PUBLIC SUPPORT OF RESEARCH:

THEORETICAL FRAMEWORK AND THE CASE OF TRANSPORT

A guide to the identification of research needs for removal of bottlenecks to social development.

by
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1. INTRODUCTION

The main objective of this paper is to show the width of the range of research tasks that are possible to carry out when government decides to intervene in a substantive sector and maximize the return on research. Our objective is pursued by providing a conceptual framework for program development and project evaluation.

Suppose someone hired us to run a grant program for hardware and software research. Assume we have a finite budget and assume, finally, that we get sensible proposals which exceed the available funds. It is clear that the government cannot fund just any project which makes sense, we need some criterion to decide which are the projects that are worth public money. If we step back for a second, we see that our program has a set goals which offer a dimension of evaluation of the projects, but these may not be detailed enough for our specific selection task. Alternatively, we can ask ourselves: "Why is governement in the business of funding research?" And we can answer this question by elaborating a theoretical framework for government involvement in research which will help us operationalize the institutional goals of the program and make the relevant choices among alternative projects. Therefore, the purpose of this paper is to provide a theoretical framework for reference in decision-making and scientific orientation of a research program. Through the correlation of program goals and economic strategy we want to explicate the key points of policy choice in such a program and illustrate the alternatives that are available. The paper then applies the framework to the integrated transport system and shows how each strategy is mapped on to different blocks of the system.

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The paper reviews and operationalizes models which cover only the normative perspective, since we want to clarify why government should be involved in trasport research, not how it got involved in a specific program. For purpose of reform, though,we should need models of social conflict and bureaucratic behavior as well, but that will be for another paper. Few people have objections to government funding of methodological, or software research, but the issue becomes more complex when support for technological development is extended to industrial companies. In this case, much more money is involved and strong ties are established with the private sector. Then, government should clearly specify the purpose of each grant and its own role in technological development. A second point that generates the need for clarity in the specification of this governmental activity is the operational scope that a crash research program may have. The short term horizon enlarges the spectrum of activities from basic research to the development of products and policy analysis. If not only long term results are sought, but also a quick impact on reality, applied research and implementation plans have to be made, as the number of things that can and have to be done increases rapidly. Therefore, the complexity of the operation commands a dramatic need for clarity of ends and means.

In part 2, we would like to summarize the arguments of neoclassical theory for government intervention in research and development activities. Going beyong this baseline model, we will extended the the capabilities and tasks of research funding through the application of a so-called "economic planning" model. In part 3, applying the framework to the integrated transport system, we should be able to provide a clear statement of the role of government in this activity and the width of the range of research tasks which should be helpful in guiding disbursement of public money.

2. THEORETICAL FRAMEWORK

In the sections that follow we provide economic categories for strategic planning of a research program.

2.1. Market Failure

The neoclassical model of general equilibrium allows government intervention in the economy to repair market failure and reestablish perfect competition.[2] There are several cases of market failure; we will illustrate those which are most relevant to government support of research. The first case that we examine regards large shocks to the prevailing equilibrium: government intervenes as the insurer of last resort. Natural disasters and national security are two areas in which government operates to prevent and repair large shocks to the economy. Support of basic research in technology, a traditional

area of governmental involvment, can also be considered an insurance activity since it involves large investment, but guarantees no sure return. Private firms, therefore, would have little incentive to pursue it without govenmental help. But the classical motives for funding basic research concern its nature as public good. Research in methodology is characterized by non rivalry in consumption: your use of a scientific concept does not limit my ability to use the same concept. Excludability, even though feasible, is not desiderable in order to get maximum social return on knowledge.

The central government may also be in the business of purchasing research as the organizer of a fragmented market whose elementary demand units are local and regional governments. Alternatively, the central government may want to provide other bodies with a "merit good for public institutions"[3], i.e. with know-how and products that are good for them, but that they do not value enough. Dissemination of information is clearly within this range of interests, so are demonstration projects. Another area of government intervention in market failure is the case of externalities. Ar externality occurs in a market transaction when all the costs, or benefits, are not born, or enjoyed, by the parties involved.

In conclusion, the normative statement of the neoclassical model implies that government should fund those projects which are not commanded by the market, but which provide a social benefit. Neoclassical theory considers a benefit anything that is marketable or has an opportunity cost. Intangible benefits are also considered, but these never regard the structure of the market per se or the kind of technology that is adopted. In the next section, we try to concretize the concept that society is affected as a whole by the path of development of knowledge and therefore alternative paths have different levels of desiderability according to one's own policy judgement.

2.2. Government as an Agent of Social Change

It is a routinely accepted notion in Italy that government should intervene in the economy not only to restore the conditions of free market, but also (and mostly?) to drive the development[4] of society "along a path not driven by spontaneous market forces". In this theory, government should intervene in the economy as a "different economic agent" endowed with peculiar objectives and contraints in order to perform its unique task.[5] We would like to qualify this paradigm of analysis as an "economic planning" model. It grows out of various schools of social science and we mean it here in a public policy sense, which is the specification of objectives and instruments of government action in a sector of the economy and society. In this section, we would like to expand on the concept of choice of technique, starting from the non determination of a free market

development of technology and showing some of the junctures of the decision process and the available alternatives. In the same context, we will try to show how public funding of research can be used as a tool for economic planning. The effects on society of the development of knowledge are pervasive. Hardware technology, management systems, ownership and control of companies affect all facets of social life: land use and energy consumption, workplace organization and community patterns, family budget and aspirations. It is therefore logical that a government which purports to be an agent of social change seek to orient society via the course of research development. The following is a set of cases which detail the economic planning model into operative actions which government may want to take, and which imply driving research towards envisioned objectives.

Reshaping the market - This intervention regards the introduction of products which would be sustained by the market, but require a societal effort in the start-up phase. Here the hypothesis is that the market doesn't work for products that are substantially different from the available ones; "each individual chooses only among the available products" and cannot bring about products that would satisfy his hidden demand. A possible reason for altering the market could be given by an income distribution, on which individual preferences depend, and which is not the way government would like it.

Strategy of national development - Boosting specific areas of technological development may require the socialization of the costs of research and privatization of the proceeds thereby. Company appropriation of patents obtained under public funding is a case in point, actually a strong incentive is provided to the private company if it can capture all the benefits of investment made with public support. Along these lines, government can exploit its power of the purse to avoid dispersion and coordinate efforts in order to reach a critical mass in some projects and obtain substantial results with a quick impact on society. A case may be provided by a crash research program, as mentioned at the beginning of this paper: it is as if government demanded a huge consulting task from the research community.

Expansion of keynesian policy - "The fading of therapeutic capabilities of macroeconomic policy has loaded industrial policy with more and more aspirations and objectives ... It is therefore of crucial importance to identify a series of specific public policies" among which a "policy of innovation" ranks very high.
The general goal of such a policy would be to "maximize the rate of technological change and orient its development path."[6]

Shaping the structure of the research industry - Government can affect the structure of the industry which produces research. Criteria for funding can privilege large or small firms, since the aid can be

targeted towards concentration of capabilities in a few institutions or aimed at widening the research base of the country. Government can pursue either one of these strategies, creating leading companies through a sub-contracting system or contracting to small firms and providing some external support to them. Government can support specific modes of production of research and firm organization as well. For instance, it could stimulate professional growth of personnel and expansion of a solid research structure by placing a premium on work done in house and by full time personnel, if this is deemed to be effective.

From these considerations, a notion emerges that qualifies all research which is recommended in the framework of the economic planning model: the notion of a "desiderable orientation of technology". With this phrase, we indicate those projects that are thought to bring about desiderable changes in the economy and society. We are aware of the vagueness that this phrase transmits, we hope the next section clarifies it a little bit.

2.3. Project Evaluation

The analytical framework we have provided so far helps us in the choice of a strategy for pursuing institutional goals and in the detailed work of project evaluation. We want to emphasize how the economic planning model changes the approach to project evaluation vis-à-vis the neoclassical model and, at the same time, how the two paradigms, though ideologically distant, can be usefully integrated for routine use and innovation in an active society. To choose among all proposals that may satisfy the given criteria, we could apply a marginalist approach and calculate the shadow value of each project and choose those with the highest payoff.[7] But there are two problems with this approach: first, it is very difficult to evaluate the shadow value of a research project because of the many unknowns and the inherent uncertainties of the field; second, this kind of evaluation is not desiderable if we accept the normative prescriptions of the economic planning model. In fact, the orientation of the trend of technology does not have a shadow value, but it depends essentially on a policy choice which has to be clearly stated. A macroscopic case in which the policy choice depends from a vision of societal development is the alternative between development of advanced vs. intermediate technology. The former may guarantee success on foreign markets, the latter may produce a sizeable improvement in quality of life at home. The former follows a supply side philosophy, the latter follows a "soft path" approach. Thus, we can see that decisions cannot be made on objective grounds, but they imply judgement and political vision. The issue seems to be conceptually similar to the problem of intangibles in cost-benefit analysis. Thus, correctness of choice can

only be entrused to a decision process in sunshine and the two paradigms, the neoclassical and the economic planning, are both instrumental in the process of policy analysis.

3. THE CASE OF TRANSPORT

In this part, we want to show how the different strategies of government intervention, that are outlined by the economic categories provided above, apply to the integrated transport system. To do so, we shall first present a rough model of the integrated system. Then, we shall try to map the program goals and strategies of intervention on the system. This procedure will be illustrated operationally by giving a few examples of concrete research projects which could result from application of the framework.

3.1. Description of the integrated transport system

This section attemps to give a description of the transport system and its interactions with society at large. Diagram 1 and the synopsis of table 1 show the subsystems that we identify for our purpose. Following is a brief description of each subsystem and its relationship to other subsystems.

A. Government - In this block we include all public organizations with specific reference to those bodies whose mission is the administration of transport. Main actors in this scene are the Ministry of Transport, at national level (A.1), and the transport authorities, at regional and local levels (A.2, A.3). Government includes both elected officials and career officiers.

Intergovenmental relations also include the transport planning process. Government's relations with the producers of goods and services include finance, regulation, taxation, real services and personnel system. Government affects social and economic organization (think of the strategies for regional development), negotiates with national unions, and it supports the activity of the scientific community in the substantive area of transport research.

B. Production of services - In this subsystem we identify all the operators that produce the transport service by operating the vehicles and the infrastructure. We also identify individual citizens as a category of operators when they use private vehicles.

Producers of services have a buyer-seller relationship with producers of goods. The same is also true for their relationship with users of services, although many would object to call it a buyer-seller one. They entertain negotiations with labor and exchange information and knowledge with the scientific community.

C. Production of goods - In this subsystem we identify manufactures of vehicles and builders of infrastructure. The steps that we can

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Diagram 1

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The integrated transport system

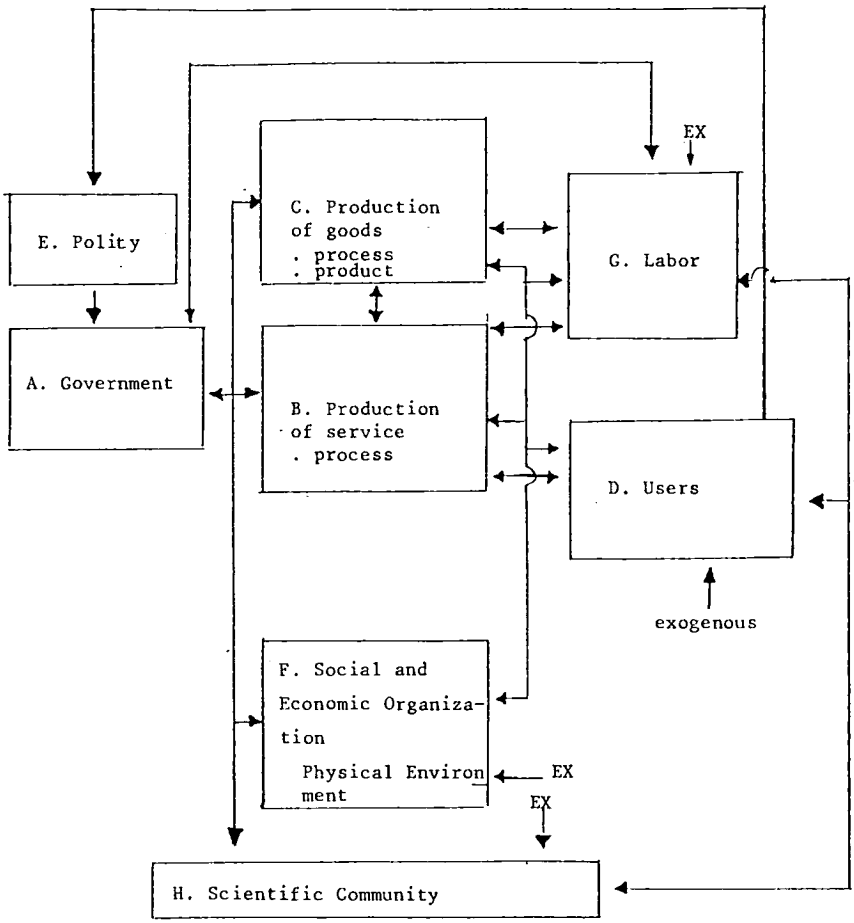

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Table 1

Synopsis of subsystems

A. Government

1. National level
2. Regional level
3. Local level

B. Production of service

1. Vehicles (modal split)
1.1. Companies
1.2. Individuals

2. Infrastructure

C. Production of goods

1. Vehicles
2. Infrastructure

D. Users

1. Passenger
2. Freight

E. Polity

1. National
2. Regional
3. Local

F. Social and Economic Organization

1. Public (administrative reform)
2. Private (market fluidification)

Physical Environment

G. Labor

1. Production of goods
2. Production of services

H. Scientific community

identify within this block are (1) the process of production and (2) the design of the product. Action on either one has an impact on the transport system.

Producers of goods do not have direct relations with users but for the specific case where users become managers of their own transport vehicle. Their relations with the rest of the system follow the same categories outlined for the producers of services.

D. Users - In this subsystem we identify the general public (individuals and companies) as final users of the transport system.

Users' major relationship is with the producers of services. Their mobility needs are generated in part by the social and economic organization and in part by their own preferences (indicated by "exogenous" in the diagram). Also, the general public virtually coincides with voters, except for citizens under voting age who are users, but not voters. Companies also intervene in the political debate.

E. Polity - In this subsystem we identify the general political process which allows the citizens to elect public officials.

The political process produces the elected officials who are responsible for the functions of government with respect to the transport system. The effectiveness of this link depends on the importance of the transport issue in the polity. It seems reasonable to assume that the link is stronger at local level.

F. Social and Economic Organization - Under this classification we want to take into account all the alterations of civil organization that have an impact on the users' mobility demand and on the ability of the production systems to carry out their tasks.

By definition, this subsystem has an impact on all other subsystems.

G. Labor - We want to keep this block separate from blocks C and B for contingent reasons of clarity rather than for a conceptual separation between management and workforce in the production areas. We do so because to some extent, the work force acts independently of management and cares about different objectives.

Unions act across companies and authorities, they may also interact directly with government officials. Their decisions may have a substantial impact on the production process.

H. Scientific Community - We include all researchers and consultants who operate in the public and private sectors.

The research community has relations with all other subsystems both as providers of information and as potential clients.

Perhaps, diagram 1 does not convey a clear sense of a dynamic evolution of the

transport system. To some extent, this is done for the purpose of evidentiating that no clear mechanism operates in the system, but a number of pulls and pushes do and they cannot be reconducted to one clear cycle of action and feedback.

It shouldn't seem out of place to incude in our chart subsystems that might seem peripheral to the transport system, as defined in a narrower sense. In fact, if our goal is that of improving the general welfare of the population as far as transport contributes to it, we shouldn't discard off hand the hypothesis that some problems are located in areas of interface between the transport system and society at large. For instance, it might happen that the real problem with local transit management is not the lack of good means of transport or efficient flow assignment models, but the lack of talent in local authorities, that are unable to attract valid professionals, lack of sensitivity to the problem in the political process or lack of a motivated work-force.[8]

It may seem dispersive to show that "everything is related to everything", but at this very early stage of analysis, we do not want to foreclose any hypothesis. We want to find out what is the problem. We might even discover that the problem is not one of research.

3.2. Mapping the government strategy on the system

In this section, we will try to show how each of the strategies that are outlined in part 2 lead to specific govenmental actions in the subsystems that have been described in the preceding section. This will be done through the process described below. We should warn that all substantive specifications that will be made have the character of example and suggestion, rather than having the pretense to be an exhaustive list of topics and problems that should actually be researched.

The process of mapping consists of:

a. recalling the governmental goals, which are a mild specification of the general objective of improving the welfare of the people as far as the transport system is concerned;

b. identifying a specific economic strategy to be implemented in order to pursue the desired goal;

c. specifying sets of characteristics that help to identify the specific research projects to be carried out;

d. applying the goal-strategy-characteristic grid to the blocks of the system.

Before presenting a few examples, let us recall a set of possible goals and a set of possible characteristics of a research project.

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a. Government goals:

1. foster international economic competitiveness of domestic industry;

2. abate external effects (pollution, congestion);

3. save energy;

4. promote safety.

b. Project characteristics:

Economic stage:

1. production: process;

2. exchange: product.

Stages of research and applications:

soft	basic	applied	policy analysis	bill and regulation drafting	implementation and/or demonstration
hard	basic	applied	development	design and engineering	production

Disciplinary classification of problems (and solutions): engineering (ship, rail, automotive ... chemical), economics, management, law, systems analysis, operations research, political science, sociology.

Applying the grid: examples of specific research projects

1. The goal of fostering the international competitiveness of domestic transport industry maps at least on to the strategy of national development which aims at creating an industrial potential. To be comprehensive, the implementation of the strategy ought to look at both the product and the process aspects of the subsystems of goods and services production. On the product side, one might want to develop the design of new vehicles through innovative engineering concepts. On the process side, one might want to analyze the labor policy costs in vehicle production through an economic and political science framework. Alternatively, one could do a system analysis of cargo rental costs and fleet management optimization in the service production area.

2. Applying the same scheme of reasoning to the goal of abatement of external effects, the goal is clearly formulated in terms of strategy: let everyone bear the costs of the service they receive. Looking at the process of producing the service of urban road infrastructure,

one might want to have a demonstration project of a scheme for the relief of traffic congestion, using the methodologies of economics, management and law, for the soft part of the scheme, and using engineering for the needed infrastructure development.

3. A third example of application of the proposed grid is in the safety area. The strategy is to provide merit goods which transport users and producers don't value enough. The process of road infrastructure use, for instance, is regulated by governmental enforcement of the traffic safety code. Applied statistical research may offer policy recommendations for management reform of the code enforcement and the technological development of traffic monitoring equipment.

From the three examples illustrated above,we can see that two grand strategies emerge as we specify the research projects: technological development (in the hardware acceptation of the word) and management of the transport system. These two strategies are not disjoined per se, but it is useful to stress the second one since it may seem more difficult to pursue. In fact, it involves a substantial widening of the researchable areas in trasport matters. The idea, therefore, is that one little step in the right direction is better than a great leap in the wrong one.

4. CONCLUSION

In this paper we have provided a theoretical framework for government funding of transport research. We have explained the normative views of the neoclassical model which are aimed essentially at restoring a competitive market equilibrium. Also, we have seen how the economic planning model tries to grasp the development of society through the evolution of technology and we have introduced the category of "desiderable orientation of technology".

A first result that the paper shows is that for program development purposes the strategies outlined by the two different economic models are complementary and not mutually exclusive.

The paper then presents a method for generating and classifying specific research projects by building a grid of reference for analysing the transport system. The grid is given by the program goals, the economic strategies and the project characteristcs. We provided examples of how this analytic process may work. The sense is that the framework helps the widening and full exploration of the range of possible governmental actions in the substantive area of transport research. The model presented should also be helpful in identifying the key areas where more and better research is needed.

As we can see, a very clear figure of public manager emerges from this outline of the cultural environment in which she operates. She makes policy choices and project evaluations on a governmental mandate, but

she has not many seriously quantifiable measures of her success. Only intermediate variables are available for guidance and check of the program: efficient processing of information and public debate of program orientation. Only a clearcut policy and effective implementation will endow the funding agency with a "light touch" and make people more appreciative of its "deep pockets".

The paper does not discuss models of program implementation nor is it meant to be a case analysis of a specific research funding program. That is for future work to be carried out with the instruments of economic, political and bureaucratic analysis and the framework provided in this paper.

Footnotes

1) See, for instance, the Project on Transport Research of the Italian National Research Council, on which my experience is based.

2) The Musgraves (p. 54 et foll.) provide a simple statement of the theory. Musgrave, R.A. and P.B. Musgrave, Public Finance in Theory and Practice, Mc Graw-Hill, 1980, 3rd edition.

3) Ibid., p. 83.

4) Boitani A. et al., Afferrare Proteo, Quaderni della Rivista Trimestrale, n. 62-63, gennaio-giugno 1980, Boringhieri, Torino, p. 71.

5) Ibid., p. 41.

6) Antonelli C., Elementi per l'analisi della politica dell'innovazione in Italia: il processo di formazione di un potenziale scientifico e tecnologico nazionale, Economia Pubblica, Milano, Angeli, n. 6/81, p. 219-220.

7) This methodology is implemented in the sophisticated Industrial Sector Technology Use Model, produced by Energy and Environmental Analysis, Inc., for the US-Department of Energy.

8) "These decisions (on infrastructure development) seem technical and economic; they are always political". E.J. Feldman and J. Milch, Technology versus Democracy: the Comparative Politics of International Airports, Auburn House, Boston, 1982, p. XXXVIII and passim.