https://doi.org/10.53656/str2024-2-3-inc

*Research and Paradigms*
*Научни изследвания и парадигми*

# INCENTIVISING PUBLICATION ACTIVITY AND THE INEVITABLE PROBLEMS

**Dr. Georgi Kiranchev, Assoc. Prof.**
*University of National and World Economy*

**Abstract.** This paper examines in a mathematically simplified form the incentive system of publication activity adopted by Bulgarian universities.

The methodology of the study is a mathematical analysis of a competitive game between multiple players. All proofs are made in the generalised case.

It is shown that in this (and similar) mathematical form of the basic formula for calculating players' rewards, there exists an optimal number of publications at which each player reaches his maximum profit.

It is shown that if individual players do not cooperate but follow competitive behavior, they will realise their maximum profits in a Nash equilibrium.

It is shown that in this equilibrium some players will prefer to have zero publication activity, which depends on the costs they incur for their publications. Easy done and cheap publications will be more competitive and more numerous.

It has been shown that it is more profitable for players to cooperate and minimise the amount of publications rather than compete.

Potential problems and distortions in the implementation of incentives are commented.

*Keywords*: incentives; publication activity; game theory; Nash equilibrium

## Introduction

Universities are in a constant competitive struggle to gain additional access to financial resources. In the process of this struggle, they are forced to meet certain criteria, some of which are the so-called "science metrics" designed to demonstrate how much scientific excellence these universities have. Between times, bureaucrats in science give the world some "King Criterion" and declare it to be the most important, indeed the most profitable. Then all the contestants rush to maximise the value of that criterion, happy that "there are clear rules now". Currently, the role of this "King Criterion" is played by publications in journals indexed in Scopus and Web of Science. When all this is ultimately reduced to absurdity, the criterion changes and the cycle repeats itself, because „All metrics of scientific evaluation are bound to be abused" (Biagioli 2016).

Such sweeps in pursuit of mirages do not pass without a trace. Each time, efforts are directed in a direction where, instead of creating more favourable conditions for valuable scientific achievements, new sources of waste of funds and time, new opportunities for fraud and new threats to discredit science and those involved in it are created. "The focus on impact of published research has created new opportunities for misconduct and fraudsters" (Biagioli 2016).

Here we will use the Game Theory methodology to explore the methodology for incentivising publication activity applied in Bulgarian universities. In one form or another, simpler or more complex, such methodologies are used by many Bulgarian universities. The methodologies of many universities are available on the Internet (the names of the internal documents are translated, the documents themselves are available in Bulgarian):

MU – Plovdiv, *Internal rules for salary in MU – Plovdiv*, art. 24, 2022;

University of Economics – Varna, *Internal rules for salary organisation*, Appendix № 2, 2021;

University of Forestry – Sofia, *Rules for supporting publication activity of lecturers at the University of Forestry*, 2022

Technical university – Gabrovo, *INTERNAL RULES for financial incentivation of publication activity at Technical university* – Gabrovo, 2022;

University "Prof. Dr. Asen Zlatarov" – Burgas;

Institute of Information and Communication Technologies, *RULES for the allocation of the funds received from BAS for the first stage of the NP "Stimulation of publication activity in reputable international and scientific journals and open access to scientific information*

The list is not exhaustive but illustrative only.

But similar methodologies are not uncommon in other organisations, not just educational, but any organisation that allocates some limited fund of money, aimed to incentivise some activity and increase its results. Therefore, the conclusions drawn in the paper can be useful for any organisation allocating cash for incentive purposes.

Notations used

We will introduce the following notations:

$N$ – number of researchers publishing scientific publications, hereinafter referred to as "players";

$A$ – the amount of the incentive fund distributed to players;

$q_i$ – number of publications of the i-th player, i= 1…N;

$q_i^*$ – the optimal number of publications of the i-th player at which he reaches the maximum profit from his publication activity;

$Q$ – total number of publications of all players;

$P$ – incentive amount (reward) received by each player for an entire publication, equal for each player;

$c_i$ – i-th player's cost per publication, different for players and publications, i= 1…N;

$U_i$ – i-th player's profit from his publication activity, different for players, i= 1…N;

Note: since in many methodologies the number of publications is replaced by "scorepoints", attributed to each publication and author, the same conclusions are valid for these scorepoints.

**Initial assumptions**

The game organiser (university, graduate school, research organisation) aims to maximise the total number of publications *Q*, for which creates a publication activity incentive fund of *A*;

The publications to be incentivised are those published within the year for which the amount of the fund is fixed. This is the practice of the universities listed above;

Each player can have a non-negative number of publications. This number does not have to be a whole integer number, as some publications may be co-authored;

Each player incurs some costs to publish their publications. Even if from a financial point of view these costs are zero, they are not zero in terms of time and effort spent. For different players these costs are different;

Each player aims to maximise his/her profit from the publication activity, otherwise the incentive function is not realised.

**Initial dependencies**

The total number of publications is the sum of each player's publications: $Q = \sum_i^N q_i$;

Each player will receive a portion of the incentive fund proportional to his publications as a fraction of the total number of publications, i.e. $\frac{A.q_i}{Q}$. This ensures that the greater the player's activity, the greater the portion of the incentive fund he will receive and this is how the incentive function of the fund is achieved;

In economic terms, we can write that the price at which each author „sells" his publication to the market, and indeed to the organisation that stimulates his publication activity, is

$$P = \frac{A}{Q} = A.Q^{-1}$$

The second notation is well known in economic theory - it is a particular case of a price with perfect elasticity with respect to the quantity offered. For every 1% increase in supply *Q*, the market responds with exactly a 1% decrease in price *P*.

The profit of each individual player is calculated as:

$$U_i = \frac{A.q_i}{Q} - c_i.q_i = \frac{A.q_i}{\sum_i^N q_i} - c_i.q_i$$

Let‘s consider the game between three players, then generalise it to N players. Each player maximises his profit function:

$$\max U_i = \frac{A.q_i}{\sum_i^3 q_i} - c_i.q_i$$

The first-order condition for maximise each player’s profit is that the first derivatives of all players’ profits are equal to 0:

$$\frac{\partial U_1}{\partial q_1} = \frac{A.\sum_i^3 q_i - Aq_1}{(\sum_i^3 q_i)^2} - c_1 = 0$$

$$\frac{\partial U_2}{\partial q_2} = \frac{A.\sum_i^3 q_i - Aq_2}{(\sum_i^3 q_i)^2} - c_2 = 0$$

$$\frac{\partial U_3}{\partial q_3} = \frac{A.\sum_i^3 q_i - Aq_3}{(\sum_i^3 q_i)^2} - c_3 = 0$$

The solution of this system of equations is

$$q_1^* = \frac{2A(\sum_i^3 c_i - 2c_1)}{(\sum_i^3 c_i)^2}$$

$$q_2^* = \frac{2A(\sum_i^3 c_i - 2c_2)}{(\sum_i^3 c_i)^2}$$

$$q_3^* = \frac{2A(\sum_i^3 c_i - 2c_3)}{(\sum_i^3 c_i)^2}$$

Here we do not intend to derive this solution analytically in detail; simple algebraic transformations are sufficient for the reader to obtain it.

The second-order condition for maximising each player‘s profit is that the second derivatives of all player‘s profits are negative:

$$\frac{\partial^2 U_1}{\partial q_1} = \frac{-2A(q_2 + q_3)}{(\sum_i^3 q_i)^3} < 0$$

$$\frac{\partial^2 U_2}{\partial q_2} = \frac{-2A(q_1 + q_3)}{(\sum_i^3 q_i)^3} < 0$$

$$\frac{\partial^2 U_3}{\partial q_3} = \frac{-2A(q_1 + q_2)}{(\sum_i^3 q_i)^3} < 0$$

As the number of publications of each player is a non-negative number, it is true for each of the above second derivatives that they are negative, and hence, given the resulting number of publications, each player will maximise his profit.

The total number of publications will equal

$$Q = q_1^* + q_2^* + q_3^* = \frac{2A}{\sum_i^3 c_i}$$

We can consider that this will be the result of stimulating publication activity and it can be measured.

A publication will receive the following proportion of the incentive fund (Or, in the scorepoints version of the methodology, this would be the price of each score-point):

$$P = \frac{A}{Q} = \frac{\sum_i^3 c_i}{2}$$

The players‘ profits at their optima would be::

$$U_1 = P.q_1^* - c_1.q_1^* =$$

$$= q_i^*.\left(\frac{\sum_i^3 c_i}{2} - c_i\right) = \frac{2A(\sum_i^3 c_i - 2c_1)}{(\sum_i^3 c_i)^2}.\frac{(\sum_i^3 c_i - 2c_1)}{2} = \frac{A(\sum_i^3 c_i - 2c_1)^2}{(\sum_i^3 c_i)^2}$$

$$U_2 = \frac{A(\sum_i^3 c_i - 2c_2)^2}{(\sum_i^3 c_i)^2}$$

$$U_3 = \frac{A(\sum_i^3 c_i - 2c_3)^2}{(\sum_i^3 c_i)^2}$$

Since a research structure with only three players is not of particular interest, the important thing we can derive from the above formulas is their generalisation to the case with *N* players. We only needed the above formulas for this purpose and to avoid having to prove the existence of an optimal solution in the case with *N* players..

The generalised formulae are as follows:

Optimal amount of publications for player i:

$$q_i^* = \frac{(N-1)A[\sum_i^N c_i - (N-1)c_i]}{(\sum_i^N c_i)^2}$$

Total number of publications:

$$Q^* = \sum_i^N q_i^* = \frac{(N-1)A}{\sum_i^N c_i}$$

It is clear from this formula that the size of the incentive fund does matter and indeed the total number of publications increases as this fund increases. On the contrary, the more expensive it costs to publish a publication (on average), the fewer publications there will be. In this sense, the universities‘ decision on an incentive fund and the related decision to offset the monetary costs of publishing are actions that should lead to an increase in the number of publications by faculty and researchers working at these universities. This decision will have a greater effect the more the size of the fund exceeds the aggregate publication costs of all players. A certain difficulty in fixing the size of the fund is that the sum of the costs is an unobservable value, whereas the number of publications and the size of the fund are fully observable. Often the authors of publications themselves cannot accurately estimate all the costs they incur per publication and the costs themselves may vary by publication, so it is more correct to work with an average. In this sense, the actual number of publications can serve as an indirect estimate of the value of $\sum_i^N c_i$ or the average cost $\bar{c}$ the other way around - given a certain size of the fund, the number of publications and the number of players, the size of the average cost is a resultant.

Share per publication of the incentive fund (incentive amount per publication or per scorepoint):

$$P = \frac{A}{Q} = \frac{\sum_i^N c_i}{(N-1)}$$

The interesting thing about this amount of money is that it does not (directly) depend on the size of the incentive fund, but only on the number of players and

the amount of their individual expenses. The larger the cost per publication (or their average), the larger the portion of the incentive fund that will be paid per publication (on average). This is quite logical, because then (with large publication costs) there will be fewer publications on which to distribute this fund.

Profit from one publication for player *i*:

$$U_i^* = \frac{A[\sum_i^N c_i - (N-1)c_i]^2}{(\sum_i^N c_i)^2}$$

The sum of all players' profits can be recorded simply as a sum, but we find another form more interesting and useful – as the difference between the amount of the fund and the total expenditure of the players:

$$\sum_{i=1}^{N} U_i^* = A - \sum_{i=1}^{N} c_i q_i^*$$

This form shows that as the number of publications increases, so will the amount of expenses that authors incur for these publications. With a fixed amount *A* of the incentive fund, this will lead to a reduction in the amount of the players' profits. There is also a potential danger in this – the large number of publications "does not pay" longer and a period of high publication activity will be followed by a period of decline.

After obtaining the generalised formulae, we will prove the important statement that the publication quantities thus obtained form a Nash equilibrium. To this purpose, we will prove that no player has an interest in deviating from his optimal publication quantity if the other players hold to their optimal publication quantities. The proof will be done for the *N*-th player simply for convenience in writing the formulas.

*Statement:*

If all *N-1* players (from first to the penultimate in number) keep their optimal quantities $q_i^* = \frac{(N-1)A[\sum_i^N c_i - (N-1)c_i]}{(\sum_i^N c_i)^2}$, then for the *N*-th player the optimal number of publications maximising his profit is $q_N^* = \frac{(N-1)A[\sum_i^N c_i - (N-1)c_N]}{(\sum_i^N c_i)^2}$

*Proof:*

Let the first *N-1* players stick to their optimal publication quantities. Then their total number of publications is the sum

$$\sum_{i=1}^{N-1} q_i^* = \sum_{i=1}^{N-1} \frac{(N-1)A[\sum_{i=1}^{N} c_i - (N-1)c_i]}{(\sum_{i=1}^{N} c_i)^2}$$

Here we will draw attention to the fact that the summation of the costs $\sum_{i=1}^{N} c_i$ is made over the costs of all players, including the *N*-th player. This sum can also be recorded as:

$$\sum_{i=1}^{N} c_i = c_N + \sum_{i=1}^{N-1} c_i$$

But summing the optimal publication quantities of the first N-1 players also implies the sum

$$\sum_{i=1}^{N-1} (N-1)c_i = (N-1)\sum_{i=1}^{N-1} c_i$$

We can therefore write the following in the numerator in a more understandable form:

$$\sum_{i=1}^{N-1} q_i^* = (N-1)A\frac{(N-1)\sum_{i=1}^{N-1} c_i + (N-1)c_N - (N-1)\sum_{i=1}^{N-1} c_i}{(\sum_{i=1}^{N} c_i)^2}$$

Now we can write down the final and much more compact expression for the quantity of publications of the first *N-1* players:

$$\sum_{i=1}^{N-1} q_i^* = \frac{(N-1)^2 A c_N}{(\sum_{i=1}^{N} c_i)^2}$$

The expression for the *N*-th player‘s profit takes the form (the denominator in expanded form represents the unknown total number of publications):

$$U_N = \frac{A q_N}{\frac{(N-1)^2 A c_N}{(\sum_{i=1}^{N} c_i)^2} + q_N} - c_N . q_N$$

The first derivative of this profit is

$$\frac{\partial U_N}{\partial q_N} = \frac{A\frac{(N-1)^2 A c_N}{(\sum_{i=1}^{N} c_i)^2} + Aq_N - Aq_N}{\left[\frac{(N-1)^2 A c_N}{(\sum_{i=1}^{N} c_i)^2} + q_N\right]^2} - c_N$$

Equated to zero, the first derivative implies the solution of the following quadratic equation for $q_N$:

$$\frac{(N-1)^2A^2c_N}{(\sum_{i=1}^{N}c_i)^2} - c_N\left[\frac{(N-1)^2Ac_N}{(\sum_{i=1}^{N}c_i)^2} + q_N\right]^2 = 0$$

$$-c_N{q_N}^2 - \frac{2(N-1)^2A{c_N}^2}{(\sum_{i=1}^{N}c_i)^2}q_N - \frac{(N-1)^4A^2{c_N}^3}{(\sum_{i=1}^{N}c_i)^4} + \frac{(N-1)^2A^2c_N}{(\sum_{i=1}^{N}c_i)^2} = 0$$

$$D = \frac{4(N-1)^4A^2{c_N}^4}{(\sum_{i=1}^{N}c_i)^4} - 4(-c_N)\left[\frac{(N-1)^2A^2c_N}{(\sum_{i=1}^{N}c_i)^2} - \frac{(N-1)^4A^2{c_N}^3}{(\sum_{i=1}^{N}c_i)^4}\right] =$$

$$= \frac{4(N-1)^4A^2{c_N}^4}{(\sum_{i=1}^{N}c_i)^4} + \frac{4(N-1)^2A^2{c_N}^2}{(\sum_{i=1}^{N}c_i)^2} - \frac{4(N-1)^4A^2{c_N}^4}{(\sum_{i=1}^{N}c_i)^4} =$$

$$= \frac{4(N-1)^2A^2{c_N}^2}{(\sum_{i=1}^{N}c_i)^2}$$

For us, only the positive root of the equation is of interest, so the only solution for the *N*-th player is

$$q_N^* = \frac{\frac{2(N-1)^2A{c_N}^2}{(\sum_{i=1}^{N}c_i)^2} - \sqrt{\frac{4(N-1)^2A^2{c_N}^2}{(\sum_{i=1}^{N}c_i)^2}}}{-2c_N} = \frac{(N-1)A}{(\sum_{i}^{N}c_i)} - \frac{(N-1)^2Ac_N}{(\sum_{i=1}^{N}c_i)^2} =$$

$$= \frac{(N-1)A[\sum_{i}^{N}c_i - (N-1)c_N]}{(\sum_{i}^{N}c_i)^2}$$

Thereby the statement is proven and indeed the optimal quantities of player publications form a Nash equilibrium. Another important result is that the Nash equilibrium is unique, which excludes players behaving ambiguously and switching from one equilibrium to another.

The existence of equilibrium is a favorite topic for economists, and it is not surprising that the decision to incentivise publication activity with economic methods leads to the proven equilibrium under this system, after all, the system was designed precisely as an economic incentive.

If the players behave like competitors among themselves, competing for the part

of the incentive fund that maximises their profits, they should reach those maxima precisely in the Nash equilibrium specified.

What hidden problems exist with this system, or can it be seamlessly applied and multiplied in other similar cases?

Without grading the problems, we list and comment on them.

**Problem 1. Too many publications**

What could be the problem with too many publications, since it is precisely their increase that is the aim of the incentive system and it is by the number of scientific publications that universities are evaluated? After all, is not this the very purpose of the incentive system for teachers and researchers in the very first place? "Human capital management aims at two specific goals. The first one is to motivate the employees to achieve the company's objectives as effectively and efficiently as possible. The second one is to create opportunities for personal and professional growth of the individual" (Tanushev 2022).

The problem has already been articulated by the main beneficiaries of the system – those who have received significant sums for the past year 2022. It says: "Next year, everyone will start writing and publishing and the incentives will cease to function".

With too many publications, the amount received per publication will be small in itself and this will have to be compensated by each player with additional publications, i.e. in a purely extensive way. In terms of the total amount of publications everything will be excellent, but not in terms of the quality of the main body of publications and the "market price" of a publication. There is a danger that publications for the sake of publications – to get money – will start to dominate, not because they have any scientific value. When the main goal is to get money for any publication, in-depth and valuable research requiring a lot of time and effort will be left behind. Moreover, it is precisely superficial publications with trivial or no scientific results that are hastily and easily written. Unfortunately, economic considerations become a weakness here – if the "price" of a publication is low for many publications, the author will try to minimise his costs (and efforts) for it. To be "competitive", each player will seek to maximise the "price:quality" ratio, and this can only be done at the expense of quality for a fixed *A*-fund amount. With decreasing price, quality will have to decrease even faster.

This will necessitate the emergence of a filter, acting as a censor, internal to the University, deciding which of the many publications should be bonused by the fund and which not. But this filter is also in danger of being jammed – after all, someone has to read this wave of publications and impartially decide which ones pass the filter. Moreover, the more publications – the more selective the filter will need to be, and the more valuable time the people involved in this function will have to spend, rather than doing the research themselves. This function is now implicitly delegated

to reviewers of „status“ scientific journals, but they bear no responsibility because they are anonymous. But even anonymous reviewers have a finite capacity to review.

A publication in The Guardian stirred up the spirits in academia and gave rise to various commentaries and interpretations about the role of those working in so-called “teaching universities”.

It was about an interview of Peter Higgs on his visit to Stockholm to receive his Nobel Prize (2013) in Physics.

“The emeritus professor at Edinburgh University … published fewer than 10 papers after his groundbreaking work, which identified the mechanism by which subatomic material acquires mass, was published in 1964” (Aitkenhead 2013).

In his words (of Peter Higgs) “no university would employ him in today‘s academic system because he would not be considered “productive” enough” (Aitkenhead 2013).

Replacing the few but meaningful publications with a mass of publications hastily compiled from other people‘s opinions and sentences is now representative of the modern academic system. The administrative and moral pressure to publish a lot and at any cost inevitably creates a problem – the university, its scientific editions and those publishing in them unofficially get the label “nothing interesting to read” and simply fall out of sight of those reading the publications. The situation and the pressures on those working in universities, where they have to do many other things in addition to their lecturing work, as opposed to pure research organisations, is very well described in an article with the speaking title “Exhausted and Not Doing Enough? The Productivity Paradox of Contemporary Academia” (Ferreira 2022). One of the main conclusions directly relevant to this situation is “Contemporary academic job management culture is fundamentally incompatible with quality research and lecturing” (ibid).

Teachers in such universities will always have to find a compromise between their own teaching work, which includes supervising PhD students, preparing courses (new and updated) and materials for them, their research work and writing countless reports on all the work they have done, because in subsidised universities proper documentation is part of the conditions for receiving subsidies. But every compromise, in one way or another, compounds the weaknesses of the solutions to which it is a compromise.

The incentive system would add another but attractive pole, the possibility of making money from publications, and so there would be both push and pull forces acting on authors. The system starts to work for its own sake - publications are written to absorb the incentives, and the incentives are increased to write even more publications. The logical conclusion follows: “any observed statistical regularity will tend to collapse once pressure is placed upon it for control purposes”, as the original wording of the law/principle of Goodhart.

This problem is also related to the second problem.

**Problem 2. Discriminating some authors and favouring others**

From the formula for the optimal amount of publications maximising the individual player's profit $q_i^* = \frac{(N-1)A\left[\sum_i^N c_i - (N-1)c_i\right]}{\left(\sum_i^N c_i\right)^2}$ one can see which players will publish more and which - less. Authors who have lower costs of publishing will have a "competitive advantage", and consequently authors with higher costs will find themselves discriminated against under such incentive system.

If we consider the part of the numerator in the middle brackets $[\sum_i^N c_i - (N-1)c_i]$, we can also predict when certain authors will not be incentivised to participate in the "who will publish more" race. There is a condition under which the optimal number of publications becomes zero and then negative. When the following condition is satisfied

$$\sum_i^N c_i - (N-1)c_i = N\bar{c} - (N-1)c_i = 0,$$

$$c_i = \frac{N\bar{c}}{(N-1)}$$

where the sum of the costs of the individual players is replaced by $N\bar{c}$ ($\bar{c}$ is the simple average of the costs of all players involved). Hence, when the unit (average) cost of writing and publishing a single publication for a player is slightly higher than the average for the population, for that player and for the group of players like him in general (for which the above condition is satisfied), the optimal behavior becomes to retire and not to participate in the game, which means to have zero publications.

Moreover, costs are not always a matter of players' willingness. Collecting empirical data can cost significant amounts of money or take a long time. There are natural processes whose timelines cannot be shortened in order to gather data faster, and this is well known to researchers in the natural sciences.

Undoubtedly a competitive advantage will be gained by authors specialising in writing the much-vaunted "literature reviews" on a subject, or promoting the work of their chosen authors (as they have understood it), or with data obtained from a telephone survey of 10 people (survey in the morning, finished paper in the afternoon).

**Problem 3. False "scientific" research disguised as publications**

The topic of publishing false (unreliable) research, direct plagiarism and other unfair practices is not a favourite in the scientific community, but it is becoming increasingly topical. Its aspects are much broader than the topic of this article and for obvious reasons we will limit ourselves to a few.

In a lengthy (64 pages with appendices and active e-addresses) report of the Commission on Counteracting the Falsification of Scientific Research at the Russian Academy of Sciences (RAS), the results of an empirical, including experimental, study of so-called "predatory journals" and the false publications of Russian authors in journals securing publication in Scopus or WoS are published.

The conclusions drawn in the cited paper are summarised as follows:

1. the costs of publishing in "predatory journals" are non-productive. They do not disseminate scientific knowledge, but are self-serving – having a publication in a journal indexed in Scopus or WoS;
2. the effect of such publications is formal – the presence of publications in a Scopus or WoS indexed journal, rather than the development of collaborations with other scientists, as co-authors are usually fictitious and do not disseminate scientific knowledge;
3. the research shows that most articles in these journals are not cited (*and in all likelyhood not being read at all* – comment mine);
4. many scientific organisations bonus authors for articles in such journals, leading to an increase in low quality articles;
5. the effect of these expenses for the development of science is close to zero, if not negative;
6. in overall, rewarding unscrupulous authors is detrimental to the science.

The authors estimate that the expenses for publishing articles, i.e. to compensate the authors for the publication expenses, are unproductive. Such costs are also provided in the Bulgarian universities.

Bonuses and salary supplements to authors publishing articles in such journals are also considered non-productive.

However, the worse effect is at a higher level. Teaching and research organisations receive funding increases based on aggregate publication metrics that include those in predator journals. A vicious circle results – the more funding there is to be absorbed, the more such hastily fabricated articles there will be. The more such articles there are, the more funding the organisation will receive.

The authors also consider the mechanisms of falsification in order to get additional "scorepoints" and thus money by authors and organisations.

It has been found experimentally that papers are published that deliberately include non-scientific "results" and non-scientific thesis which means that the proposed papers either do not go through the peer review process at all or it is formal.

The same articles are published in different journals, indicating that there is no control for repeatability. Each of the journals has an interest in taking the money of the person who wants to publish and has no interest in refusing because that means money lost.

The same articles are published, translated (often with poor quality automatic translation) into different languages, thereby circumventing plagiarism controls.

In more drastic cases, articles from other authors are published, only translated into another language as their own work. This practice is particularly popular for articles that do not exist in electronic form, making plagiarism impossible to detect.

But all this should not surprise us; demand inevitably creates an offer, and here the existence of unidirectional interests of all participants in the given process is an undeniable fact. Authors have a strong vested interest in publishing lots of papers quickly in "status" journals (read: journals indexed in Scopus or WoS) and if they don't, others will and the money will go to them. Organisations have a vested interest in increasing publication activity because this will give them more funding for "research". At the higher level, the officials are interested in reports that clearly show the growth of publications under their wise management and that are a testimony to how well they are doing their job. So why shouldn't there be journals that ensure the comfort of all these participants? The market doesn't tolerate voids, and as long as there are people willing to spend money to embellish reports, there will be ways to spend it. Assuming that the predator journals are the predators in this "ecosystem", who, among the other participants, play the role of the herbivores, scavengers, and parasites? Or are the predator journals, after all, parasites without which science can exist and develop just fine, and even better?

But all this is, one might say, the household level, the small "private business" of individuals, which pales before the great falsifications.

The real big falsifications are at the supranational level and there the source of the money are the big corporations willing to pay large (but not for themselves) sums for much more global purposes.

History knows many such falsifications, financed at different times by different companies. The hysteria surrounding the famous "ozone hole" (tomorrow everyone will die in horrible agony!), the benefits of smoking, the benefits of drinking cough syrup with heroin (Bayer AG, 1898), the lack of health hazards of consuming products containing a lot of sugar, the vital need to drink a lot of mineral water and many others. Today, this role is played by the new global "ozone hole" – global warming – to combat which fantastic sums are being wasted.

We can judge the scale of falsification in a specific field – medicine – from several rather sparing publications. For example (Horton 2015) estimates the rate of false published scientific results to be "perhaps half" (The case against science is straightforward: much of the scientific literature, perhaps half, may simply be untrue). The same publication laconically describes the role of various institutions

and scientific journals in maintaining and developing the most vicious practices in science.

The role of scientists themselves in the problem is passive, according to the author: "Part of the problem is that no-one is incentivised to be right. Instead, scientists are incentivised to be productive and innovative" (ibid). As long as scientists are asked to be productive and paid to be productive, they will be productive. But the price of that productivity will be the low or no value of that output.

Marcia Angell (2009), long-time editor-in-chief of the New England Medical Journal (NEMJ), considered one of the most prestigious alongside the Lancet, is more critical: "it is simply no longer possible to trust most published clinical trials". A conclusion she reached after more than 20 years as editor of the NEMJ. So how can one trust prestigious journals and talk about citations when most of the results in them are "untrue"?

The NEMJ itself is not an infallible "guardian of scientific truth" either. Back in 1967 it published in a literature review the (false) results of a study commissioned and paid for by the then Sugar Research Foundation (SRF), now the Sugar Association. The falsified results were "obtained" not by someone else, but by famous Harvard professors sponsored by the SRF in question. The truth was twisted and reshaped until SRF vice-president John Hickson finally approved the "results": "quite what we had in mind". After a double peer review (and worthy sponsorship by SRF), NEMJ published the paper with the conclusion (paid for and commissioned) that to reduce the risk of heart disease one need only reduce fat consumption. And not a word about sugar, and not a word about SRF sponsorship. When years later the truth was revealed , it became clear that "It was so blatant. And the "bribe" was so big".

History repeats itself in the present day. The Coca-Cola giant is sponsoring research to re-evaluate the link between sugar-sweetened beverage consumption and obesity. But this time the methods are not as direct as in the 1960s. A non-profit organisation, the Global Energy Balance Network, is set up, supported financially and logistically by Coca-Cola (O'CONNOR 2015)[1]. Scientists from this team „just disseminate" their results in scientific journals, scientific conferences and social media. Moreover, the thesis is no longer so straightforward, people just need to move more. But it's actually part of the reaction to the company's sales decline over the past 20 years. The same article cites another publication that found studies of beverages funded by Coca-Cola, PepsiCo, the American Beverage Association and the sugar industry were five times more likely to find no link between sugar-sweetened beverages and obesity than studies whose authors reported no financial conflicts.

We can conclude that the credibility of the scientific results obtained in a publication is not determined by how prestigious the journal in which the publication appeared is. Prestige is credible evidence only of how much money the author or

his sponsor paid for that publication. Included in the price, of course, is an unknown "prestige" price component, such as other consumers pay when they buy a product that bears the imprint of a "prestigious" manufacturing company.

On the contrary, in order for the big falsifications in science paid for by the big corporations to work, these falsifications must necessarily be published precisely in prestigious scientific journals in order to be read, cited and disseminated to consumers. Publishing them in non-prestigious journals "does not pay", the prestigious journals will be quoted in them, completely free of charge for the company that paid for the "research".

All in all, the subject of paid, commissioned research with a predetermined result is so vast that it is impossible to condense it in a single article.

**Problem 4. Too few publications**

There is also a danger at the other extreme, the risk of cartelising publication activity to maximise the use of the incentive fund at minimal cost. Such a danger always arises in the presence of allocated monetary funds. In the case of the economic game called competition, everyone knows what a cartel is and how it extracts additional profits from the market, but it is unlikely to be any secret in other research structures either.

The fewer publications that are realised, the larger the portion of the incentive fund each one will receive. The fewer publications that are realised, the less expenditure of time, money and effort will have been made to obtain the larger sums from the fund.

In economic reality, cartel agreements are forbidden, they are prosecuted and punished. But in science, it is not regulated in any way, and it is only a matter of time before the players understand that it is better for everyone to collude than to compete with quantities of publications. Moreover, co-authorship, collective papers and scientific collaboration are even encouraged as "good practice". As long as this "good practice" does not hide behind cartelisation for the sole purpose of more money.

In the extreme (theoretical) case, only a single publication will be realised by the author who makes the least expenditure to do so. That publication will then receive the entire amount of the allocated fund, and from there on the most interesting part follows – its distribution between him and the other cartel participants.

The amount to be distributed, taking into account the unit cost will be:

$$A - \min_i\{c_i\} = \sum_{i=1}^{N} U_i$$

This amount can be distributed among all players in proportion to their optimal profits in the Nash equilibrium, i.e. without cartelisation. If we compare the sum

of the profits under competitive behavior and under cartelisation, it is obvious that under cartelisation each player will receive a larger profit with proportional distribution:

$$(A - min\{c_i\})\frac{U_i^*}{\sum_1^N U_i^*} > \left(A - \sum_{i=1}^{N} c_i q_i^*\right)\frac{U_i^*}{\sum_1^N U_i^*}$$

This is the simplest and most obvious distribution, but not the only possible one. Moreover, not only are there multiple variations of distribution of a larger amount, but there are also multiple variations of cartel arrangements where the amount of the cost is lower than that in the Nash equilibrium. All of these variants guarantee all players profits that are no smaller than their profits in the Nash equilibrium under competitive behavior of the players.

In the light of the possible cartel agreement, the players‘ profits in the Nash equilibrium take on new meaning. These are the marginal (smallest possible) amounts that the player writing the only publication has to pay the other players **to prevent them from writing and publishing**. Since they will receive these amounts without having incurred any expenditure, they will receive additional income from their zero publication activity. Thus, zero publication activity becomes more financially beneficial for all players.

Thus, reducing the number of publications is a way of increasing the profits of the players who have reached a cartel agreement.

An indicator of the existence of a cartel agreement can be the appearance of publications with numerous of co-authors, which are in fact written by only one author, while the others are included in the list of co-authors only and only to not write. Such publications in which 10 pages are “written” (sometimes) by co-authors whose number is greater than the number of sentences in the publication and hundreds of sources are cited are not rare, and they are an interesting phenomenon beyond the scope of this article.

**Problem 5. Unstable dynamics of publication activity**

The Nash equilibrium requires full transparency and information for the players about the costs of every other player. In our case, this is a dubious assumption, since players cannot accurately know even their own expenditures at the time of writing their own publication.

This leads to so-called “reactive decisions” where, after a certain period (one tact) has elapsed, each player draws his conclusions based on facts that have already happened and are observable by him. In the case of incentivising publishing activity, this means assessing post factum the expenses incurred, the profit obtained from them and the total volume of publications made during the period by all players.

According to this evaluation, the player makes his reactive decision to change his behaviour – as a reaction to what has already happened.

The plausible reaction is when it has gained little to evaluate its efforts as insufficiently rewarded, become disappointed with the stimulation and reduce its activity in the next tact. On the contrary, the highly valued effort should logically stimulate him to increase his publications. As a result, after a period (tact) of high publication activity, the incentive amounts received will be small and the response will lead to a drop in publications, for some players to zero. In the next tact, the few publications will be highly rewarded, then more players will increase their activity and the cycle will repeat again.

The development of similar processes, but in the classical version of the Cournot-Nash equilibrium is considered by Olga Dusouchet (Dusouchet 2006). Numerical modelling (in a four-player game) shows an increasing dispersion of the offer, i.e. a non-stationary process. This is true under the assumptions made in the cited study that different players will have different reaction times, reflected in different tact durations for each of them.

However, when the length of the tact is fixed by external conditions, as in the case of the publications activity incentive, which takes place over the course of a year, it is logical that the tact length should also be the same for all players. A similar situation can be observed in seasonal activities in tourism, agriculture and the like, where the evaluation of the results and the decision to react is made after a year has passed and the reaction can be easily adapted for the next tact. In such cases, the process becomes stationary after some time of instability, where uniform high values leading to a loss for all players alternate with uniform zero values as a reaction to the preceding losses.

Of course, different publications take different time for their realisation, and writing an in-depth monograph lasting several years cannot be compared to a paper written on a Sunday afternoon. Only after the monograph has been evaluated will the player be able to decide whether it is worth pursuing this path or whether it is more profitable for him to switch to low-cost, fast-publishing publications.

Therefore, it cannot be stated unequivocally that the dynamics of publication activity will necessarily be a stationary or non-stationary process. But this does not cancel out the irregular dynamics for the reasons mentioned above.

## Conclusion

The presence and growth of publications in „prestigious“ scientific journals indexed in Scopus or Web Of Science should not be fetishised. It is not a guarantee of the scientificity of publications.

Encouraging research and publications should not be understood as simply injecting money into research without clear objectives and priorities, without problems and tasks to be solved.

The growth of publications in indexed and refereed journals should not and cannot be set as a goal. It may be the result of research, and only formal result, but not meaningful result.

Undoubtedly, the application of the system for stimulating publication activity in the Bulgarian universities is still in its early stages and the results of this system are yet to be evaluated. Several years will have to pass and observations will have to be accumulated in order to see the pros and cons of this system.

Perhaps the incentive system for publication activity should only be a part of a system to stimulate research activity.

**NOTES**

1. https://archive.nytimes.com/well.blogs.nytimes.com/2015/08/09/coca-cola-funds-scientists-who-shift-blame-for-obesity-away-from-bad-diets/?mtrref=undefined&assetType=REGIWALL.

**REFERENCES**

AITKENHEAD, D., 2013. Peter Higgs: I wouldn't be productive enough for today's academic system. *The Guardian*. HYPERLINK „https://www.theguardian.com/science/2013/dec/06/peter-higgs-boson-academic-system“ https://www.theguardian.com/science/2013/dec/06/peter-higgs-boson-academic-system .

ANGELL, M., 2009. Drug companies and doctors: A story of corruption. *The New York Review of Books 56*. HYPERLINK „https://www.dailymail.co.uk/health/article-3785753/How-sugar-industry-paid-prestigious-Harvard-researchers-say-fat-NOT-sugar-caused-heart-disease.html?ito=amp_twitter_share-top“ https://www.dailymail.co.uk/health/article-3785753/How-sugar-industry-paid-prestigious-Harvard-researchers-say-fat-NOT-sugar-caused-heart-disease.html?ito=amp_twitter_share-top .

BIAGIOLI, M., 2016. Watch out for cheats in citation game. *Nature*, vol. 535(7611), p. 201. https://doi.org/10.1038/535201a.

DUSOUCHET, O. M., 2006. Static Cournot-Nash equilibria and strategic reflexive games of oligopoly:. *Ekonom. Zh. VShE*, vol.10, no. 1, pp. 3 – 32.

FERREIRA, J. B., 2022. Exhausted and Not Doing Enough? The Productivity Paradox of Contemporary Academia. *She Ji: The Journal of Design, Economics, and Innovation*, pp. 181 – 191.

HORTON, R., 2015. What is medicine's 5 sigma? *The Lancet*, 1380. www.thelancet.com, vol 385 April 11, 2015.

O'CONNOR, A. (9 august 2015 r.). Coca-Cola Funds Scientists Who Shift Blame for Obesity Away From Bad Diets. *The New York Times*, archive, Available at: https://archive.nytimes.com/well.blogs.nytimes.com/2015/08/09/coca-cola-funds-scientists-who-shift-blame-for-obesity-away-from-bad-diets/?mtrref=undefined&assetType=REGIWALL

TANUSHEV, C., 2022. Digital Transformation: The Impact on Corporate Strategy. *Economic Alternatives*, pp. 383 – 404. DOI: 10.37075/EA.2022.3.01

Commission of the Russian Academy of Sciences on countermeasures for falsification of scientific research. (2020).

*Foreign predatory journals in Scopus and WoS: translation plagiarism and Russian unscrupulous authors*. Moscow.

✉ **Dr. Georgi Kiranchev, Assoc. Prof.**
ORCID iD: 0000-0003-3462-8560
Department of Marketing and Strategic Planning.
University of National and World Economy
E-mail: g.kiranchev@unwe.bg