On the efficiency of federal R&D spending: A public choice approach

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Abstract:

Technical knowledge is the product of innovation and innovation the result of R&D. If technical knowledge is considered a public good, then public sector participation should be evaluated in terms of efficiency characteristics. Generally, the supply of goods and services by the public sector is related to the division of costs among recipients and to their collective demand; however, in the case of funding among industries the incidence of cost rests primarily with society while benefits from the production of knowledge accrue to both. Consequently, if an efficient allocation of funds is to be achieved, priority should be shown to those industries generating the largest positive externality from R&D induced innovations.

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Article:

I. Introduction

Technical knowledge is the product of innovation and innovation the result of R&D. If technical knowledge is considered a public good, then public sector participation should be evaluated in terms of efficiency characteristics. Generally, the supply of goods and services by the public sector is related to the division of costs among recipients and to their collective demand; however, in the case of funding among industries the incidence of cost rests primarily with society while benefits from the production of knowledge accrue to both. Consequently, if an efficient allocation of funds is to be achieved, priority should be shown to those industries generating the largest positive externality from R&D induced innovations.

It has been argued that there exists another determinant of supply that may compete with efficiency criteria. If bureaucrats seek to maximize their own utility, the allocating scheme chosen may be to serve the bureaucrat himself. Stigler (1971) referred to such a concept in relation to economic regulation where private interests are advanced in a rational manner.

The significance of bureaucratic maximization viz-a-viz public interest is important in assessing the efficiency of Federal R&D spending.

II. A Simple Model of R&D Funding

The observed distribution of R&D funds among industries is assumed functionally related to the industry's demand and the government's supply. Industry demand is represented by its marginal evaluation of Federal funds. Marginal evaluation is the return placed on successive units of a public good, vertically summed over all firms within the industry. Governmental supply is related to the goal of internalizing social externalities from the application of R&D toward innovative activity and perhaps also to insuring the bureaucrat's self interest. Efficiency is measured by the relative importance of achieving social externalities rather than private interests.

If externalities are viewed as the distribution of technical knowledge from applied R&D and as the selection of R&D projects in terms of the "national interest", then a structural equation representing the demand and supply determinants of Federal R&D (FRD) may be written:

$$\text{(1)} \qquad \mathrm{FRD_i} = \mathrm{f}(\mathrm{ME_i}, \mathrm{DTK_i}, \mathrm{NI_i}, \mathrm{BSI_i})$$

where ME represents the marginal evaluation of R&D by industry i, DTK represents the distribution of technical knowledge by industry i, NI represents the application of R&D toward "national interests" by industry i, and BSI represents the bureaucrat's self interest in allocating funds toward industry i.

Consider, for example, the distribution of Federal R&D in the U.S. manufacturing sector for the year 1973 as shown in Table I. One may, at first glance, suspect that funds are efficiently allocated in terms of the "national interest" for military and/or defense research. However, casual empiricisms may be faulty.

Table I[1]

2-digit SIC classification		Federal R&D (Millions of 1973 dollars)
#29	Food and Kindred Prod.	2.0
#22-23	Textile–Apparel	1.0
#24-25	Lumber–Furniture	0.5
#26	Paper and Allied Prod.	1.0
#28	Chemical and Allied Prod.	206.0
#29	Petroleum Refining	14.0
#30	Rubber Products	35.0
#32	Stone, Clay, and Glass Prod.	3.0
#33	Primary Metals	11.0
#34	Fabricated Metals	12.0
#35	Machinery	334.0
#36	Electrical Equipment and Communication	2655.0
#38	Professional and Scientific Instruments	182.0

[1] Groups 21, 27, 31, 37, and 39 did not report Federal R&D expenditures. Groups 22-23 and 24-25 are treated as combined classifications by the National Science Foundation in reporting current data: *Survey of Science Resources* (t973).

Equation (1) was estimated using these 2-digit manufacturing industries as sample observations. ME was measured in terms of the industry's own commitment to R&D using company R&D expenditures for 1972. DTK was measured by the average 2-ditit concentration ratio.[2] The positive externality from the creation of technical knowledge equals the gap between social and private (industry) benefits generated from the innovation flow. The greater industry concentration, the greater this gap (Kamien, 1975). NI was measured as a dummy variable where the number 1 designated those industries receiving either financial or technical assistance from either the Department of Defense or NASA. All other industries were given the number 0. BSI was measured in terms of the potential voter or lobbying strength within each industry that could be internalized to the bureaucrat. This was approximated by the number of unionized workers.

The ordinary least squares results from the linear approximation of equation (1) are:

$$\text{(2)}\quad \underset{\substack{\\ \\ (-1.1592)}}{\text{FRD} = -280.0517} + \underset{\substack{\\ \\ (3.5601)^*}}{1.4816\,\text{ME}} - \underset{\substack{\\ \\ (-0.9928)}}{661.6161\,\text{DTK}} - \underset{\substack{\\ \\ (-2.9222)^*}}{1821.9542\,\text{NI}} + \underset{\substack{\\ \\ (3.1926)^*}}{10960.8955\,\text{BSI}}.$$

$R^2 = 0.9183$.

F=level = 22.4709.

n = 13.

* = highly significant t-statistics.

It appears from the coefficients and the levels of significance of the ME variable that industry demand for funds is satisfied. The coefficients on the externality variables, DTK and NI, imply that the supply of Federal R&D is unrelated to the efficiency goals these variables seek to measure. DTK is negative, as expected, but insignificant while NI is highly significant but the incorrect sign. Leonard (1971) has also concluded that Federal R&D is rarely associated with industrial growth or innovative activity. BSI is a highly significant variable in explaining the industry allocation of Federal R&D. This suggests that private interests are being maximized, perhaps at the expense of "national interests". In terms of our criteria, Federal R&D is inefficiently distributed among industries.

III. Conclusions

Although this investigation represents a small cross-sectional study from only one sector of the economy, the results confirm that conflicting interests are present in determining industry-specific endowments of Federal R&D.

Traditionally, allocation questions have been studied only from the demand side (Bergstrom, 1973), but in so doing, supply efficiency is implicitly assumed. This analysis casts serious doubt on the value of such assumptions and offers an additional approach to the question.

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[2] Leonard Weiss was the first to use such a measure at the 2~digit level. See, *Journal of Industrial Economics* (1963).

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