BEP calculating are:

\[
BEP = \frac{\text{Fixed Costs}}{\text{Marginal Profit}} = \frac{\text{Fixed Costs}}{\text{Price} - \text{Unit Var. Cost}}
\]

where

- \(\text{Fixed Costs}\) – fixed costs;
- \(\text{Marginal Profit}\) – difference between price and variable costs;
- \(\text{Unit Var. Costs}\) – unit variable costs (variable costs in the unit cost).

It should be considered that these theoretical constructions do not cover a sufficiently complete set of scientific facts, since these are general formulas that do not include taxes. For the same reason, these formulas are not applicable at the empirical level. So, we will propose formulas that take into account various types of taxes. The calculations were carried out using the example of the general taxation system (GTS) and STS, used in Russia. These formulas can be applied in any countries where taxation systems similar to the Russian simplified tax system are used.

2. Methods

In order, to calculate firms BEP, using the general taxation system, the author of this work proposes the following formula:

\[
BEP = \frac{\text{Fixed Costs} - \text{VAT}^{\text{Fixed Costs}}}{\left(\text{Price} - \text{VAT}^{\text{Price}}\right) - \left(\text{Unit Var. Costs} - \text{VAT}^{\text{Unit Var. Costs}}\right)}
\]

where

- \(\text{VAT}^{\text{Price}}\) – VAT, included in fixed costs, rub;
- \(\text{VAT}^{\text{Price}}\) – VAT, included by the seller in the price (charged to the buyer), rub.;
- \(\text{VAT}^{\text{Unit Var. Costs}}\) – VAT, included in variable costs, rub.

However, these formulas are applicable only for the case of analyzing a business that produces and sells products (services). Moreover, these products are homogeneous. But it is impossible to calculate BEP for a trading company (which does not have its own production), or for a company that produces several types of products (services), with the help of these formulas. The latter include firms performing construction and installation work.

As a rule, it is impossible to distinguish a "unit of work" in construction and installation work production. This is possible, if the firm specializes in only one type of work, but such a situation is rare.
Let's give an example: the company carries out only masonry work (brick laying). In this case, BEP calculation is possible. The work unit will be a cubic meter of a brick wall. But many firms carry out several types of work and it is necessary to offer BEP formulas for such cases. Further, the author of this work describes the formulas, developed by him.

The unit of "goods" will be 1 ruble of CIW in the construction industry. If the company performs the full scope of work, i.e. has employees and owns construction equipment (for example, owns it), then variable costs will mainly consist of material costs. On GTS, it is necessary to move from the term “costs” to the term “expenses”. So, BEP is calculated by the following formula:

\[
\text{BEP} = \frac{\text{Fixed Costs} - \text{VAT Fixed Costs}}{1 - \text{Share M}}
\]

(3)

where \( \text{Share M} \) - the share of the materials cost in the estimated cost of CIW (excluding VAT).

The second element of variable costs will be the cost of operating machines and mechanisms (OMM), for construction companies that perform an incomplete scope of work, i.e. hiring subcontractors for the production of construction equipment. For such firms, BEP calculation formula is as follows:

\[
\text{BEP} = \frac{\text{Fixed Costs} - \text{VAT Fixed Costs}}{1 - \text{Share M} - \text{Share OMM}}
\]

(4)

where the \( \text{share of OMM} \) is the share of CIW cost (excluding VAT).

BEP formulas should be changed for firms, using STS. Moreover, these formulas should be described both for the STS with the object of taxation “income”, and for STS with the object of taxation “income reduced by the amount of expenses” (hereinafter “income - expenses”). In order to calculate BEP at the "income" object, the author of this article has developed the following formula:

\[
\text{BEP} = \frac{\text{Fixed expenses}}{\text{unit price} \left(1 - \text{rate of ST STS(I)}\right) - \text{Unit.Fixed expenses}}
\]

(5)

where \( \text{The rate of ST STS (I)} \) is the rate of the single tax under the simplified taxation system with the object "I".

Let’s us note some very important details. The \( \text{rate of ST STS (I)} \) can take different values. First, the constituent entities laws of the Russian Federation can establish tax rates from 1% to 6%. Secondly, the actual rates may be less than the indicated ones by 50%, since the Tax Code gives the taxpayer right to reduce tax amount by the amount of mandatory insurance premiums, but not more than 50%. Thus, the possible values of the variable \( \text{rate of ST STS (I)} \) are in the range from 0.5% to 6%. In order to apply this formula, it is necessary to determine the average amount of labor costs, then, taking into account this value, determine the \( \text{rate of ST STS (I)} \) value.

BEP should be considered differently, using the object "income - expenses", the author of this article has developed the following formula:

\[
\text{BEP} = \frac{\text{Fixed expenses}}{\text{price} \left(1 - \text{rate of ST STS (I)}\right) - \text{Unit.Fixed expenses}}
\]

(6)

Adjustment of the variable Price (in denominator) by \((1 - 1\%)\) is explained by the fact that a minimum income tax of 1% is paid on the simplified tax system with the object of taxation "I-E" if the tax, calculated in the usual manner, is less than 1% of income.

The described formulas for BEP calculating on the STS are applicable to firms that produce and sell their products, but not for contracting construction firms. The marginal profit from each ruble of CIW, performed on the simplified tax system with the object "income", will be calculated as \( (1 - \text{rate of ST STS (I)}) - \text{Share M} \). This formula is suitable for construction companies with a full range of works, i.e. those who buy materials, but do the work with construction mechanisms themselves. In this case, it doesn't matter, whether they are purchased or rented mechanisms. If the firm does an incomplete amount
of work, i.e. orders the work of construction mechanisms from subcontractors, then the specific marginal profit will be calculated as (1 - rate of ST STS (I) - Share M - Share of OMM.

The formula for BEP calculating of a construction company with a full scope of work, applying the simplified tax system with the object "income", has the following form:

\[ \text{BEP} = \frac{\text{Fixed expenses}}{(1 - \text{rate of ST STS (I)}) - \text{Share M}} \]  

BEP of a construction company with an incomplete scope of work, applying the simplified tax system with the object "income", has the following form:

\[ \text{BEP} = \frac{\text{Fixed expenses}}{(1 - \text{rate of ST STS (I)}) - \text{Share M} - \text{Share OMM}} \]  

It was noted above that the ST STS (I) rates are in the range from 0.5% to 6%. However, if a reduced rate of this tax has not been introduced in the region where the construction company operates, then the minimum value will not be 0.5%, but 3% (in the case of maximum use by the company of right to reduce the calculated tax by the amount of contributions for compulsory insurance). If the share of labor costs is more or less stable, then this rate can be calculated with appropriate accuracy. You can also calculate the maximum BEP value (at 6%) and the minimum BEP value (at 3%).

If a construction company with a full scope of work applies the simplified tax system with the object "income - expenses", then these formulas are written differently. For a company with a full scope of work:

\[ \text{BEP} = \frac{\text{Fixed expenses}}{(1 - \text{1\%}) - \text{Share M}} \]  

For a company with an incomplete workforce:

\[ \text{BEP} = \frac{\text{Fixed expenses}}{(1 - \text{1\%}) - \text{Share M} - \text{Share OMM}} \]  

Let's us note an important detail. Traditionally, BEP units are natural indicators over a period of time (for which fixed costs are calculated), for example, pieces per month. However, for construction firms, BEP will be measured in the volume of orders (calculated in rubles) in a period of time (for which fixed costs are calculated), for example, construction and installation works per month.

3. Results
We should perform calculations, based on the economic model of a construction company, which fully reflects the object properties of observation we need. This means that the conclusions, drawn from these calculations, will be reliable. Let's calculate BEP for a company performing construction and installation work in the following composition:

- monolithic concrete erection and reinforced concrete structures of the foundation (hereinafter - work No. 1);
- monolithic concrete erection and reinforced concrete structures of the frame below the 0.000 mark (hereinafter - work No. 2);
- monolithic concrete erection and reinforced concrete structures of the frame above the 0.000 mark (hereinafter - work No. 3).

Table 1 describes the structure of the estimated cost of these works performed for a typical object (a multi-storey residential building with a frame made of monolithic reinforced concrete and brick external enclosing structures). We can project the structure of these works’ cost on those works that will be performed by the company in the future.

| Category | Work №1 | Work №2 | Work №3 | TOTAL |
|----------|---------|---------|---------|-------|

Table 1. Estimated cost of construction and installation works, thousand rubles.
We calculate BEP with the simplified tax system of various objects of taxation. So, we calculate the Share M = 83,000 / 128,650 = 0.65 and the Share of OMM = 16,400 / 128,650 = 0.13 according to the data in Table 1. Let's assume that the firm's fixed costs are 110,000 thousand rubles per a month (all workers' wages are included in fixed costs).

If a company with an incomplete scope of work uses the simplified tax system with the object "income - expenses", then BEP = \frac{110,000}{(1 - 1\% - 0.65 - 0.13)} = 506,070 thousand rubles CIW per a month.

Let's check this result. Income is equal to BEP; variable costs are equal to 506,070 x 0.65 x 0.13 = 391,010 thousand rubles; fixed costs 110,000 thousand rubles; the base of the ST STS is equal to 506,070 - 391,010 = 115,060 = 5,061 thousand rubles. The tax, calculated on this amount at a rate of 15%, will be 759 thousand rubles, which is less than the minimum tax and it is equal to 506,070 x 1% = 5061 thousand rubles, i.e. a minimum tax must be paid. Thus, the financial result will be 5,061 - 5,061 = 0, i.e. there are no losses or profits. Therefore, BEP calculation is correct.

In the same case, if a construction company uses GTS, BEP calculation will be carried out according to the data in Table 1 as follows. It is first necessary to calculate the estimated cost of construction and installation work. Let's assume that the amount of fixed expenses is 110,000 thousand rubles, includes VAT 10,000 thousand rubles. Next step, we will determine the amount of VAT, invoiced to the company by suppliers. In order to do this, we summarize the VAT values according to 1.2 and 1.3 points (columns 3, 5, 7) and get, respectively, 12,600 and 2,600 thousand rubles. So, we determine the profit: 10,900 + (83,000 - 12,600) + (16,400 - 2,600) + 11,450 = 113,450 thousand rubles. The amount of VAT, charged by the company to its customer, will be 113,450 x 20% = 22,690 thousand rubles. The share of M will be (83,000 - 12,600) / 113,450 = 0.62. The share of OMM will be (16,400 - 2,600) / 113,450 = 0.12.

Thus, if a construction company with an incomplete set of works uses the GTS, then it’s BEP = \frac{110,000}{1 - 0.62} = 387,863 thousand rubles. We should note that this is the company's profit, which does not include VAT. Let's check it. Variable costs will amount to 387 863 x (0.62 + 0.12) = 287,863 thousand rubles. Fixed costs for GTS do not include VAT, i.e. equal to 100,000 thousand rubles.
Hence, the total costs will amount to 387,863 thousand rubles, which is equal to the profit, i.e. loss (and profit) is equal to 0. So, we consider that BEP calculation is correct.

4. Conclusion
The formulas for BEP calculating of a construction company, using the simplified tax system, proposed by the author of this work, have been verified and give accurate results. These formulas will make it possible to predict the behavior of business structures in construction, and hence the construction industry state.

Analytical tools are proposed to enable a construction firm in order to assess operational risks. The formulas, proposed by the author, make it possible to estimate the monthly volume of construction and installation work, required for the break-even functioning of the company, or to obtain a given amount of profit.

We come to the conclusion, comparing in pairs formulas 8, 10 and formulas 9, 11, that the simplified tax system with the object "income" in most cases entails a higher operational risk according to the simplified tax system with the object "income - expenses". This is due to the fact that most Russian regions do not use the right to reduce the ST STS rate and it is equal to 6%. This means that the minimum value of the ST STS rate (l) is 3%, i.e. the denominator of formulas 8 and 9 is less than the denominator of 10 and 11 formulas, respectively. It follows that, all other things being equal, BEP on the STS with the object "income" will be more than on the STS with the object "income - expenses".

Let's compare BEP on the GTS with BEP on the STS. From a comparison of (4) formula with (8) and (10) formulas, it follows that the denominator in formula (8) is less than in others, which means that BEP on the GTS will be less than BEP on the STS. The same conclusion follows from a comparison of formula (5) with (9) and (11) formulas.

However, it is necessary to introduce additional conditions and perform new calculations to prove the statement that the BEP on the GTS is less than BEP on the STS. This is due to the fact that the compositions of GTS and STS expenses are different: they include VAT on GTS, but there is no VAT on STS one. So, due to the calculations above, the fixed costs for the simplified taxation system were 110,000 thousand rubles, and 100,000 thousand rubles were for the general tax system. However, even in the case when VAT will be equal to 0, the BEP on the GTS will be less than the BEP on the STS due to the fact that the denominator in formula (4) is greater than in formulas (8) and (10), and the denominator in formula (5) is greater than in formulas (9) and (11). This is rather paradoxical: companies pay less tax on the GTS, which implies higher profits. However, the construction company will receive more profit on GTS, but not on STS in a situation where BEP on GTS is less than BEP on STS (and other things being equal).

For a complete understanding of all BEP using specifics for making management decisions, we have to conclude that the accounting profit, which basis BEP is calculated on, is not a sufficiently informative indicator. However, this also applies to any other indicator, so a system of indicators is needed. For an in-depth assessment of the prospects and results of the company's activities, special financial indicators, both universal and those that reflect the specifics of construction, are of great importance. For more details see [18-21].

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