The constitutive elements of S&T public policy towards sustainable development

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Abstract

This document presents the state-of-the-art concerning the S&T public policy for sustainable development, based on constitutive elements presented by several authors in Europe, the United States of America, and Latin America. The study is developed using the “Triple Helix” model, introduced by Etzkowitz and Leydesdorff, (1995). A methodological proposal for governmental planning, taking into account the different roles of basic participants, such as entrepreneurial university, technological-based firms and pro-active government, will be presented.

It is also argued that an entrepreneurial university has the function to produce knowledge using a new organizational structure, based on multidisciplinary or interdisciplinary centers, organized around wide knowledge areas, Etzkowitz and Terra (1998). This type of university will guarantee the marketplace insertion for students and professors, perfectly integrated in their own region, and attending the global world demand. This integration will occur through an institutional link among academia, market and government, named the technology transfer office.
1. Introduction

The company of the 21\textsuperscript{st} century, this document presents the state-of-the-art concerning the S&T public policy for sustainable development, based on constitutive elements presented by several authors in Europe, United States of America, and Latin America. The study is developed using "Triple Helix" model, introduced by Etzkowitz and Leydesdorff, (1996). A methodological proposal for governmental planning, taking into account the different roles of basic actors, such as entrepreneurial university, technological based firms and pro-active government, will be presented.

It is also argued that an entrepreneurial university has the function to produce knowledge using a new organizational structure, based on multidisciplinary or interdisciplinary centers, organized around wide knowledge areas, Terra and Etzkowitz, 1998. This type of university will guarantee the marketplace insertion for students and professors, perfectly integrated in their own region, and attending the global world demand. This integration will occur through an institutional link among academia, market and government, named technology transfer office.

In order to institute an strong the entrepreneurial culture, the company of the 21\textsuperscript{st} century must promote the following actions: a) use knowledge as input and innovator product as output, b) use dynamic innovation processes, c) look for technological products in the market place, d) use patent policy, licensing and royalties, in cooperative projects, e) create the figure of an interaction university-industry-government agent, f) use fiscal incentives and subsidies available for S&T, and g) create a typology to evaluate employers involved in cooperative projects, in order to enhance the transfer of knowledge and to stimulate the in-house-entrepreneurs, Etzkowitz and Terra, (1998).

Following the "triple helix" model, in order to induce effective interaction, a new governmental function should be defined, responsible for the following actions: a) nucleate regions within S&T institutions, b) structure the S&T sector according to a strategic vision, c) finance the S&T infrastructure, d) support part of the S&T infrastructure, e) create laws to induce technology transfer protecting intellectual property, patents, licensing and royalties, f) create specific fiscal and subsidy incentives to different developing sectors in S&T, g) create mechanisms for standardization, normalization, quality and evaluation and finally, h) create a S&T public policy to attend to national and regional needs, Longo, (1996).

The aim of this work is to study public policies for sustainable development, attending to national and regional demands, including constitutive elements adequate to generate the transfer of technology.
2. Public policy formulation

The transfer technology officer, also named transfer technology center, should be seen as vital part of the necessary infrastructure for the attainment of the goals of economic and social development, strategic objective of any government planning of S&T.

Three basic inputs must be considered for policy formulation: work, capital and knowledge, which must be seen as a function of a new interaction in the society of the knowledge. Therefore, today, the challenge is to define the role of knowledge in the global society, and the interaction among the actors: university-company-government, Etzkowitz and Leydesdorff, (1996).

A Policy of Science & Technology, according to Averch, (1985), should contain actions and decisions regarding some critical subjects, such as:
- Resource allocation for technological innovation;
- Mobilization for education in science;
- Diffusion of information and evaluation structures.

In a wider context, Maculan, (1995), it can be indicated that “policy of C&T corresponds to the definition of the role and operation of the science and technology” and that the “policy of C&T is the policy that organizes the research activities and the support to innovation”.

The premises that address the world government policy of C&T, starting around the middle of last century, are changing. For many, those policies were molded by the demands of the Cold War and of the economic supremacy of some countries. Today, the Cold War ended and most enterprises of C&T have been submitted to a re-analysis, starting from six days war.

In the USA, Cosepup (1993), the federal policies of C&T were influenced strongly by two important forces: the promise of basic scientific research, which was presented in 1945, in the article “Science, the Last Border”, Brooks (1989), and the demands of the Cold War. These influences contributed in the development of a group of scientific and technological unprecedented accomplishments.

In agreement with Brooks, (1989), at the end of Second World War only the USA had adequate conditions to invest strongly in science, as well as in the commercial exploration of new developed technologies, originating from the research developed because of the war effort.
The postwar period, in the western world and in the USA, can be divided in three phases: from 1947 to 1965, under the cold war; from 1965 to 1978, under the era of the social priorities, and from 1978 to the present, under the economic competition "versus" an innovation debate.

The first period was characterized by the fast expansion of the public budgets of P&D. The next period, era of the social priorities, brought the stagnation of whole budget with decline in some fields and growth in others. Finally, the innovation period was characterized by the growth of the budget and a partial return towards the priorities of the of the cold war period.

The policies of C&T can be classified in three different groups, starting from an analysis of the mechanisms of the decision process, then following with the analysis of the constituent elements of the government plans, and then of the policies of C&T in each country, Ergas, (1987). In the group including the USA, France and United Kingdom, the policies of C&T are delineated by the national sovereignty. The main characteristic, in this case, is the centralization that happens at all the levels of the decision process, from the decision making, defined as a policy of strategic thought, until the allocation of resources and the popularization of the results. In the USA, particularly, in spite of all considerations about national sovereignty, the diffusion of information regarding acquired knowledge happens in a decentralized way, due to the territorial dimensions of the country, differently from the European community.

The second group includes Germany, Sweden and Switzerland, where the policies of C&T are delineated by the diffusion of the acquired knowledge, addressed by the industries, with the objective of generating public goods. In this case, the decision process is consensual and powered by the allocation of resources.

The third group includes only the Japan, where the policy of C&T is related to a project of "individual" sovereignty. However, this group presents some duality, because there is a high productivity in large companies and a low productivity in the smaller companies, agriculture and services. The decision process combines consent and centralization, and the implementation of the politics it presents decentralized aspects.

The constituent elements of a policy of C&T, including the definitions presented by several authors, are shown concisely in the table 1, below.
3. Priority establishment and goals

The establishment of priorities and goals, Averch, (1985), should be connected to the allocation of resources, to the examination of the scientific community's strategy, to the government strategies and to the tensions that can be generated by budget austerity or elasticity.

4. The definition of the areas of performance

The definition of the areas of performance for a policy of C&T, Cosepup, (1993), should consider the main national objectives. In the case of the USA these are:

**Health:** the policy in this area is related to the maintenance of health and prevention of diseases. One of the challenges is to create administrative structures capable of promoting the development of medical technologies that improve health care and reduce costs.

**National safety:** there is an interaction with the needs of the civil industry, once the civil technological sophistication surpasses the military.

**Environmental protection:** the existent technologies should become efficient for sustainable economic development through the production of
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energy, victuals, and industrialized products, lessening the losses in the biodiversity

5. Infrastructure

The rational base for the definition of the necessary infrastructure to the attainment of priorities and goals, Cosepup, (1993), is related to:

Excellency: the researchers should work at world levels in all the areas, because accessing the best available knowledge can solve the problems related with national objectives, even if this knowledge appears unexpectedly not traditionally in a field delineated for that objective.

Receptivity: being among the leaders of all the areas, the research group quickly learns to take advantage of significant research that happen all around the world.

Education: only working with research leaders, the students in schools and universities can be prepared to turn research leaders themselves, understanding and applying modern knowledge.

Personal: to be excellent in certain fields, the best road is to attract the young and more brilliant students, incorporating them to the excellence group.

The actors that participate in a policy of C&T, according to Guston and Keniston, (1994), are the members of the social contract, that guarantee the relationships among the scientific community and the government. In a wider way, "The scientific community should establish a new contract with the ones that they elaborate the politics, not being in the demands for autonomy or even in the budgetary increases, but in the implementation of an explicit research addressed for social" goals.

Similarly, the actors participating in the current policy of C&T are the government, the teaching and research institutions, and society.

6. The mechanisms of decision

The mechanisms of decision for the definition of the lines of application of the budget, Cosepup, (1993), must have the purpose of reaching the technological goals, looking to attain the leadership in technologies that promise to have a larger and continuous impact in the economic and industrial environments. In some areas it is important to consider the technological "key calls". These are defined by the following needs: a) to develop technologies that create new markets quickly, b) to support research
developed by companies that have demonstrated capacity of conversion of technologies in market products, and c) to identify essential technologies for the competitive politics with other nations.

The government must stimulate:

- Formulation of the public policies of C&T integrated with the different government areas
- Execution of regulatory legislation for C&T;
- Generation of incentives and specific fiscal subsidies by sector or area, to favor standardization and normalization.

7. The appropriation of the results and consequences

The appropriation of results and the penalty mechanisms and protection are important components of a public policy of C&T.

A clear definition of the appropriation of the results or goods generated by the technologies is presented by Ergas, (1987), as a synthesis of the way in which the countries treat appropriation of the technological advantages. The property of the goods generated by the technological research, in the USA and in Germany, belongs to the companies that participate in the project. In France, the state appropriates the goods generated. In Japan, the property of the generated products, starting from technological research, also belongs to the industrial group that finances the project.

According to Averch, (1985), a patent policy guarantees a partial exclusiveness, acting as a judge in the conflict between the needed exclusiveness to induce the private section to produce new information, and public use of generated results.

In relation to the penalty mechanisms and protection, Vest, (1994), bad conduct and dishonesty, although rare, can happen. To reduce its possibility, that author suggests the following procedures: a) strengthen and to transmit to the scientific community a system of values, b) form new scientists and researchers, c) create obligatory disciplines, d) guide and to accompany new educational plans, e) organize forums about ethics and integrity, f) create a self-government system, g) examine the culture of the academic research carefully, h) promote external evaluations, type audits, i) give more value to quality than to published volume, j) avoid bureaucratic systems of control, and k) avoid formal working policies to eliminate possibilities of fraud.
8. Evaluation and popularization of the results

Cosepup, (1993), presented a model for the evaluation and promotion of results, establishing priorities for the application of funds destined to reach the scientific goals of leadership, in specific areas of the science. The parameters to be considered are: a) the researchers must be leaders in their field, b) the work field must be part of the national objectives, c) the application field must be of wide interest for society, e) the application field must have a multiplier effect in other scientific areas.

In addition, the initial need must be obeyed, regarding quality, creativity and innovation. The adaptation of resources must be analyzed as a function of the time of the research / time and of the interdisciplinary aspect of the synergy between the research and education.

According to Averch, (1985), the evaluation of the results generated by a system of C&T is extremely complex and difficult, if the main component of the technological production is ignored. However, when the supporters of the research are conscious of efficiency and austerity, the scientific community evaluates the gain of information continually, in terms of its relative costs. In that way, given the inherent and unyielding characteristic of the uncertainties related to C&T projects, the research supporters must use multiple indices to estimate adequacy of resources and effectiveness of allocation.

Martin and Irvine, (1989), presented a proposal for the evaluation of so called Scientific Research Foresight. It provides an answer resolve conflicts on the establishment of priorities caused growing experimental costs, for limited resources, for complex decision making, for the pressures to generate revenues, and for the rapid attainment of the economic of the goals of the economic partner.

The foresight definition, is the process through which one arrives to the understanding of the structural forces for the long term future, that should be taken in consideration in the formulation of policy, planning and decision making. Under this aspect, both quantitative and qualitative monitoring indices of the tendencies and emergent developments are included. In the opinion of Martin and Irvine, (1989), it is possible to accomplish the foresight if: a) there is area identification of science guided by the curiosity, b) evaluation of the technological perspectives and economic of long period partner, regarding different research areas that are competing for support; and c) determination, for the government, of the infrastructure of necessary P&D for the industry and the other users that wish to explore future results.
The author’s argument in favor of the application of the foresight is that understanding of the evaluation need is not enough. It is also required to know the economic tendencies and the demand for scientific research, the forces and internal weaknesses in P&D and the relative positioning in strategic scientific and technological areas, and the domestic capacity to market the results of the promising research.

Vest, (1994), argues that universities should promote strongly the successes of the university research and of the education system.

C&T can be considered the base of the economic and social development of an area. However, structural situations can work as a lever for development of the innovation systems, at national, state or regional levels.

The government objectives regarding the university-company-government interaction can be, Pimenta Bueno, (1994):

**Primary**: to enlarge the interaction degree to promote a positive change in the innovative capacity of the Brazilian companies, exploring larger synergy among the resources of available P&D in the country, and to stimulate interaction in areas and preferential modalities, according to orientation given by the government.

**Subsidiary**: to improve the capacity for technological university management, to stimulate the enterprising capacity of the university: teachers, students and administration. Also to register and monitor interaction, and to generate knowledge for the formulation of new public policies to accomplish tangible economic and social benefits of the public investments.

9. Conclusions

Maculan (1995) indicates that the internationalization of research activities introduces new elements for the formulation of research policy. Besides, the actions of each country are determined by several critical factors, of difficult control, such as the promotion of a technical culture in society, the existence of a cooperative tradition between companies and scientists, and the capacity to appropriate scientific and technical progresses from other countries.

The growing desire of the managers to participate in the formulation of C&T policies has induced institutional changes in the universities. These changes have influenced the university-company-government relationship, because the scientific research is accomplished in almost completely at universities. Then, it
is of great importance the adequate management of the office of technology transfer.

The redefinition of this new C&T policy requires the establishment of new support mechanisms for scientific research, for technological training and for innovation, including the decentralization of power making by areas, the appropriation of the knowledge, the organization of the technology transfer, the search of new non budgetary financing sources and the evaluation of demands.

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