

# Research Policy - a Question of Allocation

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By Caj-Gunnar Lindström<sup>\*)</sup>

*This report is a contribution to the discussion concerning the formation of a research policy. In the report the formation of such a policy is discussed on the basis of the different demands placed on research. A concrete example of a research policy is provided and how the policy is put into operation when giving priority to and directing certain types of research is discussed.*

## 1. Introduction

In 1969 approximately Fmk. 229 million were spent on research and development in Finland, i.e. about 1 % of the gross national product. The public sector financed some 49 % of these costs while the private sector provided about 50 % of the costs of research with foreign sources providing the remaining 1 %. The distribution of costs by discipline was as follows:

| Discipline                      | Fmk. (mill.) | %   |
|---------------------------------|--------------|-----|
| Natural sciences and technology | 207          | 69  |
| Agriculture and forestry        | 35           | 12  |
| Social sciences                 | 23           | 8   |
| Medicine                        | 22           | 7   |
| Humanities                      | 10           | 3   |
| Unspecified                     | 2            | 1   |
| Total                           | 229          | 100 |

Table 1.1.

*Allocation of research funds in Finland, 1969.*

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Research techniques in a number of the disciplines referred to above have developed in such a way that they now demand quite large financial resources. At the same time the number of research workers is on the increase, which means that the competition for the limited resources available is becoming stiffer. The problem resulting from this situation is one of allocation, and furthermore of an allocation which has different dimensions: 1) allocation by discipline, 2) allocation by area of research within each discipline and 3) allocation by individual research project.

Allocation problems encountered in operations analysis usually have as their goal when allocating resources either the minimisation of the total cost or the maximisation of returns. Which is or should be the objective when allocating the limited resources at our disposal to the three different phases of research mentioned above? In other words, what should our research policy look like?

The aim of this report is to cast some light on the problem of forming a research policy which aims to give priority to and to steer certain types of research. In order to give the discussion a firmer foundation, if indeed such a thing is possible, I shall limit myself to discussing the two latter phases of research. In connection with the discussion a concrete plan of a first attempt to form an explicit research policy on the part of a research council in Finland is presented. In 1969 this council allocated funds to finance some 3 % of the research carried out in the social sciences in Finland.

The formation of a research policy should be seen as the result of a process of interaction of demands made from three different sources, namely from society, from education and from those carrying out the research. The community, or society, demands that the research should be relevant to the needs of the community and be of importance for the development of the community. Behind this demand there lies the demand for scientific, objective analysis of current problems among other things. Higher education is and should be linked to research, an application of scientific methods. This means that the possibility of doing research must be made available. The demands made by the research workers themselves are usually to be looked upon as a demand for freedom. This demand for freedom is partly the demand that they should be economically independent in their research and partly that they be formally free. This latter may be formulated as the freedom to choose their research methods and the freedom to evaluate the results of their research.

The normal way of implementing a research policy seems to be a process by which competing research projects are given priority and placed in some sort of order of preference. In the council an attempt was made

to form an explicit research policy in which the ranking criteria were as follows:

- A: How relevant is the project to the needs of the community?
- B: How important is the project for the discipline in question?
- C: How competent is the applicant?
- D: How has the applicant's research plan been formulated?

The members of the council were divided into five sections: the economic (3), the juridical (1), the political science (3), the psychology and pedagogic (2) and the social science section (3). The number in brackets refers to the number of representatives participating in the attempt.

When the research funds were allocated in the autumn of 1971 an attempt was made to implement the research policy formed on the basis of the four criteria above. Each member of the five sections was required to rank the research projects being considered bearing in mind each of the four criteria and finally to make his own personal suggestion as to the allocation of the funds available.

This attempt to implement a given policy provides material for a number of interesting analyses. The fundamental questions put forward in the analysis are:

1. Can the criteria used to decide the order of preference be considered relevant?
2. Can any one or more of the criteria be regarded as of being of greater importance than the others?
3. Is determining an order of preference the most suitable method bearing in mind the criteria?

Whether any one or more of the criteria can be considered more important than the others and whether the final order of preference arrived at using the criteria provide the reason for selecting the final order of preference may be determined using a multiple regression analysis. A further analysis which can cast light on the problems involved is to investigate the correlation between the different orders of preference arrived at by the members of the council.

Analysis of the results has been made somewhat more difficult on account of a certain variety in the ways in which the assessments were carried out. Three of the members of the council used a system of points instead of simply ranking the projects. In four cases the personal proposal put forward as to the order of preference was interpreted in the analysis. Another weakness in the analysis is the limited number of observations per section. In the majority of cases this results in a reduction in the level of significance of the results of the analysis.

## 2. Analysis of the Correlation Between the Orders of Preference

Kendall's model for determining the degree of correlation was used for the analysis. This is referred to below as  $W$ . Kendall's coefficient and is the ratio between observed ratings and expected ratings. If  $W = 1$ , then there is complete correlation; if  $W = 0$ , there is no correlation at all. the  $Z^2$ -test was used as a test of the level of significance. The material of the analysis and the numerical results are given in Table 2.1. It was not possible to carry out an analysis of the juridical section. The analysis shows that the correlation within sections is quite good. In particular attention is drawn to the figure  $W = 0.91$  for the political science section. Different opinions seem to prevail in part within the social science section where  $W = 0.55$ . Within the psychology and pedagogic section the number of observations was lowest. This is reflected in the somewhat lower value for the level of significance. The correlation, however, is high,  $W = 0.91$ , even significant.

The analysis shows that there exists a common view towards the different research projects within each section. The question is therefore whether and to what degree ranking on the basis of the four criteria explains the final order of preference.

## 3. Analysis of the Weight Accorded to the Criteria in Deciding Personal Orders of Preference

The analysis has been conducted as a multiple regression analysis based on the following model:

$$O = \alpha A + \beta B + \gamma C + \delta D + a$$

In the first stage of the regression is included the criterium which alone provides the best explanation ( $R^2$ ). The significance of the explanation has been tested using an F-test and the significance of the coefficients of regression by means of a t-test. In stage two are included the two criteria which together provide the best explanation and so on. If the criteria used were regarded by the members of the council as being of equal value then the regression coefficients in stage four would be of the same size and also significant.

The result of the analysis is given in Tables 3.1, 3.2. and 3.3. The level of significance is indicated by \* for 95 % and \*\* for 99 %. The different sections are indicated by the letters E = economics, J = juridical, S = social science, P = psychology and pedagogics, and PS = political science.

Table 2.1

| Economics                                                      |    |                |     | Social Science                                                |    |                |     | Psychology                                                    |    |                | Political Science                                               |    |                |     |
|----------------------------------------------------------------|----|----------------|-----|---------------------------------------------------------------|----|----------------|-----|---------------------------------------------------------------|----|----------------|-----------------------------------------------------------------|----|----------------|-----|
| Applic.                                                        |    | Section member |     | Applic.                                                       |    | Section member |     | Applic.                                                       |    | Section member | Applic.                                                         |    | Section member |     |
| no                                                             | I  | II             | III | no                                                            | I  | II             | III | no                                                            | I  | II             | no                                                              | I  | II             | III |
| 001                                                            | 5  | 7              | 6   | 033                                                           | 13 | 27             | 23  | 063                                                           | 11 | 11             | 074                                                             | 1  | 6              | 1   |
| 2                                                              | 6  | 10             | 9   | 34                                                            | 21 | 30             | 9   | 64                                                            | 3  | 2              | 75                                                              | 7  | 16             | 9   |
| 3                                                              | 2  | 6              | 7   | 35                                                            | 25 | 24             | 26  | 65                                                            | 9  | 8              | 76                                                              | 2  | 4              | 7   |
| 4                                                              | 8  | 5              | 3   | 36                                                            | 26 | 7              | 22  | 66                                                            | 4  | 4              | 77                                                              | 4  | 7              | 3   |
| 5                                                              | 4  | 2              | 1   | 37                                                            | 5  | 3              | 2   | 67                                                            | 1  | 1              | 78                                                              | 9  | 18             | 12  |
| 6                                                              | 1  | 3              | 4   | 38                                                            | 14 | 6              | 5   | 68                                                            | 10 | 9              | 79                                                              | 6  | 1              | 10  |
| 7                                                              | 3  | 1              | 2   | 39                                                            | 6  | 19             | 3   | 69                                                            | 5  | 10             | 80                                                              | 10 | 5              | 4   |
| 8                                                              | 12 | 13             | 10  | 40                                                            | 24 | 28             | 27  | 70                                                            | 6  | 6              | 81                                                              | 15 | 13             | 11  |
| 9                                                              | 9  | 9              | 8   | 41                                                            | 10 | 5              | 24  | 71                                                            | 8  | 5              | 82                                                              | 8  | 3              | 6   |
| 10                                                             | 13 | 11             | 13  | 42                                                            | 19 | 8              | 12  | 72                                                            | 7  | 7              | 83                                                              | 22 | 22             | 22  |
| 11                                                             | 11 | 12             | 5   | 43                                                            | 27 | 29             | 28  | 73                                                            | 2  | 3              | 84                                                              | 17 | 14             | 18  |
| 12                                                             | 7  | 4              | 11  | 44                                                            | 7  | 26             | 7   | $W = 0.91$<br>$\chi^2 = 18.27$<br>$P\{\chi^2 < 16.9\} = 0.95$ |    |                | 85                                                              | 19 | 15             | 14  |
| 13                                                             | 10 | 8              | 12  | 45                                                            | 17 | 18             | 13  |                                                               |    |                | 86                                                              | 14 | 12             | 8   |
| $W = 0.78$<br>$\chi^2 = 28.22$<br>$P\{\chi^2 < 28.3\} = 0.995$ |    |                |     | 46                                                            | 16 | 17             | 20  |                                                               |    |                | 87                                                              | 3  | 8              | 5   |
|                                                                |    |                |     | 47                                                            | 8  | 1              | 17  |                                                               |    |                | 88                                                              | 18 | 20             | 19  |
|                                                                |    |                |     | 48                                                            | 28 | 14             | 21  |                                                               |    |                | 89                                                              | 20 | 17             | 17  |
|                                                                |    |                |     | 49                                                            | 23 | 23             | 16  |                                                               |    |                | 90                                                              | 5  | 2              | 2   |
|                                                                |    |                |     | 50                                                            | 22 | 15             | 14  |                                                               |    |                | 91                                                              | 21 | 21             | 21  |
|                                                                |    |                |     | 51                                                            | 2  | 12             | 6   |                                                               |    |                | 92                                                              | 11 | 11             | 13  |
|                                                                |    |                |     | 52                                                            | 3  | 2              | 8   |                                                               |    |                | 93                                                              | 16 | 9              | 16  |
|                                                                |    |                |     | 53                                                            | 29 | 10             | 1   |                                                               |    |                | 94                                                              | 13 | 10             | 15  |
|                                                                |    |                |     | 54                                                            | 4  | 9              | 10  |                                                               |    |                | 95                                                              | 12 | 19             | 20  |
|                                                                |    |                |     | 55                                                            | 1  | 4              | 29  |                                                               |    |                | $W = 0.91$<br>$\chi^2 = 57.37$<br>$P\{\chi^2 < 49.0\} = 0.9995$ |    |                |     |
|                                                                |    |                |     | 56                                                            | 15 | 11             | 11  |                                                               |    |                |                                                                 |    |                |     |
|                                                                |    |                |     | 57                                                            | 20 | 20             | 25  |                                                               |    |                |                                                                 |    |                |     |
|                                                                |    |                |     | 58                                                            | 9  | 16             | 4   |                                                               |    |                |                                                                 |    |                |     |
|                                                                |    |                |     | 59                                                            | 18 | 22             | 30  |                                                               |    |                |                                                                 |    |                |     |
|                                                                |    |                |     | 60                                                            | 11 | 21             | 19  |                                                               |    |                |                                                                 |    |                |     |
|                                                                |    |                |     | 61                                                            | 12 | 25             | 18  |                                                               |    |                |                                                                 |    |                |     |
|                                                                |    |                |     | 62                                                            | 30 | 13             | 15  |                                                               |    |                |                                                                 |    |                |     |
|                                                                |    |                |     | $W = 0.55$<br>$\chi^2 = 48.09$<br>$P\{\chi^2 < 49.6\} = 0.99$ |    |                |     |                                                               |    |                |                                                                 |    |                |     |

*Analysis of the correlation between the orders of preference.*

Within the economic section criterion B seems to have been given a high priority. The value for B alone as an explaining factor drops no lower than 67 % in Table 3.1. In Table 3.3 quite high values for the degree of explanation are obtained but it should be noted that not all coefficients are significant for the separate assessments. The high values imply that the criteria used are adequate to explain the orders of preference. On the other hand Table 3.2 shows that not all the criteria need be considered absolutely necessary.

Only one assessment has been made in the juridical section. This shows that criterion C has been accorded considerable importance with a value of 60 %. In Table 3.2 the degree of explanation rises to 83 % using a combination of criteria C and D. The value does not, however, rise noticeably when A and B are included in Table 3.3. Furthermore, there is a negative coefficient for B.

Within the social science section it would seem to be criteria A and D which are accorded the greatest degree of importance. In Table 3.2 A is included by each of the members of the section together with D, C and D respectively. The degree of explanation varies, however, from 41 % to 90 %. For the first member of this section at least the criteria used would appear to be quite irrelevant. They are certainly not adequate to explain the final order of preference. Significant coefficients are obtained for all criteria as far as the other two members of the section are concerned in Table 3.3. The coefficients are of almost the same value, which indicates that the criteria may be considered adequate and necessary to explain the order of preference arrived at.

The analysis of the results arrived at by the psychology and pedagogic section has been complicated by the fact that only a limited number of observations was possible ( $n = 10$ ). This has a decimating effect on the level of significance of the analysis values, which in turn has a negative influence on the possibility of assessing the consequences. In Table 3.3 negative values for criterion C were obtained for both members of the section. The coefficients, however, are not significant.

In the political science section it is possible to detect two types of assessment. The first, used by the second member of the section, is characterised by the stress laid on criteria C and B giving a degree of explanation of 84 % in Table 3.2. There is no increase in the degree of explanation in Table 3.3. The other type used by members 1 and 3 of the section emphasises criteria A and D, here the degree of explanation in Table 3.2 is 89 % and 81 % respectively.

It would seem somewhat rash to draw any general conclusions as to the relevance and importance of the criteria on the basis of this analysis. To begin with, the analysis is based on only one attempt to make some kind of assessment: it has therefore been impossible to carry out any comparison. Secondly, the number of observations is relatively low.

| Section member<br>criterion<br>R <sup>2</sup> |                                           |                                           |                                           |
|-----------------------------------------------|-------------------------------------------|-------------------------------------------|-------------------------------------------|
| Section                                       | I                                         | II                                        | III                                       |
| E                                             | $\beta = 0.84^{**}$<br>$R^2 = 0.67^{**}$  | $\beta = 0.99^{**}$<br>$R^2 = 0.98^{**}$  | $\beta = -5.28^{**}$<br>$R^2 = 0.75^{**}$ |
| J                                             | $\gamma = 0.77^{**}$<br>$R^2 = 0.59^{**}$ |                                           |                                           |
| S                                             | $\delta = 0.56^{**}$<br>$R^2 = 0.31^{**}$ | $\alpha = 0.72^{**}$<br>$R^2 = 0.51^{**}$ | $\delta = 4.18^{**}$<br>$R^2 = 0.86^{**}$ |
| P                                             | $\alpha = 0.64$<br>$R^2 = 0.41^{*}$       | $\beta = 0.92^{**}$<br>$R^2 = 0.84^{**}$  |                                           |
| PS                                            | $\delta = 6.75^{**}$<br>$R^2 = 0.74^{**}$ | $\gamma = 0.95^{**}$<br>$R^2 = 0.77^{**}$ | $\alpha = 0.86^{**}$<br>$R^2 = 0.74^{**}$ |

Table 3.1.

Results of the analysis using one criterion to explain the final order of preference.

| Section member<br>criterion<br>R <sup>2</sup> |                                                                   |                                                                   |                                                                    |
|-----------------------------------------------|-------------------------------------------------------------------|-------------------------------------------------------------------|--------------------------------------------------------------------|
| Section                                       | I                                                                 | II                                                                | III                                                                |
| E                                             | $\beta = 0.57^{**}$<br>$\delta = 0.54^{**}$<br>$R^2 = 0.88^{**}$  | $\beta = 0.74^{**}$<br>$\delta = 0.27^{**}$<br>$R^2 = 0.99^{**}$  | $\beta = -3.70^{**}$<br>$\gamma = -2.41^{**}$<br>$R^2 = 0.92^{**}$ |
| J                                             | $\gamma = 0.61^{**}$<br>$\delta = 0.52^{**}$<br>$R^2 = 0.83^{**}$ |                                                                   |                                                                    |
| S                                             | $\alpha = 0.34^{*}$<br>$\delta = 0.42^{*}$<br>$R^2 = 0.41^{**}$   | $\alpha = 0.69^{**}$<br>$\gamma = 0.39^{**}$<br>$R^2 = 0.66^{**}$ | $\alpha = 1.32^{**}$<br>$\delta = 3.65^{**}$<br>$R^2 = 0.90^{**}$  |
| P                                             | $\alpha = 0.49$<br>$\delta = 0.31$<br>$R^2 = 0.49$                | $\beta = 0.74^{*}$<br>$\delta = 0.24$<br>$R^2 = 0.86^{**}$        |                                                                    |
| PS                                            | $\alpha = 4.36^{**}$<br>$\delta = 5.54^{**}$<br>$R^2 = 0.89^{**}$ | $\beta = 0.29^{*}$<br>$\gamma = 0.83^{**}$<br>$R^2 = 0.84^{**}$   | $\alpha = 0.56^{**}$<br>$\delta = 0.40^{*}$<br>$R^2 = 0.81^{**}$   |

Table 3.2.

Results of the analysis using two criteria to explain the final order of preference.

Table 3.3.

| Section member |                |        |        |          |
|----------------|----------------|--------|--------|----------|
| Section        | Criterion      | I      | II     | III      |
| R <sup>2</sup> |                |        |        |          |
| E              | $\alpha$       | 0.31*  | 0.14   | — 1.00   |
|                | $\beta$        | 0.22   | 0.60** | — 3.00** |
|                | $\gamma$       | 0.30   | 0.16   | — 2.00** |
|                | $\delta$       | 0.43** | 0.13   | — 1.00   |
|                | R <sup>2</sup> | 0.93** | 0.99** | 0.97**   |
| J              | $\alpha$       | 0.90   |        |          |
|                | $\beta$        | — 0.17 |        |          |
|                | $\gamma$       | 0.66** |        |          |
|                | $\delta$       | 0.55** |        |          |
|                | R <sup>2</sup> | 0.85** |        |          |
| S              | $\alpha$       | 0.24   | 0.48** | 1.71**   |
|                | $\beta$        | 0.14   | 0.41** | 1.73**   |
|                | $\gamma$       | 0.10   | 0.50** | 1.65*    |
|                | $\delta$       | 0.37   | 0.30** | 1.87**   |
|                | R <sup>2</sup> | 0.43** | 0.92** | 0.96**   |
| P              | $\alpha$       | 0.16   | 0.22   |          |
|                | $\beta$        | — 0.93 | 0.56   |          |
|                | $\gamma$       | — 1.39 | — 0.15 |          |
|                | $\delta$       | 2.70   | 0.47   |          |
|                | R <sup>2</sup> | 0.74   | 0.89*  |          |
| PS             | $\alpha$       | 3.57** | 0.01   | 0.59*    |
|                | $\beta$        | 1.96*  | 0.18   | 0.05     |
|                | $\gamma$       | 4.66*  | 0.75** | — 0.11   |
|                | $\delta$       | 2.82*  | 0.18   | 0.42*    |
|                | R <sup>2</sup> | 0.93** | 0.84** | 0.81**   |

*Results of the analysis using four criteria to explain the final order of preference.*

As is shown in Table 3.3 significant values for all criteria are obtained in only three cases and these are in sections with the largest number of applicants. A point of interest in the analysis is the light it casts on the characters of the members of the sections. It might be said somewhat jokingly that the economist sticks up for his own subject, the jurist is strictly formal, the sociologist is very community-minded, the psychologist wants a more penetrating analysis while the political scientist tries to find a diplomatic compromise between the community and formal requirements.

## 4. Evaluation

The ranking criteria used build a complex which is interpreted in different ways by the different members of the sections. The criteria have not been formulated operationally and this in turn means that it is difficult, if not altogether impossible, to compare different research projects on the basis of a particular criterion. This is especially so if the research projects have to be specifically ranked. Ranking presupposes a single scale of measurement. It is therefore possible that ranking cannot be carried out in connection with the actual formulation of criteria giving priority to certain qualities.

The greatest problem in comparing different research projects is to transform subjective opinions as to the qualitative attributes of projects into quantitative values. The realisation of a research policy should be carried out using a method which both sides regard as natural and of which the result is a ranking of different research projects.

One natural method of evaluating is to assess the projects on the basis of a scale good, average, fair, etc. with reference to a fixed criterion. This type of evaluation can even be applied to the types of criteria referred to here. By giving 3 points for good, 2 for average and 1 for fair a comparison between ranking and a points system has been made possible: the results are given in Table 4.1. The example has been selected quite arbitrarily.

When ranking it is natural to add together sub-rankings. In point-setting such addition is not so natural since it leads to an evening out of high and low points. Multiplication results in a higher evaluation of the high points, cf. projects No 005 and 006 in Table 4.1.

| No  | A | B | C | D | $\Sigma$ | R  | A | B | C | D | $\Sigma$ | R  | // | R  |
|-----|---|---|---|---|----------|----|---|---|---|---|----------|----|----|----|
| 001 | 7 | 1 | 1 | 2 | 11       | 1  | 1 | 3 | 3 | 3 | 10       | 2  | 27 | 2  |
| 002 | 5 | 6 | 5 | 1 | 17       | 5  | 2 | 1 | 2 | 3 | 8        | 4* | 12 | 5* |
| 003 | 6 | 4 | 3 | 3 | 16       | 4  | 1 | 2 | 3 | 2 | 8        | 5* | 12 | 6* |
| 004 | 3 | 3 | 2 | 6 | 14       | 2* | 3 | 3 | 3 | 2 | 11       | 1  | 54 | 1  |
| 005 | 2 | 7 | 4 | 7 | 20       | 6* | 3 | 1 | 2 | 2 | 8        | 6* | 12 | 7* |
| 006 | 4 | 5 | 6 | 5 | 20       | 7* | 2 | 2 | 2 | 2 | 8        | 7* | 16 | 4  |
| 007 | 1 | 2 | 7 | 4 | 14       | 3* | 3 | 3 | 1 | 2 | 9        | 3  | 18 | 3  |

Table 4.1.

*Comparison of ranking and point-setting.*

The specific formulation of a research policy may be seen as an a priori weighting of the ranking criteria. In Table 4.1 the criteria have been given a weighting of 1. In the regression analysis above the weightings for the different criteria were obtained in the form of the regression coefficients  $\alpha$ ,  $\beta$ ,  $\gamma$  and  $\delta$ . The model for implementing the research

policy within a defined area of research (e.g. a section) would, using varying weightings, be as follows:

$$R = A^{\alpha} \cdot B^{\beta} \cdot C^{\gamma} \cdot D^{\delta}$$

where R gives the order of preference.

The model may be expanded to cover a policy distributing resources between different sections by including a multiplier  $\epsilon_i$ , an allocation factor. This factor has a value  $0 < \epsilon_i < 1$  in the case of a policy in which a certain research sector were to be treated restrictively and  $1 < \epsilon_i$  when it is desired to explicitly direct resources to a particular field of research. Estimates of A, B, C and D are obtained as the average values of the points evaluation for each project.

The increased competition for research funds makes an explicit research policy a necessity. Any attempt to direct research activity, however, involves a number of negative factors which are strongly stressed by the research workers. A policy which aims to steer research can lead to stereotyped contributions and to a reduction in spontaneous research. The research policy should therefore be formulated so flexibly that spontaneous contributions can also be taken into account. The attempt analysed here is *one* possibility and the suggested allocation model is also *one* possible method of implementing a research policy. In order to formulate a research policy in such a way that the interaction between the different demands made on the policy can be balanced a search-learning process is needed within which the results of each attempt can be evaluated.

#### References:

Central Bureau of Statistics: Statistical Report 1971. Ko 1971/13. Helsinki, 1971.

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