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The Governmental Promotion of Technological Progress

Today technological progress is promoted by governments in numerous and diverse ways. What forms does this intervention take? Is governmental promotion of technological progress necessary? Is it even justifiable?

Following Schumpeter, it has become customary to describe technological progress and its effects in terms of invention, innovation, and imitation. These stages of technological progress are here regarded as starting-points of possible promotion by governments. In order to illustrate the three stages, one might first think of an invention for which a patent has been applied and then granted by the patent office. Only when somebody is willing to use this invention do we reach the stage of innovation, which becomes manifest, for example, as an innovation in the method of production or an innovation of the product itself. The level of imitation by other companies is reached when licences are sold, an event that depends upon the prospects of the innovation's generating profits.

Governmental promotion can be classified according to its methods. Direct governmental intervention needs to be distinguished from the mere creation of favourable global conditions for the development of technological progress. This latter method of indirect promotion is normally concerned only with the general conditions, the framework, and correspondingly general financial rewards irrespective of specific projects. Direct governmental promotion, by contrast, is primarily directed towards individual projects or research institutes and their concrete plans in certain branches of industry or in defined regions.

As far as the promotion of inventions is concerned, the public authorities at various levels can attempt to generate technological progress directly by financing basic research at universities and other research institutes. In order to strengthen the chances of inventions, public funds may also be invested into private research and into the development of such diverse fields as energy, public health, and maritime research. Moreover, specific research tasks may be sponsored in the context of governmental procurement, for example, in military and space research.

At the level of invention, the significance of indirect promotion through the law of patents reaches beyond individual projects. The legal protection of patents stimulates the development of inventions. The periods of this protection are intended to safeguard the economic utilization of an invention. As potential innovation and imitation require an invention, the law of patents extends to all levels of technological progress. Subsidies and tax benefits, occasionally granted to high-risk private investments, also belong to indirect research promotion at the level of inventions. Tax benefits for inventions and bounties for methods of rationalization may likewise be counted among the forms of global research promotion.

At the level of innovation – i.e. during the process of carrying an invention through, which cannot always be separated clearly from the levels of invention and imitation – direct governmental promotion is dominated, once again, by specific individual measures, whereas the promotion beyond single projects and branches of industry belongs to global encouragement by the state. To illustrate the first case, one might think of the direct promotion of methods of production, system innovation or the explicit support of so-called technology parks. With regard to indirect promotion, the structural conditions and the financial arrangements of an economy again receive the main emphasis. A stimulus to promote technological progress beyond individual branches of industry may be achieved, in particular, by means of a properly conceived system of taxes including payroll taxes. The system of taxes is the principal test of an economy's power to build up capital.

At the level of imitation, i.e. the third stage of technological progress, municipal technology parks, which have frequently been founded in the recent past, may serve as the prime example of direct promotion. Apart from imitation, the process of creating the general acceptance of an invention plays a significant role here.

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In order to speed up the imitation of technological progress beyond individual sectors and projects, the granting of tax and expenditure benefits, initially intended to encourage invention and innovation, may be tied to the condition that the results of publicly funded research must be made available to all interested parties. This measure will to some extent reduce the range of the law of patents. This and similar methods would ensure that the diffusion of technological change will not be delayed. Advisory boards and consultants' offices, for example on behalf of small industries, provided or subsidized by the government, facilitate the fast diffusion of new knowledge. Thus, at the level of imitation, we may also distinguish between direct and indirect forms of research promotion, though the distinction is here a rather principal or theoretical one. Looking at individual examples, the boundaries between direct and indirect promotion are not always defined clearly.

Theories of Economic Growth

In order to determine whether the government intervention can be justified from the theoretical point of view, let us begin with a fundamental evaluation of governmental promotion of technological progress in the light of determinants of economic growth and growth policy. Even though it cannot be doubted that the financing system, the law of patents and copyright regulations have an impact on technological progress, a fundamental evaluation on the basis of theories of economic growth has to consider other significant growth factors. In view of the instruments used to promote the development of technical procedures, new products, an improved division of labour, and innovative methods of production, it needs to be asked which other determinants define economic growth. A theoretically founded and universally accepted theory of economic

growth has not yet reached the stage of empirically verifiable hypotheses of effects. It will thus be plausible that different economists will provide different answers when requested to identify the most important determinants of economic growth. The following criteria are traditionally regarded as crucial aspects of economic growth:

- the chances of invention and innovation and the speed of imitation;
- the level of knowledge that prevails in the population, the so-called human capital;
- the work mentality of the population and the role of trade unions;
- the existing capital stock and the investment activity of a given country;
- the willingness to enter a risk and the entrepreneurial spirit;
- the evaluation of entrepreneurship among the population and in the media (press, television);
- the country's endowment with natural resources;
- the political stability of a country;
- the type and intensity of the international division of labour;
- the rate of public expenditure for scientific research and development purposes;
- the intensity and structure of competition.

This listing of the determinants of economic growth shows that technological progress with its various stages is classified among the crucial factors, but that it is by no means the only criterion for economic development. Seen in this light, it is quite controversial that the state intervenes, for instance, in the development of:

Starting-points and Forms of Governmental Promotion of Technological Progress

Types of governmental promotion	Stages of technological progress		
	Invention	Innovation	Imitation
Direct promotion of projects and institutes (by participation and decision)	financing of basic research (universities and research institutes) public spending in private research and development development commissions in the context of public procurement	innovations of products, procedures of production, and systems (e.g. in transport and communication) direct support of private innovation and imitation public technology parks	application of technological innovations in the public sector (e.g. cable television)
Indirect promotion (financial rewards) irrespective of individual projects; at most, selection of sectors and branches of industry	favourable global conditions for inventions and methods of rationalization; subsidies and tax benefits, especially for high risk investments	mobilization of risk capital encouragement to the keeping of profits programmes of credit (public loans/reduced rate of interest) tax and deduction benefits	public support for the dissemination of new products, procedures, etc. (advisory services; research and development marketing) information agencies (e.g. bureaus for technology transfer)

- communication and information technology;
- micro-electronics and data processing;
- regulation and control technology, especially computer-based procedures of production;
- electronics in the motor-car industry;
- biotechnology.

Empirical Foundations Lacking

Empirical studies have shown that purely economic factors exert only a comparatively small influence on the overall growth-rate of an economy. The correlations between the long-term rate of growth on the one hand and, for example, the rate of investment, the level of fixed assets, and the level of employment on the other hand, are small or cannot be supported at all. In macro-economic functions of production, the impact of capital and labour input on the growth-rate of the national product is investigated. With these two factors, however, it has only been possible to explain a small fraction of the rate of growth. A much larger proportion can only be accounted for by a third factor, frequently called "technological progress", and constituted by a set of highly diverse aspects. Sociological and socio-psychological phenomena, the conduct and behaviour of politicians, the number of Schumpeter's so-called "dynamic entrepreneurs" willing to take a risk – all these aspects become part of a growth function, the empirical basis of which is still insufficiently clarified. The significance of these influences competes with the various interventionist measures of the government.

The diverse and numerous possibilities of promoting technological progress by means of financial measures, therefore, should not deceive us about the fact that the effects of these public activities are burdened with considerable risks. What really leads to an invention or even an innovation is very difficult to ascertain and the proper starting-point of governmental intervention is correspondingly difficult to define. We may thus find that a measure which initially looked apt to promote technological progress reveals itself in the end as an inefficient subsidy and as an inflated state activity. It seems probable that factors other than the encouragement of existing inventions and their application by means of fiscal policies will prove more efficient eventually. Effective national and international competition as the framework of economic growth, certain historical constellations such as the years of rapid industrial expansion in Germany after 1871, the immediate post-war years, or – to choose a more recent example – the creation of Silicon Valley, achieved without any public support, and a general public that is open-minded as regards entrepreneurial activity are

aspects of decisive significance for economic growth. From the perspective of theories of economic growth it must therefore be concluded that the chances of governmental promotion of technological progress beyond the level of support for basic research are limited. Basically, the empirical foundations for an effective and specific political promotion of economic growth are still lacking.

Theories of the Public Sector

As a second perspective from which to evaluate the public promotion of technological progress let us take the viewpoint of political economy. In an economic system that is decentralized in principle, governmental activity has to be justified. With regard to the topic presently under consideration this means that a justification has to be provided for the governmental promotion of technological progress, especially by means of financial policies. The theory of public goods and, in a broader sense, an economic theory of the state provide reasons for the necessity of public intervention, arguments that are by and large derived from failures of the market mechanism. Generally speaking, the question of the role of the state in a market economy can be answered in terms of the following tasks:

- To begin with, the state provides the fundamental structural conditions, especially the conditions for a competitive structure, in order to guarantee the efficiency of the markets. The struggle against a concentration of power, in particular the avoidance of tendencies towards monopolies and oligopolies, belongs to this task.
- Secondly, the state complements market allocation by the so-called internalization of external effects and the supply of public goods, i.e. goods which due to their distinctive features cannot be provided by the market.
- Thirdly, the state stabilizes the market process when it intervenes on behalf of full employment and the stability of price levels or when, in the case of social and distributive policies, it corrects those market results which it regards as undesirable.

If one attempts to justify the governmental promotion of technological progress on the basis of the outlined general justification of state activity within the market economy, the following arguments emerge:

In the context of a given economic system, an adequate Patents Act and corresponding copyright regulations have to be provided. In other words, the state has to encourage invention and innovation by the indirect means of a sufficiently long period of protection by patent.

Because of the special significance of basic research and its positive external effects for the population, public support of universities and research institutions can be justified. However, recent developments in the Federal Republic of Germany, for example, show that private universities have a chance of survival too and that private research institutes can also provide important new impetus to technological development.

In the case of those investments the risks of which cannot be evaluated accurately collective risk-taking can be argued for. Where fixed overheads are extremely high, the production of a first unit is indeed to be financed publicly. The construction of railway systems and aeroplanes, or space travel, may serve here as examples. It has to be ensured, however, that the state will withdraw from such ventures once the take-off financing is achieved. One might also consider an obligation to pay back governmental support once profits have risen sufficiently.

Public Interest

A second type of justification emerges when the state is acting on behalf of the so-called public interest. This situation arises when the state is interested in certain technological developments and the protection by patents is considered to be insufficient. The state's interest in positive technological developments is given, in particular, on the basis of full employment policies and of an intended continuous and adequate economic growth. This interventionist strategy, however, is opposed by the argument that whenever the dynamics of the market are regarded as insufficient, the state should better concentrate on supporting the competitive structure and the forces of the market, instead of getting directly involved. A Keynesian policy of intervention on the demand side is here contrasted by an economic policy concentrating on supply, which is in line with the theory of M. Friedman and others.

Finally, the state often claims to act on the basis of better information with regard to future developments. The state claims to possess superior knowledge and thus justifies its intervention even when, among its citizens, a corresponding desire for the state's activities is not at all given, or only detectable in a distorted manner. The state derives the justification for its activities against, or irrespective of, the citizens' priorities in particular from the so-called decreased evaluation of future needs.

It is my conviction that the above-mentioned arguments do not amount to a sound economic justification of governmental promotion of technological progress beyond the protection by patents and the

financing of basic research. I am particularly reluctant to believe the state's claim to possessing information superior to that generated by the market process. In the case of governmental promotion of technological progress it can more easily happen that bad investments arise on a large scale, whereas similar misjudgements in the private sector normally remain on a smaller scale and are tied to clearer sanctions. Moreover, technological break-throughs do not necessarily correlate with the extent of the financial promotion by the state. The recent developments in physics that have led to a new era in electronic technology go back to inexpensive table-top science and constitute an impressive example, as these developments originated in private enterprise.

On the basis of the above considerations of technological progress in the light of theories of economic growth and of political economy, we can draw the following conclusions:

Firstly: in a market economy, innovations are generally directed by competition. An effective system of competition is one of the most important factors which determine economic growth. The system of competition must be complemented by laws on patents and copyright regulations which ensure a sufficient remuneration for the research achievements of private inventors.

Secondly: the government, as the responsible agent of economic policies, ought to keep an eye on those aspects of the economy that are particularly significant for its structural development. In addition, it should provide systematic information on the patterns of technological change in order to facilitate its assessments. It should abstain, however, from attempts to guide the direction and extent of development within individual sectors. This principle – to provide merely favourable global conditions for inventions, innovations and imitations – is demanded from the state because of considerations relating to the political framework as well as due to the low success-rate of direct state intervention in this difficult context.

Thirdly: the global and indirect promotion of research is superior to the methods of supporting specific projects and selective financing of research and development tasks. The only public activities that can be justified in principle are the provision of an effective system of competition and the financing of basic research in the public sector (universities and research institutes). Measures of technological policy that intervene directly by favouring or discriminating against private companies, branches of industry, or specific regions can thus be dispensed with.