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ON A SCIENTOMETRIC PROCEDURE FOR THE EVALUATON OF THE ROMANIAN INNOVATIVE POTENTIAL IN R & D.

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1. Introduction.

Patents are an intellectual property right issued by authorized bodies to inventors to make use of and exploit their inventions for a limited period of time (generally 20 years). Patents are granted to firms, individuals or other entities as long as the invention is novel, non-obvious and industrially applicable. The patent holder has the legal authority to exclude others from commercially exploiting the invention (for a limited time period). In return for the ownership rights, the applicant must disclose information relating to the invention for which protection is sought. The disclosure of the information is thus an important aspect of the patenting system. A patent is a policy instrument intended to encourage the making of inventions and the subsequent innovative work that will put those inventions to practical use; it is also expected to procure information about the invention for the rest of the industry and the public generally. By providing a legal framework for protecting inventions, the patent system affects economic performance by stimulating innovation that increases productivity. Patents are a key measure of innovation output, as patent indicators reflect the inventive performance of countries, regions, technologies, firms, etc. They are also used to track the level of diffusion of knowledge across technology areas, countries, sectors, firms, etc., and the level of internationalization of innovative activities. Patent indicators can serve to measure the output of R&D, its productivity, structure and the development of a specific technology / industry. Among the few available indicators of technology output, patent indicators are probably the most frequently used. The relation-ship between patents as an intermediate output resulting from R&D inputs has been investigated extensively. Patents are frequently viewed as an output indicator; however, they could also be viewed as an input indicator, as patents are used as a source of information by subsequent inventors

The relation between economic growth and R & D development is constantly investigated. Substantial progress has been made in the calculation and assessment of the economic growth parameters.

However, problems concerning the calculation or R & D development parameters in relation to economic development are still unsolved. They particularly regard the conception and selection of appropriate parameters.

One of the indicators is the innovative production. Specialists have suggested different equations for calculation of this indicator. Below we propose another equation for a similar purpose, using Romanian data from national R & D system.

2. Calculation relations of the innovative production.

Like any other indicators, patent indicators are associated with many advantages and disadvantages. The advantages of patent indicators are: *a)* patents have a close link to invention; *b)* patents cover a broad range of technologies on which there are sometimes few other sources of data; *c)* the contents of patent documents are a rich source of information (on the applicant, inventor, technology category, claims, etc.); and *d)* patent data are quite readily available from patent offices.

However, patents are subject to certain drawbacks: *a)* the value distribution of patents is skewed as many patents have no industrial application (and hence are of no value to society) whereas a few of them are of substantial value; *b)* many inventions are not patented because they are not patentable or inventors may protect the inventions using other methods, such as secrecy, lead time, etc.; *c)* propensity to patent differs across countries and industries; *d)* differences in patent regulations make it difficult to compare counts across countries; and *e)* changes in patent law over the years make it difficult to analyze trends over time.

Nevertheless, in the absence of a "perfect" innovation output indicator, patent indicators are the best available indicators of innovation output.

For the calculation of every country's innovative production, S. Teitel [1] uses the following variables:

N – Number of innovations per resident of a country.
S – Human resources (every country's total number of researcher).
E – R & D expenses.
Y – National income per capita.
P – Number of inhabitants.

S. Teitel considers that the innovative production depends on human resources and the research expenses:

$$\mathbf{N = N\ (S, E)} \qquad \mathbf{(1)}$$

More explicitly, this suggests the equation:

$$\mathbf{N = N_0\ S^a\ E^b} \qquad \mathbf{(2)}$$

where: $a \geq 0$; $b \geq 0$.

The above relation, $\mathbf{N = N_0\ S^a\ E^b}$, draws attention on the **human factor**, which can affect the innovative production.

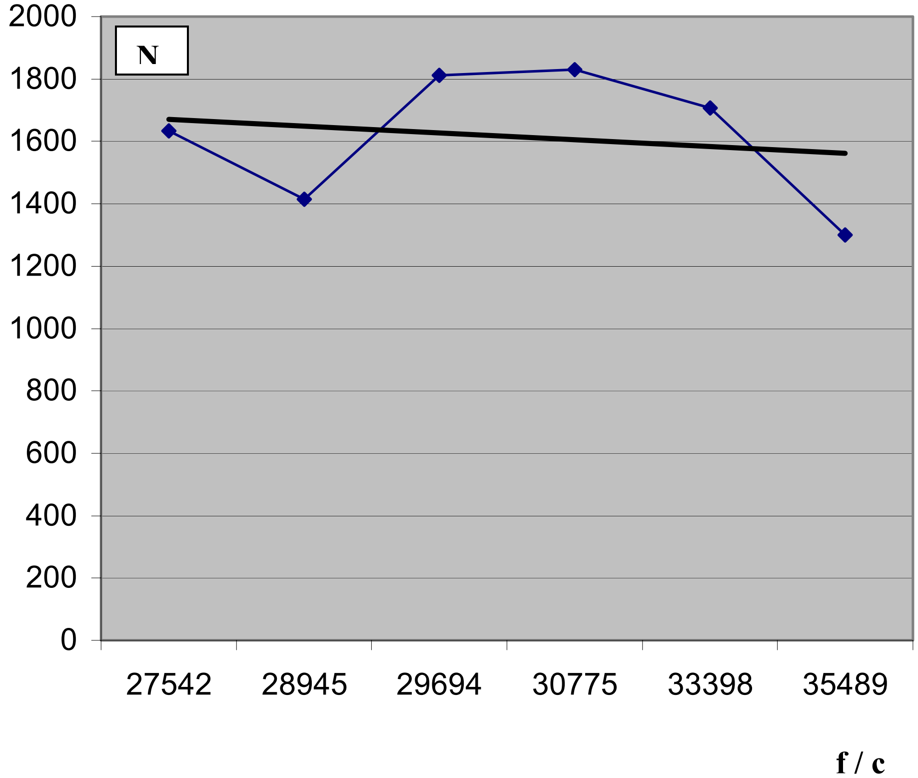
In his study, C.J.J. Maclean [2] presents a linear correlation between the annual budget (X) and the annual number of publications (p):

$$\mathbf{p = uX} \qquad \mathbf{(3)}$$

where: $u \geq 0$.

The equation **p = uX** points out the influence of **financing** upon the scientific (**innovative**) production.

Using Romanian data [3], we indicate the dependence of number of patent applications on the specific financing (f / c), as it is shown in Figure 1.



N – Number of patent applications.
f – Financing, **€**.
c – Number of researchers.

Figure 1

The specific financing (f / c) is the ratio between funds earmarked for R & D (f) and the total number of researchers (c).

If we denote: $\mathbf{f / c = \varphi}$ **(4)**

then we can write the relation: $\mathbf{N = b\varphi}$ **(5)**

The specific financing, **φ**, is a complex factor, as, on the one hand, it depends on the policy decision – making and, on the other hand, it is affected by the responsiveness of the human factor of the research units. Through the coefficient "b", the specific financing affects the innovative production. With the aid of Figure 2 we can analyze the significance of coefficient "b".

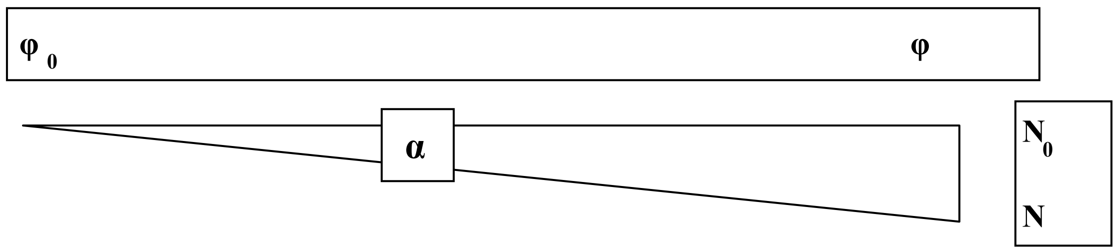


Figure 2

$$\mathbf{b = tg\alpha = (N_0 - N) / (\varphi - \varphi_0) = \Delta N / \Delta\varphi} \qquad \mathbf{(6)}$$

Let's make the dimensional analysis of the relation: $\mathbf{b = \Delta N / \Delta\varphi}$.

$\mathbf{[b] = [\Delta N] / [\Delta\varphi]}$ = Number of inventions / Currency per number of researchers **(7)**

or: **[b] = (Number of inventions / Currency) x Number of researchers** **(8)**
Therefore:

$$\mathbf{[b] = \{ [N] / [f]\} \times [c]} \qquad \mathbf{(9)}$$

that is: $\mathbf{b = (N/f) \times c}$ **(10)**
and the result is:

$$\mathbf{b = (N / c) \times (c^2 / f)} \qquad \mathbf{(11)}$$

where: $\mathbf{N / c = \pi}$. **(12)**
$\boldsymbol{\pi}$ is the innovative performance of the researchers. Equation (11) combined with equation (12) becomes: $\mathbf{b = \pi c^2 / f}$ **(13)**

Combining equation (13) with equation (5), the result is:

$$\mathbf{N = (\pi c^2 / f)\varphi} \qquad \mathbf{(14)}$$

Equation (14) can be written as:

$$\mathbf{N = (\pi\, \varphi / f)\, c^2} \qquad \mathbf{(15)}$$

If we are noting: $\mathbf{\pi\, \varphi / f = m}$ **(16)**
then:

$$\mathbf{N = m\, c^2} \qquad \mathbf{(17)}$$

The factor "m", from the equation $N = mc^2$, has the significance of a **human resources utilization yield.**

This factor can be expressed as: $\mathbf{m = (\pi / f) \times (f / c)}$ **(18)**

The innovative productivity of researchers (**π**) is a qualitative **effect,** which represents the specific production of inventions by a scientific researcher, i.e. his / her creative work intensity.

The number of employed researchers (c) is the result of the **effort** made by society as a whole and is dependent on financing capabilities of the society to support active researchers.

It is known that productivity means the ratio between the **effects** and the **effort** made in a particular work.

The single reason of the R & D activity is to generate, as an effect, a certain level of **innovative productivity**, while society makes efforts to support the generation of the effect. Thus, it seems logical to consider that the factor "m" of the equation $N = mc^2$ is the **human resources utilization yield from R & D activity**.

Figure 3 makes a comparison between annual values of factor "m" in Romania.

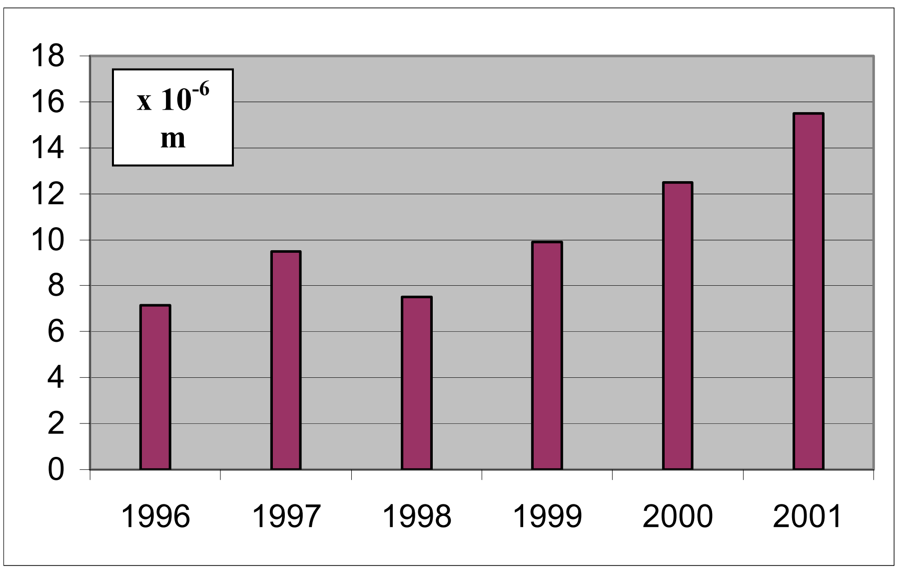


Figure 3

While the Romanian factor "m " was at a value of 5 x 10^{-6} in the year 1996, under the influence of the new legislation, for financing the innovation stimulation, in the year 2001 reached a value of 15,5 x 10^{-6}. In the same period, the financing per researcher capita was increased from 28.945 € / capita to 46.315 € / capita [4] and this increasing represents the stimulating mechanism which raised the value of the factor "m".

3. Conclusion

The equation for calculation of the innovative potential of scientist, proposed by this paper, indicates that **the innovative potential of a country, particularly Romania, depends on the square number of researchers**, which proves the necessity and usefulness of an strategic policy in R & D human resources, such that the respective resources is stimulated to the benefit of the development.

The proposed equation can be also applied to comparative analyses concerning the evolution of the innovative output of different countries, under the impact of various national policies.

4. References

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