Going to business or intending in science?

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GOING TO BUSINESS OR INTENDING IN SCIENCE?

Abstract: This paper discusses the urgent problem of Russian graduates: job search after graduation. It is shown that, in connection with the growing population of the country due to migrants, the arrival of cheap labor from neighboring countries and other economic factors, the search for a decent job as a graduate remains a difficult and relevant problem in modern Russia. The result of this study can be considered as follows. It is shown that there is the possibility of decent earnings in the scientific field of activity when working with students. A mathematical model and an algorithm for simulating the demonstrated situation are developed. It is shown when a graduate should start searching for additional income and when he can catch up with the total amount of money paid if he went to work in a commercial company. This research is purely theoretical.

Keywords: mathematical modeling, business, science, graduates of Russian universities, job search

INTRODUCTION

The modern world of the XXI century is as different as possible from the previous ones [1]. Such a strong difference is due to many factors, of which we distinguish two: science and business. Science and business went in almost all spheres of human activity parallel to each other until the XVIII century [2, 3], when the Industrial Revolution began. The Industrial Revolution could not fail to be reflected in classical textbooks on history and economics, where the main merit is the transition from an agrarian to an industrial society and is presented as an undoubted benefit in the long-term development of mankind. It is worth mentioning separately that any positive change carries with it the negative side [1].

A business that so desperately needs modern science today, without realizing it, came to science in the 21st century. As an example of such a "arrival", it is worth mentioning the new market, which was formed relatively recently – the market of scientific publications [4, 18]. The market for scientific publications (hereinafter referred to as the market) did not develop particularly actively in Russia until the May Decrees of the President of the Russian Federation [4], in which the President of the Russian Federation reflected that the time had come for the rapid development of not only business, but also science. Many scholars [5–8] agree that the Decree states that from now on it is important not so much the quality of the articles, but how much in what volume and in which journals the author has placed them. The framework was also worked out by each university, research institute,

etc. scientific institutions how many and what publications each employee should publish for a certain period. Since 2013, the market began to grow sharply, because there was a demand. For an absolutely small amount of money, it seems possible to become a co-author (to buy a place in the list of authors) in journals peer-reviewed by databases (hereinafter referred to as DB) of the RSCI, HAC and for quite impressive money it also seems possible to "become" the author of an article in the Scopus database (hereinafter referred to as Sc) or Web of Scinece (hereinafter WoS). Some universities have gone even further than the above decrees. They began to impressively reward their employees at the end of the year for publications published in certain scientific knowledge bases, such as Sc and WoS, thereby encouraging their employees to evaluate the possibilities of buying "places" co-authored by such articles, and, in turn, The university was given the opportunity to report to higher authorities for the serious work done in the field of science in accordance with the May Decrees of the President. Sometimes such a bonus is more than a six-month employee's salary and may even exceed the cost of buying a "place" in an article.

For obvious reasons, young people who have just graduated from a university cannot always afford the opportunity to buy a "co-sponsored place" to report to the university's management about the work done, which in turn can greatly affect the final salary of yesterday's graduate and even the term his agreement with the university to accept him for work.

It is worth considering that this situation is aggravated by the fact that the salary of a young specialist at a university or research institute is extremely small, and accordingly, the monthly budget can hardly afford to cover the necessary needs.

A modern graduate, knowing about this situation, does not go into science, but wants to go into business, where the starting salary of a young specialist is on average several times higher than that of an assistant chair or ml. Researcher at the Research Institute.

It is believed that in the early stages of development of a young man after university, high income and work in the field of science are two points that cannot be realized simultaneously. Many authors of works [9–11] agree that, firstly, income at enterprises and companies is higher and more stable, and secondly, that finding a highly paid job[1] in a graduate in Russia specializing in such rare and complex as a mathematician, the physicist is literally impossible. It is also worth adding to the consideration of the following set of economic factors. Firstly, in 2001, fertility over mortality has been projected in Russia [12], secondly, the ongoing economic crisis [13–15] caused by US sanctions and other forms of influence on the Russian economy, thirdly, every year there is a substantial number of migrants from the countries of the Near Abroad [16] who are ready to work for a lower salary [16], which also does not increase the average salary in the regions of the country [16]. Together, all this will entail a reduction in jobs, which will complicate the job search for graduates. We note separately that each year Russia issues about 1 million people [17].

Thus, we can conclude that the problem of job search after a university graduate in Russia is complex and relevant.

GOALS AND OBJECTIVES

First, let us doubt the opinion generally accepted by many authors of scientific works about the extreme difficulty of finding a job after graduation, and secondly, as a goal of this work, offer an option for graduates to achieve a goal (stable and decent income and work in a specialty at a university or research institute) and justify its achievement, both from a scientific and economic point of view.

MATHEMATICAL MODEL

Each university (in different universities in different ways) has its own system of support for talented students in the form of scholarship competitions. However, as is well known, not every student of even an older bachelor's degree (specialty) or master's degree program has experience or the desire to write scientific papers, by publishing which one or another scholarship can be won. Interest fueled by writing articles

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[1] Under the work is understood not only hired labor, but also their own business.

for several reasons. Firstly, a small amount of monthly payments in comparison with the 0.5 rate in the "office" or for work at the factory while studying at the university, secondly, writing an article for students is a long labor-intensive work[2], thirdly, a small number of scholarships in the competition, fourthly, there is a risk that the article may not be published on time – late, which will entail inevitably fewer points in the competition, and, consequently, will reduce the student's chances of winning the competition.

As a university (an example) for the further solution of the problem, we choose the main university of the Far Eastern Federal District – Far Eastern Federal University (hereinafter FEFU). All types of FEFU scholarships can be found on the official website[3].

This opens up the opportunity for a young scientist to earn money.

The main earning strategy is as follows: a young scientist (hereinafter referred to as a graduate) is looking for a student, the student makes an advance payment, the graduate helps in writing an article by purchasing it on third-party services or by writing and publishing it independently, and then the graduate completes the student as a co-author[4]. The student submits documents for the scholarship commission and wins the competition. A student can recommend a graduate to other students to work and start word of mouth, and other students who want "easy" money can also reach for such a graduate. Next, half of the earnings monthly[5] goes to the true author of the work (graduate) of this (this) student (group of students).

SCHOLARSHIPS AS A FINANCIAL RECOURSE

According to the regulations of the FEFU [19], the university has a large number of various rewards in the form of scholarships. However, we will focus on considering the simplest types of scholarships to achieve – "Scholarship for research activities" (N), "Scholarship of the Governor of Primorsky Krai" (D), "Scholarship of the Government of the Russian Federation" (Π_1) and "Scholarship President of the Russian Federation" (Π_2). Note that it is impossible to get the last two scholarships at the same time, so you have to choose one of them.

Consider the process of benefiting from scholarships in more detail.

SCHOLARSHIP FOR ACHIEVEMENTS IN RESEARCH ACTIVITIES

Getting H represents the fulfillment of several conditions simultaneously. Firstly, all achievements submitted for consideration by the commission should be received for the last semester, and secondly, all achievements are evaluated in accordance with tables 2 and 3 [19, p. 18–20]. In tables 2 and 3 [19, p. 18–20] reflects the number of points a student can receive upon the publication of a work. Then, all points are added up, evaluated in accordance with the achievement table 2 and 3 [19, p. 18–20]. The sum of points corresponds to one of the 4 levels of scholarships. The first level is the most expensive – the scholarship recipient receives with this level the largest scholarship in terms of the monthly payment. We compose a mathematical model for calculating the optimal number of articles, the number of authors in the article.

CONVENTIONS AND VARIABLES

$p_{k_1}(T)$ – profitability (thousand rubles / sem.) from level from the scholarship to the semester T,

where $k_1 = \{II, III, IV, V\}$. We will not consider the first degree, since it is literally impossible to get it in the framework of our task. By degree $k_1 = V$ we mean that the student did not take a place in the competition.

$c_u = const.$ – Student contribution (thousand rubles) to pay for articles in paid journals with a 5-year impact factor of less than 0.2[6].

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[2] The student needs to understand the essence of the matter – to study the problem. While each researcher has already completed this item.

[3] https://www.dvfu.ru/student-life/student-opportunities-and-financial-support/scholarship.

[4] https://www.kommersant.ru/doc/3035895, https://theins.ru/obshestvo/165368.

[5] Half of the monthly scholarship is the usual monthly fee in Primorsky Krai for article writing services.

[6] Predatory magazines are magazines peer-reviewed by the Higher Attestation Commission, where it is enough to comply with the editorial formal requirements for registration and pay a certain fee to publish an article [20, 21].

$A_n^l(T)$ — The number of primary points for achievement l, related to the category (the number of columns in table 2 or 3 [19, pp. 18–20]) $n = 1:3$ in period T,
where $l^7 = \{HAC, Sc/WoS, RISC, EVM\}$.

$M = 6$ — the maximum number of co-authors in (4).

$B(T)$ — the maximum number of works that a true author can write per semester T (2).

$$x_{un}^{li} = \begin{cases} 1, if\ student\ u\ is\ a\ co-author\ of\ work \\ of\ type\ i\ in\ the\ range\ n\ \ 0, otherwise \end{cases}.$$

$$\lambda_{in}^l = \begin{cases} 1, work\ of\ type\ i\ falls\ in\ the\ range\ n \\ 0, otherwise \end{cases}.$$

$$q_{uk_1} = \begin{cases} 1, if\ student\ u\ corresponds\ to\ level\ k_1 \\ 0, otherwise \end{cases}.$$

The mathematical model for finding the optimal solution to the subtask on the distribution of students by articles will take the form:

$$\sum_{u,n} x_{un}^{li} \leq M \tag{1},$$

$$\sum_{u,l,i,n} x_{un}^{li} \leq B \tag{2},$$

$$\sum_n \phi_n^l \lambda_{in}^l \leq \sum_{u,n} x_{un}^{li} \leq \sum_n \Phi_n^l \lambda_{in}^l \tag{3},$$

$$\sum_n \lambda_{in}^l \leq 1 \tag{4},$$

$$\sum_n x_{un}^{li} \leq 1 \tag{5},$$

$$\lambda_{in}^l \in \{0; 1\} \tag{6},$$

$$x_{un}^{li} \in \{0; 1\} \tag{7},$$

where ϕ_n^l and Φ_n^l are values that reflect the number of authors minimum and maximum, respectively, for the category of achievement l, taken from tables 2 and 3 [19, p. 18–20]). Restriction 1 means that the number of authors of a work of type i may not exceed M. Restriction 2 is designed so that the total number of works does not exceed the number in period T. (3) is intended to determine the category n for an article of type i.

(4) and (6) exist in the system of restrictions in order to ensure that only one category corresponds to work i of type l. (5) and (7) are called upon to assert that work of type i, if published, then corresponds to a maximum of one category.

We determine which categories of student achievement u correspond to (8):

$$\sum_{l,i,n} x_{un}^{li} A_n^l \geq \sum_{k_1=II} a_{k_1} q_{uk_1} \tag{8},$$

where a_{k_1} — thresholds to reach level k_1.

However, according to [19], in order to achieve category II or III it is necessary that there be at least one article from the Sc / Wos or HAC / EVM, respectively (9–12).

$$\sum_{i,n} x_{un}^{li} \geq q_{uII}, l = Scopus \tag{9},$$

$$\sum_{i,n} x_{un}^{l_1 i} + \sum_{i,n} x_{un}^{l_2 i} \geq q_{uIII}, \tag{10},$$

$$\sum_{k_1} q_{uk_1} \leq 1, \tag{11},$$

$$q_{uk_1} \in \{0; 1\} \tag{12},$$

where $l_1 = HAC$, $l_2 = EVM$.

The objective function takes the form (13):

$$\sum_{k_1=II}^V \sum_u p_{k_1} q_{uk_1} \to \max \tag{13}.$$

Note that writing an article is a long difficult process [22, 23], and accordingly, a graduate learns to write work with each subsequent period no slower than the previous one. In this regard, we assume that, depending on the period T, the number of published works I_l of type l will not change downward (14–17).

$$\sum_{i,n,u} x_{un}^{li} \leq I_l(T), l = Sc. \tag{14},$$

$$\sum_{i,n,u} x_{un}^{li} \leq I_l(T), l = ЭВМ \tag{15},$$

$$\sum_{i,n,u} x_{un}^{li} \leq I_l(T), l = ВАК \tag{16},$$

$$\sum_{i,n,u} x_{un}^{li} \leq 4, l = РИНЦ \tag{17}.$$

As noted above, to publish the work requires financial resources. We write down the budget constraint (18).

$$\sum_{i,n,l} C^l \lambda_{in}^l \leq \sum_u \sum_{k_1} c_u q_{uk_1} \qquad (18),$$

where C^l − cash costs for publishing work type l.

Separately, we note that everyone who has overcome the minimum threshold a_{IV} receives a scholarship.

SCHOLARSHIP OF THE GOVERNOR OF PRIMORSKY TERRITORY

To obtain G it is also necessary to fulfill a number of requirements. Since, according to the requirements[8] of the sponsor − the Government of the Primorsky Territory, there are no special tables for assessing students' achievements, as it was for obtaining N, then with the exception of the formal requirement − a student completed a session without triples for two semesters in a row on time, the path to victory seems easy enough in the competition G.

However, this is just a first impression, and it is not true. Here the competition organizer − FEFU comes into force. FEFU each semester provides students at the time of filing with documents to familiarize themselves with the standards [19] d_n^l for assessing their achievements l. Usually they do not change. But there is a subtlety. Unlike H, competition G has a minimum threshold, $D(T)$, which every semester rarely drops, but basically only rises.

PARAMETERS AND VARIABLES

d_n^l − the number of primary points for work of type l with the number of authors in the range n.

p − monthly scholarship amount (thousand rubles / seme.).

$$z_u = \begin{cases} 1, if\ student\ u\ won\ the\ competition\ G \\ 0, otherwise \end{cases}.$$

To the constraint system (1−12, 14−18) we add constraints (19), (21) and the objective function (20).

$$\sum_{l,i,n} x_{un}^{li} d_n^l \geq z_u D. \qquad (19),$$

$$\sum_{k_1=II}^{V} \sum_u p_{k_1} q_{uk_1} + \sum_u p z_u \rightarrow \max \qquad (20),$$

$$z_u \in \{0; 1\} \qquad (21),$$

where restriction (19), (21) exist to take into account the minimum score threshold, which is necessary for the applicant for scholarship G to overcome. (20) − total monthly income from each student.

We get the linear integer programming problem. We will solve such a problem by the mixed method of branches and borders with the Gomorry[9] cutoff method.

SCHOLARSHIP OF THE GOVERNMENT AND THE PRESIDENT OF THE RUSSIAN FEDERATION

According to the testimony of the data holder, as a rule, if a student earns H level *II*, then with a probability of 95% he can submit $\Pi_s, s \in \{1;2\}$ for the contest and win exactly (only one of two contests can be won).

CALIBRATION AND SOLUTION RULE

As noted above, each of students with probability P_u can lead to a graduate student. We assume that this range lies in the range from 0 to 3 students.

We take into account the risk that the article may not be published in time (elibrary) and, accordingly, will not be taken into account by the competition commission. In this regard, we assume that P^1 is the probability with which the article may not appear on time.

In addition, from the students' side we will take into account one more risk − ending in session and without triples (P^2).

Students are not deprived of all human qualities, both positive and negative, therefore, a student may be deceived and the latter may not pay the graduate a fee. In this regard, we introduce P^3 as the probability that one of the students may deceive and not pay a scholarship.

With a probability of P^4, we assume that a student who has completed his undergraduate studies successfully enters a master's program and continues to work with a graduate.

8 Government of the Primorsky Territory: https://www.primorsky.ru/authorities/executive-agencies/departments/youth/stipendia.

9 https://www.mathworks.com/help/optim/ug/intlinprog.html.

We put P^5 as the probability that the student wins Π_1, $1- P^5$ − the probability that the student wins Π_2.

P^6 − the probability that the graduate himself will find another student himself.

We also note one more condition: if a student's personal income for half a year of work (semester) is less than 15 thousand rubles, he usually leaves.

Writing articles and publishing them in the Sc database is a long and complicated process. The management of the scholarship competition understands this and, as a rule, if a student has an article in Sc, then the student receives with a probability of 70% Π_1 and a probability of 30% Π_2.

If a student came to a graduate with a proposal to work, and the latter, for some reason, could not do this, we will assume that the service is not provided, and the student no longer turns to the graduate with a proposal.

At the beginning of the algorithm, we assume that two graduates already have a graduate to organize work. The input data for these students are shown in *table 1*.

Table 1

Data on students at the time T = 0

Quantite	Bachelor/MSc	Semesters, №	Last semester, №
2	1	4	8

Source: compiled by the authors

In *table 2*, we determine the probabilities with which student υ can bring {0,1,2,3} students.

Table 2

The probabilities with which student can lead {0,1,2,3} students

Studednts quantity	1	2	3	0
	21	16	6	61

Source: compiled by the authors

In *table 3* we introduce the input data on the probabilities

Table 3

Probability Values P^v, $v = 1{:}5$

P^v	P^1	P^2	P^3	P^4	P^5
%	4	6	2	53	69

Source: compiled by the authors

Define the recurrence ratio of the maximum number of articles in the next period $B(T+1)$ (22):

$$B(T+1) = B(T) + 1 \qquad (22).$$

The threshold that a student needs to overcome in order to win the competition D is defined in the recurrence relation (23):

$$D(T+1) = D(T) + \varepsilon_1, \, \varepsilon_1 \in [-1;5], \, M(\varepsilon_1) = 0 \quad (23),$$

where ε_1 − random variable of discrete type (hereinafter SVDT), $M(\varepsilon_1)$ − expected value ε_1.

The leadership of the university approves every semester a change in the monthly yield from N (24).

$$p_{k_1}(T+1) = p_{k_1}(T) + \varepsilon_{k_1}, \, \varepsilon_{k_1} \in [-1;3], \, M(\varepsilon_{k_1}) = 1 \quad (24),$$

where ε_{k_1} − random variable of continuous type (hereinafter referred to as CBHT), $M(\varepsilon_{k_1})$ − expected value ε_{k_1}.

We reflect in *table 4* the initial data for (22−24).

Table 4

Initial data for ratios (22−24)

Parameter	B(0)	D(0)	$p_{k_1}(0)$
Meaning	10	129	(17.6, 12.1, 10, 0)

Source: compiled by the authors

In *table 5* we put the data on the maximum number of works of each type, which the graduate can write himself or purchase.

From all of the above, it becomes clear that finding the optimal solution to such a model seems hardly possible due to the lack of a real apparatus for working with multiple probabilities. For this reason, it is proposed to use a mixed type of solution search using simulation and mathematical modeling. The latter has been described above. We offer an option for the first.

We turn to a direct discussion of the progress of the algorithm for finding a solution. At each moment T, the search for the optimal solution occurs, according to the model (1−12), (14−21). As input parameters, we put the data from this section (*table 1−5*, relations (22−24)).

In order to justify the fidelity of the work of the author's idea, let's compare two options for the development of events after graduation from the university: the author's (stated above, as well as with a monthly salary of 20 tr., Which will

The maximum number of jobs of each type depending on the period

T	$I_l(T), l = Sc$	$I_l(T), l = HAC$	$I_l(T), l = EVM$
0	0	6	1
1	0	6	1
2	0	7	1
3	0	7	1
4	1	10	2
5	1	10	2
6	1	10	2
7	1	10	2
8	2	16	3
9	2	16	3
10	2	16	3
11	2	16	3
12	2	16	3
13	2	16	3
14	2	16	3
15	2	16	3
16	2	16	3
17	2	16	3
18	2	16	3
19	2	16	3
20	3	20	3
21	3	20	3
22	3	20	3

Source: compiled by the authors

increase by 60% after defending the dissertation after 4 years) and the most widespread in the labor market of Vladivostok – a graduate goes to work in the "office" and receives monthly 60 tons with an annual salary indexation of 5%[10], every 4 years (8 semesters) he is expected to increase at work and his salary with a probability of 90% increases by 60%[11] (with a probability of 10% does not increase). The comparison period will be 22 semesters (11 years) from the date of graduation.

For the reliability of the study, we will conduct 1000 iterations of this model and compare the average results of its work. We will use the Matlab programming environment using the Parallel Computing Toolbox[12] for parallel computing.

DISCUSSION

Figure 1 shows the total accumulated cash for all periods for all iterations. Black (grad) color shows all the results of iterations. Red (*grad_ave*) shows the average accumulated amount of cash. Light blue (Office) color indicates the trajectory of accumulated funds for the graduate, if he worked in the office. Pink (*office_ave*) color indicates the average indicator of accumulated cash by an office employee. Comparing the indicators *grad_ave* and *office_ave* from *figure 1* it follows that basically the graduate gets more in the role of a researcher who acts according to the scheme described above.

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[10] This amount is quite high for the Vladivostok labor market. We intend to slightly overestimate this indicator for a clearer contrast of the research results.

[11] We intend not to index the salary of a research associate in our model in order to increase the contrast of the results.

[12] https://www.mathworks.com/products/parallel-computing.html.
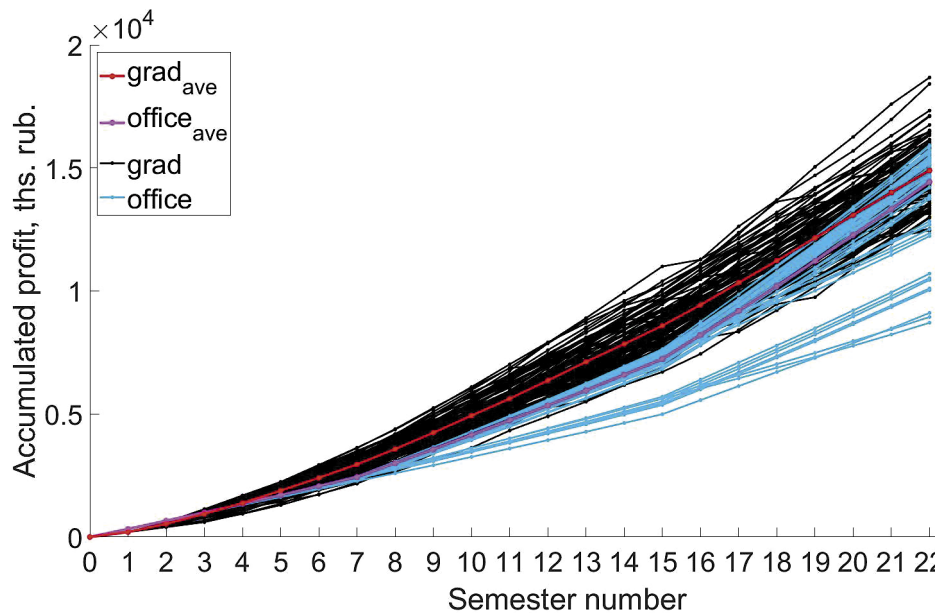
Figure 1. **Accumulated cash for all periods**

However, at the first stages of work according to this scheme, this is not so. Consider *figure 2*. From *figure 2*, we can see that, firstly, on average, the first semester (0.5 years) of a researcher receives less than the office salary, and secondly, on average starting from the second semester (1 year), a researcher already has a large thirdly, the first 3 semesters (1.5 years) the scientist receives less than the office, but on the fourth semester (2 years) the first one overtakes

the second on average. On average, starting from the 16th semester (8 year) *(figure 1)*, on average, the salary of an office employee becomes higher than that of a scientific employee.

Consider the income structure of the researcher closer. *Figure 3* shows all the possible trajectories of the number of students involved in the earnings scheme. On average (in red) it can be seen that the indicator fluctuates on average in the range of 7−8 people per semester.
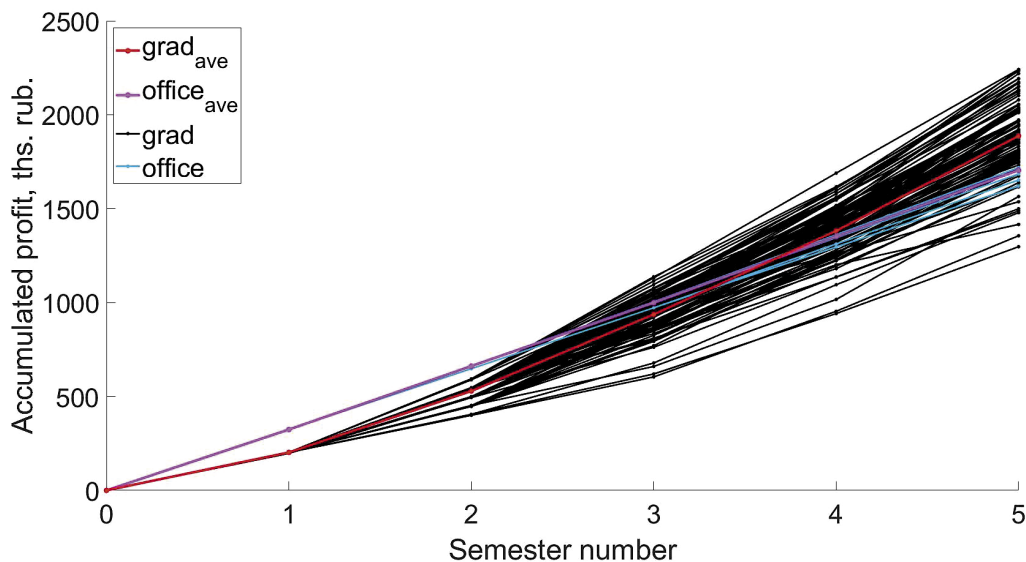

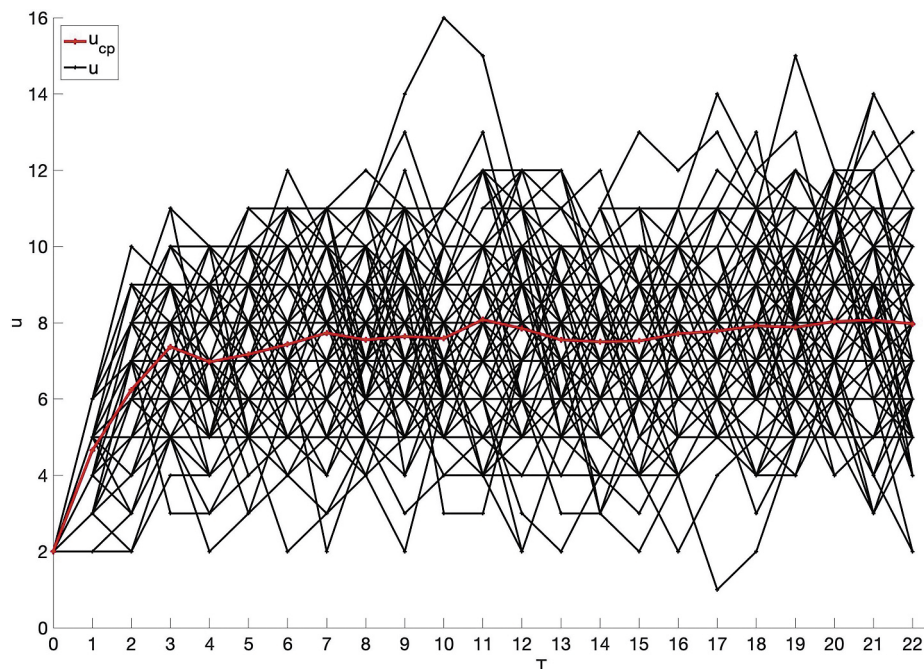*Figure 2.* **Accumulated cash for periods**

Figure 3. **The trajectories of the number of students involved in the project**

Figure 4 shows the average student income. From *figure 4* it follows that the last semesters of work are the most productive, since from *table 5* you can see that the number of Sc articles is maximum in the last semesters, and it is the presence of Sc articles that entails maximum profitability (see *table 4*).

It should be noted that all of the above does not mean at all that a researcher will in the future receive an average salary higher than an office one. This separate fact is evident from *figure 5. Figure 5* reflects the relative frequency v, when the monthly income for all iterations was higher for the office employee
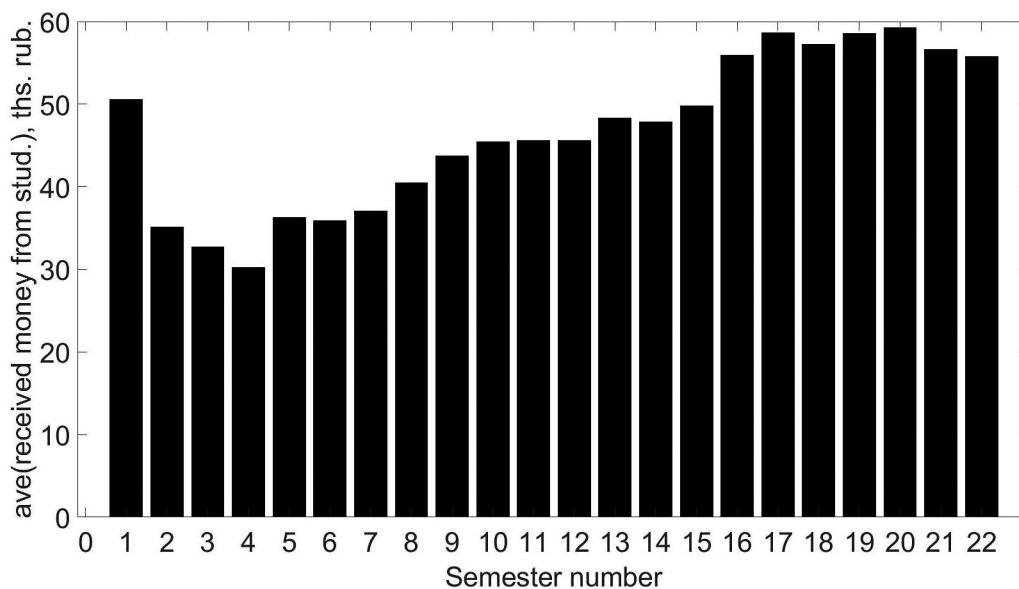

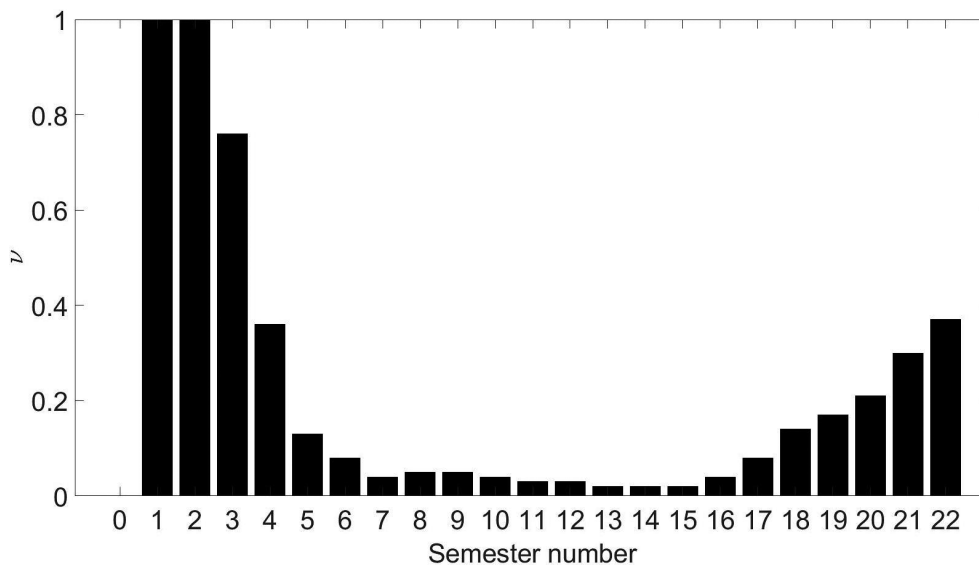*Figure 4.* **Profitability of a researcher by semester per person**

Figure 5. **The relative frequency when the monthly income for all iterations was higher for the office employee than for the scientific**

than for the scientific one. It can be noted here that in the period from the 5th to the 18th semester (6.5 years) the income of a researcher is on average higher than that of an office employee.

Thus, we consider it possible to note that this scheme of work is quite stable, but does not lead to absolute dominance over work in the office. It should be noted that in the future it is expected that the office employee will go on the trajectory when he will receive a higher salary than a scientific one. However, we do not take into account in our work that a researcher can work on grandees, which can bring a solid income. In addition, we do not take into account the incentive payments that the university is willing to pay to a researcher upon the publication of articles corresponding to a certain level.

CONCLUSION

The paper considers the issue of the implementation by a graduate of a Russian university of self in the labor market. The region of the Far Eastern Federal District – Primorsky Krai – is taken as an example. As a university, FEFU was considered. It is shown that this problem is relevant for graduates of Russia as a whole. An author's model of the graduate's work at the university or research institute is proposed. As part of the work, a mathematical modeling apparatus with elements of parallel programming was used. It is shown that the profit of the graduate in the office will be higher the first time, and after that the profit will be higher for the employee of the university, but then the profit will most likely be higher for the employee of the office if the researcher does not start looking for additional ways to earn money.

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