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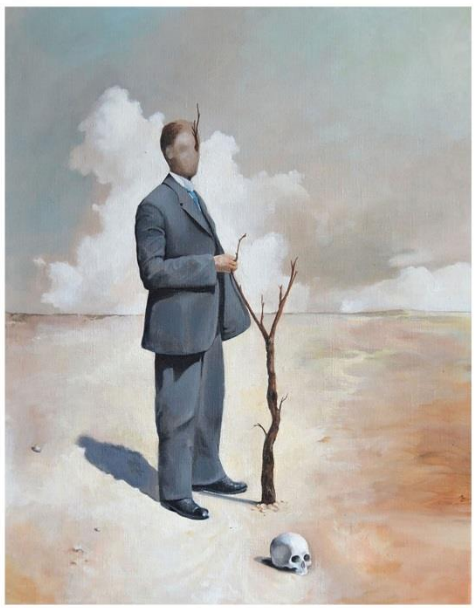

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Modeling the optimal structure of the incentive payments fund of an organization

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Abstract

The article reveals the author's approach to optimizing the fund of university incentive payments. The proposed model allows to structure the existing fund of incentive payments in such a way as to increase the average level of faculty salaries. As a result, a change in the structure of incentive allowances at a constant amount has a noticeable effect on the average wage level. In conclusion, due to an increase in average wages, one can achieve a higher place in domestic and international ratings of higher education institutions.

Keywords: Optimization, University, Payments Fund, Rating.

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Modelando la estructura óptima del fondo de pagos de incentivos de una organización

Resumen

El artículo revela el enfoque del autor para optimizar el fondo de pagos de incentivos universitarios. El modelo propuesto permite estructurar el fondo existente de pagos de incentivos de tal manera que aumente el nivel promedio de los salarios de los docentes. Como resultado, un cambio en la estructura de las asignaciones de incentivos a un monto constante tiene un efecto notable en el nivel salarial promedio. En conclusión, debido a un aumento en los salarios promedio, uno puede alcanzar un lugar más alto en las calificaciones nacionales e internacionales de las instituciones de educación superior.

Palabras clave: Optimización, Universidad, Fondo de pagos, Calificación.

1. INTRODUCTION

In conditions of market competition, the choice of an educational organization by stakeholders is usually determined by the indicators occupied in the world and Russian ratings of higher educational institutions. At the same time, one of the key factors affecting the place occupied in the rankings is the quality of the teaching staff, financing and the average level of remuneration. As a rule, most state educational organizations have a mixed nature of financing with a fixed share of budget subsidies, which have a strict purpose (LAPTEV & FILINA, 2016).

In this regard, there is an urgent need for the rational management of their own financial resources in such a way as to maintain the existing potential. One of the effective tools to ensure the quality of managerial decisions is an optimization model that allows you to distribute funds according to a given structure necessary for solving tactical tasks (KRUKHMALEVA, 2012). The competitive advantage of the university, which provides opening and recruitment for basic educational programs, both in specialty, undergraduate, graduate and postgraduate studies, is the faculty.

Consequently, not only the quality of educational services but also the reputation of the university and its development strategy depend on the proportion of academicians, professors, associate professors, teachers in the total number of faculty. A large share of professors necessitates the maintenance of serious funding for their level of wages since the high qualification of employees allows them to freely compete in the labor market. In turn, the top management is faced with the task of supporting the staff in such a way as not to infringe on the interests of the university and to minimize labor costs. The need to solve this problem is dictated by the fact that currently mixed financing of expenses forces to save on the wage fund, finding the gold proportions in the ratio of the number of faculty members (KUPRIYANOV, 2015).

At the same time, the model of an effective contract used by the university allows accumulating expenses on incentive payments in order to motivate individual employees based on their activity and observing the principle of adequacy to creative labor costs. Another urgent task of any educational organization is to maintain the average salary of faculty at a level not lower than the average salary in the region. Moreover, the limited resources, on the one hand, the heterogeneous number of faculty on the other, the preservation of the motivational component on the third hand, force top management to look for compromise solutions and tools. The solution to this problem is possible using only mathematical modeling of the optimal structure of the fund of stimulating payments (GOURIEROUX, 2000).

2. METHODOLOGY

When constructing a model, a number of difficulties and limitations arise. First of all, the structure of the wage fund is mixed. It may include budget subsidies, grants and endowment funds, cash received by the university from income-generating activities. In this case, incentive payments are formed only from the third party. In addition, their value for the university is not constant and must be coordinated not only by the leadership of the university but also by the trade union organization (YENDOVITSKY, 2016).

The second requirement that the model should satisfy is related to the heterogeneity of the staff. In this case, it is necessary to take into account not only the share of the rate occupied by the employee, but also the position, available rank, the possibility of combining posts, and the functions performed by the employee. The staffing is also a variable (DAVNIS & TINYAKOVA, 2005).

The third requirement is the motivational component of labor. The distribution of the fund of incentive payments should be performed in such a way as to provide compensation not only for labor costs but also for the formation of intellectual potential (ENDOVITSKY, 2018).

We give a brief description of the model, which reflects the mechanism for the formation of wages of each k-th type of employee. To do this, we introduce the following notation: y_k - the total amount of wages from two sources; r_k - a fixed value equal to the salary received for the implementation of training instructions provided for in the load; d_k - the maximum possible amount of additional payment from the fund of incentive payments;

ε_k - a random variable with zero mathematical expectation characterizing the accuracy of the model with which the total payment is reproduced;

x_k - a dichotomous random variable that takes on values in accordance with the following rule: $x_k = 1$, if the employee has the right to receive incentive payments, $x_k = -1$, if the employee does not have this right.

In the general case, using the introduced notation, the total salary of employees of the k-type, obtained from two sources, can be represented by the following model:

$$y_k = \acute{r}_k + d_k x_k + \varepsilon_k \,, \qquad k = \overline{1,m} \,. \tag{1}$$

To use this model in further calculations, it is necessary to proceed to its mathematical expectation, which, given the known probability distribution P_k of a random variable x_k, can be obtained as follows:

$$E(y_k) = \acute{r}_k + d_k E(x_k) + E(\varepsilon_k) =$$

$$\acute{r}_k + d_k[(+1)P_k + (-1)(1 - P_k)] =$$

$$= \acute{r}_k + d_k[2P_k - 1] \qquad (2)$$

The probability distribution in the proposed approach plays an important role. It is determined for each type of employee, characterizing the level of the creative potential of the corresponding group. With its help, a mechanism for the formation of a supplement from the funds of the second source of wages is implemented. The most justified solution to this problem is the econometric approach, which uses probit models:

$$P_k = P(x_k = 1/z) = \frac{1}{\sqrt{2\pi}} \int_{-\infty}^{b_0+b_1 z} e^{\frac{t^2}{2}} dt \qquad (3)$$

or logit-models of binary choice

$$P_k = P(x_k = 1/z) = \frac{1}{1+e^{b_0+b_1 z}}. \qquad (4)$$

The estimation of the parameters b_0, b_1 of these models using the maximum likelihood method is provided for in many statistical processing packages and is therefore solved without problems. More complex is the problem of determining the factor space, the characteristics of which affect the creative activity of the faculty and can be used as factors of binary choice models. In principle, the main set of factors is known, but it is not systematized and most importantly, in most cases, the factors of this set do not have quantitative measurement and therefore are useless in econometric modeling (LUKINOVA, 2015).

The credibility of the generated variant of the possible values P_k is achieved by using the actual values of the wages of the employees of the corresponding group for a certain period of time. If we present, the actual salary of the i-th employee of the k-th group in the form of the sum of the solid salary and the allowance:

$$y_{ki} = \acute{r}_k + \Delta y_{ki} \quad k = \overline{1,m}\,, \quad i = \overline{1,n_k}\,, \qquad (5)$$

then an estimate of the possible probability value can be determined using the following expression:

$$\hat{P}_k = \frac{\acute{r}_k + \frac{1}{n_k}\sum_{i=1}^{n_k}\Delta y_{ki}}{2\acute{r}_k}\,, \qquad k = \overline{1,m}\,. \qquad (6)$$

Using (6), a valid estimate value is obtained, since, provided that the average allowance does not exceed a fixed salary, the estimate less than 1 and at the same time more than 0.5, thereby providing a semantic interpretation of the mechanism of formation of wages from two sources, described by expression (2). Formula (6) can be easily modified to calculate individual estimates or estimates that reflect the action of the mechanism of wage formation at certain time intervals. This feature allows you to create a fairly representative set of possible options for subsequent expert determination of the most preferred option (LAPTEV, 2017).

The final result of the expert assessment is a group assessment obtained from averaging individual assessments assuming their high consistency. The level of consistency is determined using the concordance coefficient.

$$W = \frac{12S}{m^2(n^3-n)}, \qquad (7)$$

where

$S = \sum_{i=1}^{n}\left(\sum_{j=1}^{m} h_{ij} - \acute{h}\right)^2$ - the sum of the squares of the deviations of the ranking estimates from the average value of the rank for all evaluated options;

h_{ij} - the rank assigned to the i-th option by the j-th expert;

$\acute{h} = \frac{(n+1)m}{2}$ - the average value of the ranking;

m - number of experts;

n - the number of evaluated options.

Equality of the coefficient of concordance 1 means that the opinion of experts on all options completely coincides, if it is equal to zero, then all the ranking of the options is different. In all other cases, the value of the concordance coefficient is between 0 and 1. The closer its value to 1, the closer the relationship between individual ratings and the higher the level of reliability of the group score. For the case when the number of evaluated options $n > 7$, the statistical significance of the resulting assessment of the coefficient of concordance is checked using the criterion χ^2, the value of which is calculated in accordance with the expression:

$$\chi^2 = Wm(n-1). \qquad (8)$$

The statistical significance of the concordance coefficient indicates a rather high reliability of the obtained group estimates, allowing them to be used in further calculations as subjective probabilities characterizing the creative potential of each group of employees. When constructing a model of the optimal distribution of incentive benefit fund funds, it is assumed that the incentive benefit fund size is fixed during the calendar year, the employee's salary is also constant, and staffing is assumed to be stable. We denote this vector $w' = (w_1, w_2, \dots w_m)$ and, given that the sum of its components is 1, i.e. using this vector, you can specify the structure of the stimulating fund, we write, using this property, the size of the fund in the following form:

$$y = \sum_{k=1}^{m} w_k (r_k + d_k x_k) \qquad (9)$$

A motivation fund in the form of (9), in essence, is a portfolio formed of private funds intended for paying allowances to various categories of employees. It is customary to use mathematical expectations in the calculations, rather than random variables. Therefore, for the case where the probability P is known, the mathematical expectation of expression (9) is representable in the form:

$$E(y) = \sum_{k=1}^{m} w_k r_k + \sum_{k=1}^{m} w_k d_k (2P_k - 1) \qquad (10)$$

The first term in the resulting expression represents the weighted amount of fixed rates, and the second weighted amount of the expected allowances, due to which you can increase the average wage. The task is to determine such an option for structuring the incentive fund at which a given average level of wages will be achieved, with the minimum possible amount of allowances. Formally, this optimization problem is written as follows:

$$\sum_{k=1}^{m} w_k^2 [d_k (2P_k - 1)] \rightarrow min \qquad (11)$$

$$\sum_{k=1}^{m} w_k[r_k + d_k(2P_k - 1)] = \mu \tag{12}$$

$$\sum_{k=1}^{m} w_k = 1 \tag{13}$$

This statement provides for minimizing the sum of the squares of the allowances, provided that the allowances provide a given level of the average wage. Restriction (13) provides that the solution should be in the form of a normalized vector. For the convenience of further exposition, we write model (11) - (13) in the vector-matrix form, introducing for this purpose the following notation:

$$\Sigma_d = \begin{pmatrix} d_1^2(2P_1-1)^2 & 0 & \cdots & 0 \\ 0 & d_2^2(2P_2-1)^2 & \cdots & 0 \\ \vdots & \vdots & \vdots & \vdots \\ 0 & 0 & \cdots & d_m^2(2P_m-1)^2 \end{pmatrix}$$

$$r = \begin{pmatrix} r_1 + d_1(2P_1-1) \\ r_2 + d_2(2P_2-1) \\ \vdots \\ r_m + d_m(2P_m-1) \end{pmatrix}, \qquad i = \begin{pmatrix} 1 \\ 1 \\ \vdots \\ 1 \end{pmatrix}$$

Using the introduced notation, we write the model (11) - (13) in a compact form:

$$w'\Sigma_d w \to min \tag{14}$$

$$w'r = \mu \tag{15}$$

$$w'i = 1 \tag{16}$$

It is convenient to obtain analytical solutions of optimization problems by introducing Lagrange multipliers, which make it possible to balance the number of equations with the number of unknowns. We write the Lagrange function for this problem:

$$L_w = w'\Sigma_d w - 2\lambda(w'r - \mu) - 2\delta(w'i - 1) \tag{17}$$

and differentiate it with respect to m +2 variables w_i. We write the resulting system of equations in matrix form:

$$L'_w = 2\Sigma_d w - 2\lambda r - 2\delta i = 0 \quad (18)$$

$$L'_\lambda = w' r - \mu = 0 \quad (19)$$

$$L'_\delta = w' i - 1 = 0 \quad (20)$$

From (18) we obtain:

$$w = \Sigma_d^{-1}(\lambda r + \delta i) \quad (21)$$

and substituting the resulting expression in (19) and (20), we can write the system of equations:

$$r\Sigma_d^{-1}(\lambda r + \delta i) = \mu \quad (22)$$

$$i\Sigma_d^{-1}(\lambda r + \delta i) = 1 \quad (23)$$

solving which by the Cramer method, we find the values of the Lagrange multipliers:

$$\lambda = \frac{i'\Sigma_d^{-1} i\mu - r'\Sigma_d^{-1} i}{(r'\Sigma_d^{-1} r)(i'\Sigma_d^{-1} i) - (r'\Sigma_d^{-1} i)^2}, \qquad \delta = \frac{r'\Sigma_d^{-1} r - r'\Sigma_d^{-1} i\mu}{(r'\Sigma_d^{-1} r)(i'\Sigma_d^{-1} i) - (r'\Sigma_d^{-1} i)^2}.$$

Thus, in accordance with (21), we obtain the optimal solution in the following form:

$$w = \Sigma_d^{-1}(\lambda \; r + \delta \; i) \quad (24)$$

The problem of the practical use of the optimal solution is that it should be implemented in a situation where, on the one hand, the number of employees by category is different, and on the other hand, the size of the incentive fund is limited (OZERNIKOVA, 2018). Therefore, the details of the whole complex of calculations will be demonstrated using a conditional example.

3. RESULTS AND DISCUSSION

In the example, we will assume that the annual stimulating fund of the conditional faculty is V = 1 000 000 rubles. Total payments cannot exceed the value of this fund and at the same time must provide a given level of the average wage. Before proceeding to a detailed description of the model for determining the optimal structure of incentive allowances, we will form the necessary data set. For the convenience of references, when describing the calculations, we present this set in the form of table 1 (SAVINOVA, 2017).

Among the data in table 1, there are constant values, which include the number of categories (L) and the salary value (r). They are included in the table for the reason that with their help the average value of incentive surcharges is determined by categories (d). The calculation of the incentive supplement is performed under the assumption that its average value should be proportional to the salary. To this end, first, for each category, in proportion to the salary, the share of the incentive fund is determined:

$$g_k = \frac{L_k r_k}{\sum_{i=1}^{4} L_i r_i}, k = \acute{1,4} \qquad (25)$$

Using the obtained value, the stimulating fund of each category is determined:

$$S_k = V * g_k, k = \acute{1,4} \qquad (26)$$

then double the average monthly allowance:

$$h_k = \frac{S_k}{12 L_k} k = \acute{1,4} \qquad (27)$$

taken as appropriate d_k..

Table 1: Initial data for building a model

Name of indicators	Head of the department	Professor	Associate Professor	Lecturer
Number (L)	9	10	50	80
Salary (r)	46500	42000	34000	22000
Activity (P)	0,62	0,64	0,64	0,54
Allowance (d)	1802,9	1628,5	1318,3	853,0

The category premiums calculated in accordance with formulas (25) - (27) are included in the last row of table 1. The values of the activity parameter P for each category of employees were determined in accordance with expression (6). The data in table 1 is sufficient to build the model. Using these data and guided by expressions (14) - (16), we write in detail the digital representation of the model:

$$w'\Sigma_d w = \begin{pmatrix} w_1 \\ w_2 \\ w_3 \\ w_4 \end{pmatrix}' \begin{pmatrix} 187237 & 0 & 0 & 0 \\ 0 & 207911 & 0 & 0 \\ 0 & 0 & 136250 & 0 \\ 0 & 0 & 0 & 4656 \end{pmatrix} \begin{pmatrix} w_1 \\ w_2 \\ w_3 \\ w_4 \end{pmatrix} \to min$$

$$w'r = 46932{,}7w_1 + 42456w_2 + 34369w_3 + 22068{,}2w_4 = 30000$$

$$w'i = \begin{pmatrix} w_1 \\ w_2 \\ w_3 \\ w_4 \end{pmatrix}' \begin{pmatrix} 1 \\ 1 \\ 1 \\ 1 \end{pmatrix} = 1$$

Using the generated model, multivariate calculations were performed, which are given in table 2.

Table 2: Multivariate calculation results

Name of indicators	Head of the department	Professor	Associate Professor	Lecturer
Optimum premium structure	0,0555	0,0444	0,0524	0,8476
Highest possible allowances	311,23	248,97	293,60	4748,94
Salary 25 thousand rubles	46574,7	42070	34082	22380
Optimum premium structure	0,1606	0,121	0,1195	0,5988
Highest possible allowances	899,94	678,07	669,76	3354,96
Salary 30 thousand rubles	46716	42190	34188	22268
Optimum premium structure	0,2657	0,1976	0,1867	0,3500
Highest possible allowances	1488,66	1107,20	1045,90	1960,98
Salary 35 thousand rubles	46857	42310	34293	22157
Optimum premium structure	0,37078	0,2742	0,2538	0,1012
Highest possible	2077,38	1536,30	1422,10	566,99

allowances				
Salary 40 thousand rubles	46998	42430	34398	22045
Optimum premium structure	0,4128	0,3048	0,2807	0,0017
Highest possible allowances	2312,86	1707,90	1572,60	9,40
Salary 42 thousand rubles	47055	42478	34440	22001

The calculation options presented in the table show that a change in the structure of incentive allowances at a constant amount has a noticeable effect on the average wage level. Moreover, the analysis of these options allows us to conclude on the principles that should be followed in the case of the realization of desires aimed at increasing the average level of wages. The increase in the average wage requires an increase in each ruble of the incentive fund share, which is spent on stimulating employees with high official salaries. Therefore, the decision to increase the average level of wages due to incentive payments should be balanced.

4. CONCLUSIONS

The model is quite compact and versatile. Its size is determined by the number of categories of employees of the educational institution, which are not very many, and its versatility allows it to be used both at the university level and at the level of its individual structural units: faculties, departments, laboratories. The only problem is the correct determination of the required data set. It is impossible, for example, that the total amount of allowances exceeds the incentive fund or that the expected average wage is excessively large.

In addition, the model contains capabilities that were not demonstrated in the multivariate calculations shown in table 2, but which significantly expand the practice of its use. For example, thanks to the P coefficients characterizing creative activity, the model can be turned into a tool for building up creative potential. At the level of the university as a whole, it allows not only rationally distributing incentive payments, but also generating forecast options for the next calendar periods.

But the main result is that without attracting external financing, but only by optimizing the available financial resources, to achieve an increase in the average salary of the faculty, which is one of the indicators monitored by the control bodies of educational organizations. This provides a competitive advantage since due to an increase in average wages, one can achieve a higher place in domestic and international ratings of higher education institutions.

We can recommend testing the proposed model not only by universities but also by other organizations that use incentive payment funds in the mechanism of wage formation.

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