論　説

IMPERATIVE CONDITIONS OF BIO-INDUSTRY AND FUNCTIONS OF BUSINESS ASSOCIATIONS IN JAPAN

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Abstract

Since the beginning of the 1980s, together with the development of biotechnology research and industry, new associations that in many cases join members from industry, academia and administration have been established in Japan. In this paper I argue that the theory of neocorporatism fails to explain the creation of associations with such heterogeneous membership. Instead, applying Jessop's governance theory I propose the analysis of the relationship between associations' functions and the characteristics of biotechnology, in order to explain this kind of associations. In this paper I analyze the characteristics of biotechnology and policies for biotechnology, and the imperative conditions they involve for the development of bio-industry. Then I analyze associations' activities in Japan. I conclude that associations in the Japanese bio-industry have three main functions: adaptation of the economic system to the imperative conditions of biotechnology, networks construction, and collective learning.

Contents

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1 Introduction

Since the 1970s the expenditure of developed countries in scientific and technological research has been increasing, occupying a growing part of their economies. Japan's research expenditure steadily increased from less than ¥ 5 billion in 1975 to ¥ 16 billion in the year 2000. The US expenditure increased from about ¥ 5 billion in 1975 to ¥ 28 billion in the year 2000. Considering the rate that research expenditure represents on the GNP, in Japan it grew from the 2.0% in 1975 to the 3.12% in the year 2000. Also in the US it grew from the 2.2% in 1975 to the 2.65 in 2000 (MET, 2001). Also the research personnel have increased, growing the proportion in the labor force that it represents. Thus, in Japan it grew from near 65 researchers per 10,000 workers in 1980 to 109.3 in the year 2000, and in the US from 60 in 1980 to 73.8 in 1996 (MET, 2001). In addition, the weight of research in the industry has grown. In Japan the percentage of research expenditure on the total sales of private companies grew constantly from 1985 to 1992, from the 2.31% to the 2.83%.[1)] Although it has slightly fallen to the 2.72% in 1994, due to the economic crisis of the 1990s, it is still higher than in the 1980s (JETRO, 1997). This increasing presence of technology and science in the economy and industry reflects the importance of the introduction of innovations into industry in form of new products and processes, and improvement of the previous ones.

The industry that applies biotechnology, either in its products or in its processes, is one example of the process of technologization of industry. The biotechnology related market has grown in Japan from ¥ 200,000 million in 1989 to ¥ 1,179,470 million in 1998 (METI, 2001a). Together with the development of bio-industry in Japan, associations of companies, researchers and public officials, have been established. At present, in Japan there are 14 bio-industry related associations, of which 5 are nation-wide associations and 9 are regional associations. Their mixed membership makes these associations different from the trade associations in other industrial sectors, which are organized as representatives of the companies in those sectors. Theories of interests groups, which have theoretically and empirically analyzed trade associations, are not able to explain the

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1) The industries with a bigger proportion of research expenditure on the total sales in 1994 were pharmaceuticals (7.79%), electrical machinery (5.86%), precision instruments (5.51%), and chemicals and textiles （4.24%) (JETRO, 1997).

composition of these associations. Considering the theory of neocorporatism, I argue that the problem is that this theory is too much centered on authority relations. I argue that instead, the functions of the associations to satisfy the imperative conditions imposed by the technical characteristics of bio-industry are an important explicative element. For this, I analyze what characteristics bio-industry and its related policy-making have. Then I analyze the activities of associations and their relation with those characteristics.

2. Theoretical approaches

2.1. Theory of neocorporatism

The theory of neocorporatism (Schmitter, 1979; Schmitter and Streeck, 1981; Streeck and Schmitter, 1985) assumes that companies in an industrial sector get organized into business associations due to two associative logics. One is the logic of membership. According to this logic companies establish associations with other companies sharing the same interests, in order to promote them in front of the state and other organizations with conflicting interests. If this logic dominates the collective action, the system of associations will become a pluralist system in which many associations promoting narrow interests in conflict compete with each other for public policies.

However, in many European countries and in Japan, the action of the state involves the action of a second associative logic, the logic of influence. According to this logic the state selects and promotes the association that wants as representative of a specific industry. Thus, the logic of influence involves that associations behave within the limits of the game rules that the state is willing to accept. It also involves that selected associations have a privileged access to the state, therefore not selected associations merge with them or lose their membership.

The interaction between the logic of membership, which pushes for disintegration, and the logic of influence, which pushes for integration, produces that associations integrate in pyramidal structures, becoming different sections of a larger association that represents the whole industrial sector in front of the state. In this association, the sections that represent conflicting interests negotiate in the association. According to this theory the plurality of conflicting interests is a kind of complexity, and the integration of conflicting interests in a unified organizational structure, which manages them and “imposes” on them solutions for the issue at stake, is what the authors call organized complexity. Associations can manage their members’ conflicting interests because associations’ bureaucracy gains autonomy from the membership and gets authority from the state to participate in policy-making, including policy formation and implementation, becoming the representatives of the companies of the same industrial sector. With this, associations undertake the function of maintaining the social order.

However, bio-industry associations' membership in many cases is composed by actors with a different nature, including researchers, public officials, and companies from different industrial sectors. And, as I will show in this paper, the main function of these associations is to create connections between those agents, and to provide them with forums where they can interact and cooperate. Thus, the neocorporatist explanation is not suitable enough for bio-industry associations.

2.2. Governance theory

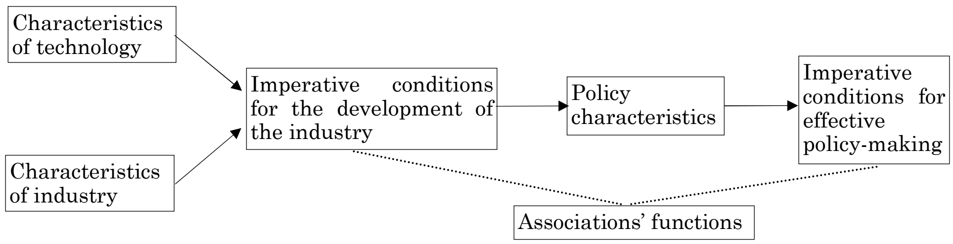
The governance theory proposed by Jessop has a different conception of complexity. This concept of complexity is more based on the limits of knowledge than on conflicting interests. For Jessop, economic globalization and technological change have produced an increase in the diffusion of resources in the society and an increase in the autonomy of the actors who hold them. But, these same processes have also increased the interdependences among the different actors. Thus, to solve a problem it is necessary the cooperation of different actors in order to understand the causal relations and to coordinate the actions of different actors to create a strategy to solve the problem. This process is what Jessop calls governance. He defines governance as “the complex art of steering multiple agencies, institutions and systems which are both operationally autonomous from one another and structurally coupled through various forms of reciprocal interdependence” (Jessop, 1997, 96). For the same author, the process of governance involves the creation of networks between actors, organizations and social systems (the economy, the policy, and civil society), to negotiate to reach common aims, and to create common languages to interpret the world, share some values and so on (Jessop, 1997; Jessop, 1998).

We can use Jessop’s governance framework to explain the organization of associations with mixed membership in biotechnology. As we will see, the development of biotechnology involves actors with different resources: different researchers have different knowledge, industry has the knowledge of the markets and the means to produce goods and services, administration has regulatory power and economic resources, and so on. Thus, forms of coordination of the actions of the different actors are a requirement for the development of bio-industry.

3 Characteristics and imperative conditions of bio-industry and bio-policy

I consider the characteristics of biotechnology research and bio-industry, and what imperative conditions they involve for the development of this industry. Then I consider the characteristics of the policy that is oriented to the satisfaction of those imperative conditions, and what kind of policy-making it requires. Elaborating on all these imperative conditions I consider the number and nature of actors that are engaged in biotechnology research, bio-industry and in the policy-making for biotechnology, what kinds of relations are involved, and what issues are at stake. I analyze the bibliography on the technological characteristics of biotechnology, and the characteristics of bioresearch, bio-industry and bio-policy in Japan. In the next section I will consider whether or not Japanese associations in bio-industry promote the satisfaction of such imperative conditions (Figure 1).

Figure 1: Relation between biotechnology characteristics and associations' functions



3.1 Characteristics of biotechnology and bio-industry

The development of biotechnology can be divided in three periods, which can be called the pre-scientific period, the traditional biotechnology period, and the modern biotechnology period. The prehistory of biotechnology is found in the traditional fermentation industry before the 19th century, which produced bread, cheese, beer, and so on. This production process was not the application of technologies based on science, but it was based on empirical experience without the understanding of the scientific principles, and the producer had little control on the production process (Orsenigo, 1989, 33).

After this pre-scientific period, traditional biotechnology started in the 19th century with Pasteur's discovery of the implication of microorganisms in fermentation. In this period main innovations were in the fermentation technique. Later, the knowledge on the role of bacteria in illness and on the human immunology system let to the application of vaccines. Vaccines, glycerol and other products mark the application of large-scale fermentation to industries other than food. Since the 1940's, penicillin fermentation allowed the large-scale production of antibiotics, and also, with the improvement of the fermentation techniques, amino acids, enzymes, vitamins and other products were industrially produced. In the 1960's continuous large-scale fermentation diffused in the industry and proteins were industrially produced (Orsenigo, 1989, 33-36).

The third period in the development of biotechnology, or the period in which modern biotechnology has been developed, involves techniques other than fermentation. The main techniques are cell fusion and DNA modification –recombinant DNA (rDNA) —. The rDNA technique has its scientific base in the discovery of the double helix structure of DNA in 1953, and was invented in 1973 at two American universities.[2)] The cell fusion technique was invented at a British university in 1975.[3)]

Definitions of biotechnology range from very narrow definitions, which include only the techniques of DNA modification, to very wide definitions, which include everything involving the use of living organisms for the production of goods and services (Orsenigo, 1989, 32). The OECD offers a definition that is wide enough to include traditional and modern biotechnology, but narrows the concept of biotechnology to only the science-based techniques. According to this definition, biotechnology is: "the application of scientific and engineering principles to the processing of materials by biological agents to provide goods and services" (OECD, 1982, 18).[4)] Bio-industry consists in the large-scale production of

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2) The inventors were Chang and Cohen at Stanford University and Helling at the University of California in San Francisco. The technique consists on the introduction of the selected genes from one organism in cells of other organisms (Orsenigo, 1989, 37).

3) The inventor was Kohler at Cambridge University. The technique, also called hybridoma technique, consists on the creation of a new cell that mixes the genetic material of two cells. The researcher does the fusion of the two cells, but the genetic material mixes naturally (Orsenigo, 1989, 37).

4) The definition of biotechnology offered by the Japan Bio-industry Association is similar to that of the OECD, and includes traditional as well as new biotechnology: "any technique that uses living organisms or parts of organisms to make or modify products, to improve plants or animals, or to develop microorganisms for specific use" (JBA, 2000). The adoption of a wide definition that includes the food and beverages industry that applies fermentation is due to the preponderant presence of this industry in Japan.

The Japanese government has adopted a narrower definition, considering biotechnology as "modern

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goods and services using biotechnology, and their commercialization. From the 1980s, the technologies that have experienced greater innovation and multiple applications in industry, and have been the object of most public policy for biotechnology, are those included in modern biotechnology.

Japan is strong in research and industry in the traditional biotechnology,[5] especially the production of amino acids, nucleic acids, and antibiotics is remarkable. Also the production of enzymes, although smaller, is remarkable when considering the impact their application has in the production of many processed foods and chemicals. However, in products using recombinant techniques, except in the chemical industry, Japan is internationally weak (Tsugawa, 1997, 46-49).

Orsenigo has described the characteristics of biotechnology using the concept of technological regime.[6] According to this author biotechnology has the next properties: is a science-based technology, is multidisciplinary, has a high degree of technological opportunities and uncertainty, and has a low degree of appropriability (Orsenigo, 1989, 40-49).

The development of different techniques in biotechnology is strongly based on scientific research. As we have seen, the different technologies have been developing from basic research at universities. In addition, the development of genetic engineering has been

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biotechnology, which uses the techniques of recombinant DNA, cell fusion, cell cultivation, bioprocess, etc. The biotechnology industry is the industry that applies these technologies" (Committee for Bio-industry Technology Strategy, 1999).

5) Before the birth of biotechnology Japan had developed a strong traditional industry of products using fermentation, like miso, soy sauce and sake. With the development of biotechnology, traditional biotechnology based on fermentations developed further more. For example, the technique of amino acid fermentation was invented in Japan in 1956 (Tsugawa, 1997, 46).

6) Nelson and Winter (1982) elaborated the concept of technological regime in order to study the role of technological innovation in economic change. A technological regime is composed by the base knowledge, the sources and degree of technological opportunities, and the technological appropriability and cumulativeness. The base of knowledge refers to the source (customers and suppliers, science and so on) and plurality of knowledge that has been used to create a technology, and the ways by which it is acquired. The technological opportunities refer to the facility or difficulty to achieve innovations in a specific technology. Appropriability consists on the capacity of appropriation of the revenues of innovation by the innovative agent. A low appropriability means that the innovation results are public goods. And, finally, cumulativeness consists on the incremental nature of innovation. Thus, high cumulativeness means that agents who have innovated will have more capacity to innovate. A technology with low cumulativeness is that in which new-comers have the same possibilities to innovate as previous innovators.

possible because of the research on molecular biology at the American National Institutes of Health (NIHs). Even more, biotechnology is the result of the combination of knowledge from microbiology, biochemistry, genetics, biochemical and chemical engineering, electronic engineering, instrumental engineering, and software. Thus, biotechnology is strongly science-based and multidisciplinary (Orsenigo, 1989, 40; OECD, 1982, 22-33).

The technological opportunities of biotechnology are high because of the novelty and the multidisciplinary of this technology. The de-codification of the human genome, which is the basis of the medical application of biotechnology, has been completed recently, much still remains unknown about existing microorganisms, animals, plants, and their genomes, and in the so-called post genome era[7] researchers are focusing on the discovery of genes' functions, proteins structure, and proteins functions. And then, there are huge possibilities for the invention of techniques for the application of such discoveries to modify and create organisms with characteristics useful in the production of goods and services in different industrial sectors. And last, the industrial processes for production at a large scale must be created. The range of industries that apply biotechnology is very large. These, and some examples of their products, are the chemical industry (amino acids, enzymes for detergents, limited enzymes, reagents, polymers, organic acids), electronics (biochips, bio-computers, biosensors), the instrumental industry (instruments for de-codification of DNA, micro-actuators), environment (dissolution of dioxins), agriculture and food (yeast, food additives, genetically modified organisms (GMOs), glucose and high-fructose syrups), information (software for de-codification of DNA and for the analysis of proteins), energy (biomass, methane, ethanol), and medicine (human insulin, interferon, genetic treatment, order made medicines) (METI, 2001a, 2001b; OECD, 1982). In addition, due to the high technological opportunities, innovation in biotechnology techniques and their application to goods and services are very close (OTA, 1991).

However, the feasibility of potential applications of biotechnology, the time required for their developement and the economic revenues they could produce are very uncertain. This is shown by the difference between different estimates of the world markets for biotechnology made by different organisms, and also by the difference between the estimates and the actual realizations (Orsenigo, 1989, 43).

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7) Post genome era refers to the research that is realized using the results of the genetic decodification, and analyzes the functions of genes, and proteins' structure and functions.

The production at large scale with fermentation requires knowledge based in experience, and is difficult to imitate, thus it has a high degree of appropriability by the innovator agent of the benefits of innovation. However, the basic science knowledge is available to the scientific community, and many products based on techniques different from fermentation are easily imitated, thus they have a low appropriability (Orsenigo, 1989, 44-47). Therefore, patents have come to be an important mechanism to prevent the free use of the innovations by agents that have not shared the costs of innovation.

3.2 Imperative conditions of biotechnology and bio-industry

The characteristics of biotechnology considered above pose some imperative conditions for the development of biotechnology research and bio-industry. Because bio-industry is strongly based on the development of techniques that are directly based on multidisciplinary science, the development of an efficient basic science system is necessary. Besides competent scientists and research facilities, a fluid relationship between them is fundamental. Scientists in different disciplines, and in public and private research centers, have to communicate and exchange knowledge, increase their multidisciplinary knowledge and engage in cooperative research projects in order to create new technologies based on different disciplines.

In addition, since innovation in goods, services and industrial processes depends on technological innovation, the close relationship between industry and academia has a positive effect on innovation and technology transfer from universities to industry. We have seen biotechnology has a high degree of technological opportunities. Scientists and managers can engage in knowledge exchange processes in order to match technological seeds with industrial needs. To be able to develop these relations, industry and academy need a certain degree of mutual knowledge on the industrial and the scientific world, and to develop a common language and share some values and aims. In addition, as their mutual knowledge and cooperation deepens, their joint capacity to innovate can increase.

Since knowledge that can give place to innovation in biotechnology is much diffused, and technological opportunities are high, the possibility to create venture companies by the researchers who have made an innovation is an important way to develop bio-industry. In the country where bio-industry is more developed and competitive, the United States, 62% of companies in the biotechnology sector are venture companies. This means that the availability of venture capital and a fluid relationship between researchers and venture capitalists are necessary. This also implies that both actors must develop a common language and knowledge pool, in order to be able to evaluate the possibilities of the innovations. Also their knowledge on patents and the patenting procedures is necessary.

In addition, the different industrial sectors exchange their biotechnology related products: biochemical products are used in the pharmaceutical, agriculture, food, and environment cleaning industries; pharmaceutical products are also used for livestock; instrumental, electronics and information industries are the tools for research and the production process in other sectors; and the agriculture sector is the source of most of the raw materials for biotechnology (OECD, 1982). Thus, different companies are interrelated in the production process, they are interested in securing their exchanges, and they can innovate with cooperative research.

However, Japan shows important weaknesses in these areas. About basic research, Japan shows a shortage of researchers when compared with the US. In 1996 there were 1,875 graduates and 996 postgraduates in biology in Japan, while in the US they were 62,081 and 12,009. Also Japan's basic research is less productive than in the US. **B**etween 1992 and 1994 in Japan 8,927 papers on life sciences[8)] were published, while in the US 45,176 papers were published (Bio-Industry Technology Strategy Conference, 1999). In addition, the public investment in life sciences-related research is comparatively small in Japan. The Japanese government invested 560,000 million yens in 1998, while the US government invested 2,080,000 million yens in the same year (Miyata, 2000).

The transfer of technology between universities and industry is another week point of the Japanese bio-industry. This is showed by the facts that there are few patents held by university researchers or shared by researchers and companies, there are very few venture companies born from university research, and Japanese companies usually prefer to make cooperative research with American universities or to buy their technology rather than to make cooperative research with Japanese universities. The causes of these weaknesses are found in the lack of venture capital, researchers low mobility, the restrictions on public researchers to take other jobs at the same time, the difficulties to get a patent and so on[9)]

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8) Papers on molecular biology, genetics, and microbiology.

9) Attempting to overcome these weaknesses new polices aiming at structural change have been elaborated. In 1998 a law for the establishment of technology-transfer organizations (TLOｓ) was passed; in 1999 a law that allows companies to appropriate the intellectual rights of the results of research undertaken with public finance (Sangyo katsuryoku saisei tokubetu sochiho), a law that

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(Tsugawa, 1997, 47-48; Science and Technology in Japan 1999, 7-8; Kneller, 1999, 415-428; saxonhouse, 1986).

In conclusion, the development of biotechnology research and bio-industry require the promotion of relationships between, and the creation of a pool of knowledge shared by, scientists in different disciplines, academia and industry, different companies, and possible entrepreneurs and venture capital. However, in Japan there are important deficiencies in these areas.

3.3 Characteristics of bio-policy

3.3.1 Policy for industrial promotion

The development of the bio-industry sector involves the creation of technologies, based on basic research, and their application in the industry for the improvement of industrial processes to manufacture conventional products (for example, improving processes of traditional fermentation), and for the development of new products. Also, the facilities for large-scale industrial production must be provided. And finally the new technologies must be safe, and final products must find consumers willing to consume them and not distrustful, which implies the formulation of new government regulations. These three elements orientate the policy for the promotion of bio-industry, and differentiate it from the policies that promoted previous industries.[10)]

Due to the high degree of uncertainty in biotechnology, the Japanese government has

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deregulates public researchers' side-jobs, and a law to support new venture business (Chusho kigyo gijutsu kakushin seido) were also passed. In addition, the patents law has been revised, an "angel" tax system for venture capitalists, two share markets for high technology, and venture funds have been established. However, problems still remain. For example, in the case of national universities, patents are granted either to the individual researcher or to the state, since national universities cannot hold patent rights. This discourages research since patenting is too expensive for individuals. Also, university researchers' careers depend on the number of published papers, and the number of patents held by the researcher is not taken into account. This discourages researchers' cooperation with industry and application for patents (Science and Technology in Japan, 1999: 7).

10) These characteristics distinguish bio-policy from the industrial policy in other sectors like, for example, iron and steel, which faced problems with the supply of raw materials, energy prices, construction of huge and expensive infrastructures, labor relations, overproduction problems, and the like (O'Brian, 1994; Yonekura, 1999). Also, in the same sector, the production relationship was sequential, not interdependent, and the research and development was more punctual, based on only one discipline (engineering), and implying fewer interdependencies among different actors.

participated in much research programs. However, because biotechnology affects many different industrial sectors, every ministry in Japan has organized its own research projects, and has constructed its own facilities and data banks. The government has tried to overcome this dispersion with the constitution of the Human Genome Committee in 1990 to coordinate genomic research (“Science and Technology in Japan, 1992), and with the joint elaboration of the “Basic Policy towards the Creation of Biotechnology Industry” by the concerned ministries and agencies in 1999. The aims of this plan are the enlargement and coordination of the measures for the promotion of basic research and R&D, the improvement of the relations between university researchers and industry, the promotion of venture capital and technology transfer, and the improvement of the patents system. Therefore, coordination of different ministries’ policies is necessary. In the case of Japan, the involved ministries are the Ministry of Economy and Industry (METI), the Ministry of Education and Technology (MET),[11)] the Ministry of Health and Welfare (MHW), and the Ministry of Agriculture, Forestry and Fisheries (MAFF). They have established a coordinated policy –the Millennium Project (MITI, 2000) — in which there is a common program (which represents 21.6% of the project’s budged), and the rest are coordinated, although autonomous, programs.

In addition, industrial policy for biotechnology crosses, and its success is embedded with, other transversal policies. Since technology transfer is for bio-industry as fundamental as raw materials for other industries, regulations that restrict contacts between industry and academia,[12)] or restrict the mobility of researchers, become brakes on the development of bio-industry. Also, since the development of biotechnology is based on the production of new ideas, and the knowledge and idea-creation capacity are dispersed among different researchers, small venture companies become a way for them to convert their ideas into products, and at the same time an incentive for invention. Thus,

11) Ministries were reorganized with the administrative reform of 2001. Since January of this year the Japan Science and Technology Agency (JSTA) has been incorporated into the Ministry of Education (ME), changing its name to the Ministry of Education and Technology (MET). Also, the Ministry of International Trade and Industry (MITI) has changed its name to Ministry of Economy and Industry (METI). In this paper the abbreviations ME and MITI, or MET and METI are used according to the name of the respective ministry in the period concerned.

12) For example, in Japan, the law restricting the private job of university researchers, and the not inclusion of patents got by university researchers in their evaluation, are factors outside the industrial policy that affect industrial development.

regulations that make start-ups difficult, and insufficient access to venture capital, become fundamental problems for the development of bio-industry. Consequently, different policies for SMEs, which give financial support, services, and managerial formation to entrepreneurs, become fundamental indirect industrial policies for bio-industry. Different policies are elaborated and implemented by different agencies, at different territorial levels, and with the participation of different industry organizations. All this poses problems of coordination.

3.3.2 Regulatory policy for bio-industry

Regulatory policies affecting not only the access to financial resources, technology transfer, and start-ups, but also regulations on patents, safety measures, and commercialization rules, have consequences on the development of bio-industry. While in other industries the main source of conflict is that between capital and labor, and also between producers in cases of overproduction, in bio-industry the main source of conflict lies around the topic of patents and intellectual rights, access to research resources, safety, ethics and consumer's right of choice.

What can be or not object of a patent, in addition to ethical issues, poses the question of the incentive or disincentive effect of patents on research, technology transfer, commercialization, and prices. Also, R&D is frequently realized with the participation of different actors and finance sources, private and public, consequently the way in which benefits are shared can arouse conflicts among the partners. These conflicts can prevent research, the sharing of databases, and so on.

The discussion on ethics is remarkable on the topics of protection of private information and the use of human tissues and biological samples for research and production of medical treatments. The regulation of these problems must involve the citizens, since without their cooperation no samples would be provided.

The safety issue can be divided in three areas. The first one is the safety of the facilities for research and industrial production of biotechnology products. This issue mainly involves the interests of industry, researchers and the public administration. The second issue is the liberation of biotechnology products to the environment. This can be for research or for production of biotechnology agriculture products. This issue, in addition to researchers, industry, and administration, involves also other stakeholders, like the agriculture sector and environmental groups. The third issue consists on the evaluation and commercialization of biotechnology products. The regulation of this issue, in addition to the previous actors, also concerns actors involved in the different moments of the commercial process, the general consumer and consumer associations.

In addition, the regulation of the safety issues involves problems of competition and coordination among the different ministries and agencies regulating biotechnology. This is especially remarkable in Japan, where every ministry has established its own independent guidelines: The Ministry of Education and Technology regulates universities' research,[13] the Ministry of Economy, Trade and Industry regulates the chemical industry, the Ministry of Health and Welfare regulates the pharmaceutical industry, and the Ministry of Agriculture, Forestry and Fisheries regulates agriculture and food industries.

3.4 Imperative conditions of bio policy-making

The scientific base of biotechnology implies the need to promote the relationship between scientists and the public administration. Since scientists are the agents who have the expertise on their discipline, they should participate in science policy making in order to make science and research policies efficient.

In addition, the applicability of biotechnology to many different industries makes necessary the coordination of different ministries in the elaboration of their research programs, in order to avoid duplicities, increase the possibility of cooperation among researchers in different sectors, and avoid inter-ministerial conflicts due to overlappings –this is clear in with the problem of the plurality of safety regulations. Also, every industrial sector has its own economic, technological, and public regulation characteristics, but all of them share an interest in the development of biotechnologies and their diffusion in industry in order to improve production and create new products. Thus, when different ministries have a shared strategy for biotechnology, and the different industries in biotechnology have also a unified position about their political demands, administration and industry can cooperate in policy-making in order to make it more efficient.

Finally, when biotechnology products are for the consumer markets, if consumers do not accept those products the markets cannot grow. For example, the lack of trust of

13) Before the administrative reform, the Science and Technology Agency had its own guidelines for non-university public research centers, and the Ministry of Education had its own guidelines for universities' research (Tanaka, 1991, Science and Technology in Japan, 1992).

consumers on GMOs has led to their rejection and strict regulation in Japan and Europe. For this, it is necessary that public policies guarantee the level of safety that consumers demand, the regulation on ethical issues that citizens demand, and the protection of privacy of citizens. Also, the advances in bio-medicines and treatments will lead to the possibility of avoiding certain gene-related illnesses, the enlargement of life, and even the possibility of improvement of individuals' capacities and/or selection of genetically more "suitable" individuals (Fukuyama, 2002). The regulation of these questions should be made with the participation of the wide range of affected actors, since there are many stakeholders: academy, administration, industry, consumers, citizens, and experts in ethics, patients, doctors, and so on. Finally, biomedical research requires the provision of human tissues. This involves the regulation of the protection of privacy, informed consent, and patents. The regulation of these topics should involve also citizens, who are the main affected actors, in addition to doctors, industry, scientists and administration.

In conclusion, same as with biotechnology research and industry, public policies for biotechnology require the involvement of many different actors, the creation of a common pool of knowledge, of a common language, and of consensus on what kind of biotechnology is socially desirable.

4 Associations and their functions

4.1 Associations in the Japanese bio-industry

The first association that included biotechnology in its activities was the Japanese Association of Industrial Fermentation (JAIF)[14], which organized the Bio-Industry Development Center (BIDEC) as one of its sections in 1983. This initiative was the response to the Ministry of International Trade and Industry's (MITI) request to create an organization in order to assist the ministry's targeting of biotechnology. In 1987 JAIF and BIDEC merged, and became an "incorporated foundation"[15] with the name of Japan

14) This association had been founded in 1942 with the aim to promote the production of alcohol during the war.

15) In Japanese, "zaidan hojin". Incorporated foundations and incorporated associations "shadan hojin" are organizations that have been recognized by the government as groups of public interest. With this recognition they get tax privileges and privileged access to their respective ministry, but not to other ministries. That close relation includes information exchange, participation in policy-making and exchange of staff. In addition they have been criticized for becoming a privileged destine for retired public officials. However, the degree of independence of incorporated

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Bio-Industry Association (JBA) in 1990.

Successively other ministries also targeted biotechnology in their areas, and promoted the formation of business associations in biotechnology in order to assist their policies. Thus, the Ministry of Agriculture, Forestry and Fisheries (MAFF) promoted the "incorporated association" Society for Techno-innovation of Agriculture, Forestry, and Fisheries (STAFF) in 1990; and the Ministry of Health and Welfare (MHW) promoted the Japan Health Sciences Foundation (JHSF) in 1984 (incorporated in 1986). Also, in the pharmaceutical sector, the Japan Pharmaceutical Manufacturers Association (JPMA) had already been established in 1968 as a voluntary association[16] with the aim of promoting research in the pharmaceutical sector, and became interested in biotechnology as a way to develop new medicines. In addition, matching with the attempts by regional and local administrations to promote bio-industry from the mid-80s, associations at regional level were established to promote the relationship between industry, academia and local administration, and to promote public acceptance (PA) of biotechnology.

In the second half of the 90s two new associations have been established with the participation of other of the Japanese bio-industry associations. These new associations are the Japan Biological Informatics Consortium (JBIC) and the Japan Association of Bio-Industries Executives (JABEX). JBIC is an incorporated association and has the aim of promoting bioinformatics[17], and JABEX has the aim of lobbying the government for policies to promote modern biotechnology.

4.2 Organization and activities of associations

I analyze the activities of Japanese bio-industry associations in order to make clear the functions of these associations and the relationship of these functions with the imperative conditions of bio-industry. In order to make this analysis I have surveyed documents of the associations and realized interviews with their officials [18] (the results of this analysis

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organizations varies case by case, and they are considered to have become more independent from the 1980s.

16) In Japanese, nin-i dantai. Voluntary organizations do not have tax privileges and are more independent from the government than the incorporated organizations.

17) Bioinformatics consists on the combination of information technologies with biotechnology. The development of bioinformatics is considered to have been one of the main factors in the rapid decodification of the human genome, and to be a fundamental technology for the post genome period.

18) The analyzed documents are the annual reports, internal rules, public opinions, web pages, and

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are shown in Table 1).

1) Japan Bio-Industry Association (JBA)

JBA is a "public interest foundation" aimed at the promotion of bioscience, biotechnology and bio-industry. About 300 companies, about 100 public organizations and 1,300 individuals –mostly university researchers— compose its present membership.

The Presidency and the Board of Directors compose the Direction organs (50 members). There is also an Advisory Committee (54 members). The direction is elected by the General Assembly, which is formed by the regular members of JBA. Under the board of Directors there is the Secretariat, a research institute and 8 sections, which are composed of different subcommittees.

The Technology and Information Committee has 5 subcommittees, and its activities are the study of the evolution of technology, the evolution of international standardization, study of measures for the promotion of venture companies, and discussion of property rights regulation, organization of study groups on the future of biotechnology and the formulation of proposals to the government. The Industry-Academia Exchange Committee has 8 subcommittees, and promotes the exchange of information and joint study of technical topics by industry and university researchers by organizing research groups, study meetings, providing research grants, and publishing a magazine. The International Affairs Committee has three subcommittees, and its activities are the exchange of information and opinions with foreign associations, the realization of surveys abroad, the representation of the Japanese bio-industry in international forums, the analysis of international regulations, and the submission of opinions on them to the government. The Industry and Society Committee has three subcommittees, and promotes public acceptance (PA), promotes relations among bio-industry associations and them and the government, and organizes symposia, conferences, and surveys. The Safety and Environment Committee, with one subcommittee, analyzes measures of international organizations on food safety, on genetically modified organisms (GMOs) safety, and on health care. Also studies the effects on bio-industry of the biological arms prohibition treaty, and gives opinions to the government. The Biological Resources Research Center makes studies on policies on the supply of biological resources, and undertakes public research projects on

reports on the industry and policy. See the sources in the references section.

biological resources with the participation of member companies. In addition, in 1999 the Biotechnology Industrialization Forum was established with the aim of promoting new venture companies in biotechnology. Its activities are the organization of symposiums for entrepreneurs, scientists, venture capitalists, technology transfer organizations' personnel (TLO), and so on. In addition, it has organized a committee of senior members of JBA, who act as consultants for venture companies. Also, in 1999, 30 chemical companies joined in the Green Biotechnology Strategy Forum to discuss a strategy to implement biotechnology in the production process in order to reduce the generation of pollution and waste. Its activities are the research on technical processes, protection of biomass, production of energy from biomass, and the study of environmental problems and of forms of international cooperation and regulation of these topics.

2) Society for Techno-Innovation of Agriculture Forestry and Fisheries (STAFF)

STAFF is a "public interest association" with the aim of promoting biotechnology, and technological innovation in general, in the agriculture, forestry and fisheries sectors. 185 companies, 47 prefectures' governments, and 13 individuals are members of STAFF.

24 members compose the Direction of STAFF, which is elected by STAFF's Assembly. There are also two advisory bodies, with 39 members in total. Under the Direction the organizational structure of STAFF is limited to its Secretariat and STAFF's research center, which is undertaking public research on vegetables and animals' genomes. The Secretariat has the Personnel and General Affairs Committee, the Planning and Survey Committee, the R&D Committee, which plans and implements R&D projects, and the Research Coordination Committee, which coordinates the relationship with the research center and undertakes training programs.

However, STAFF organizes many less formal committees, ad hoc committees and study groups, which are made up by STAFF's members. The most relevant of these committees are as follows. The Publishing Committee is in charge of distributing information through the publication of a magazine and other publications. The Experiments Evaluation Committee makes research on GMOs, evaluates experiments (made by the association, by its members, or by external organizations) on GMOs, and makes surveys on the same area. The Vision Analysis Committee analyzes the technology and industrial conditions, and elaborates a strategy for the development of biotechnology in the sector. The Research Area Supporting Committees support research through the organization of study meetings, lectures, and so on. And the Management Committee organizes activities for the promotion of public acceptance.

3) Japan Human Science Foundation (JHSF)

JHSF's objective is to contribute to the improvement of health and welfare, by promoting research in basic sciences and technology in the fields of health care, pharmaceuticals, medical and health-related devices, and public hygiene. Focusing on the promotion of biotechnology, new materials, and other advanced technologies, the Foundation interconnects, and promotes collaborative research, between industry, academia, and public research centers. At present 148 companies are members. They are big companies related to the health industry, and include companies from the pharmaceutical, chemical, medical materials, food, and fiber industries, 3 banks, and 5 semi-public research centers (incorporated associations or foundations).

50 members compose the Direction of STAFF. Under the Direction there is the Secretariat and two differentiated structures. The General Services Committee and its subcommittees compose one structure. All the members of JHSF can participate in these subcommittees. Their activity is oriented to provide services and support to the membership for research and development projects. The General Services Committee and its Steering Subcommittee are the main committees organizing members' activities, and discussion on general strategies for the sector and the association. Its subcommittees analyze and make statements on standards and regulations, represent the Japanese medical industry in international discussions on standardization, undertake surveys on technology for the medical and food industries, surveys on biological resources, cooperate with JHSF's Health Sciences Resources Bank, organize seminars, symposia, and so on, and cooperate with the tasks of the other committees.

Three committees and the Health Sciences Research Resources Bank form the other structure. These committees depend directly from the Direction and the Secretariat. The AIDS Drugs Committee cooperates with the research of the MHW on drugs to combat AIDS. The Examination of the Supply of Research Resources Committee (4 subcommittees) studies measures for biological resources supply, measures for the utiliztion of the Resources Bank, and manages databases. The Joint Research Committee cooperates with the research of the Ministry (MHW) by undertaking personnel exchange programs, contacting foreign researchers, providing information, organizing the participation of

Table 1: Organization and activities of bio-industry associations in Japan

Associations and their committees	Activities
JBA	
1.Industry-Academia Exchange Committee	1.Several research groups and study meetings; research grants; magazine.
2.Industry and Society Committee	2.PA promotion; training; meetings with other groups; seminars at regional level; surveys.
3.Survey Committees	3.Surveys.
4.Biological Resources Research Center	4.Research on the access to biological resources; coordination of research projects for the government.
5.Technology and Information Committee	5.Analysis of the patent issue; study groups on the future of technology and proposals to government; analysis of international standardization; information exchange.
6.International Affairs Committee	6.Surveys on foreign biotechnology; participation in international forums; relations with foreign biotechnology groups
7.BIP Forum	7.Support to the creation of venture companies and TLOs through the supply of information, advice, and the organization of business meetings and symposia.
8.Safety and Environment Committee	8.Study on the international organizations' measures on food safety, on GMO safety, on health care, and study of the effects of the biological arms prohibition agreement. Opinions to the government.
9.Green Technology Strategy Forum	9.Promotion of green biotechnology through research on technical processes, protection of biomass, production of energy from biomass, and the study of environmental problems and on the forms of international cooperation and regulation.
STAFF	
1.Publishing Committee	1.Diffusion of information, magazine.
2.Vision Analysis Committee	2.Strategy-making
3.Experiments Evaluation Committee	3.Research, experiments evaluation and surveys on GMOs.
4.Survey Committees	4.Surveys.
5.Research Area Supporting Committees	5.Support to research, organization of study meetings and lectures.
6.Research Coordination Committee	6.Evaluation of safety; opinions to government.
7.Management Committee	7.PA and consensus conference.
8.Research Center	8.Genome analysis (government project).
JHSF	
1.General Services Committee	1.Elaboration of visions, strategy and internal coordination; political statements; symposia, conferences and technology transfer; study of standardization, international participation on the discussions on standardization, and political statements; participation in the management of the resources bank.
2.Joint Research Committee	2.Support to the MHW's research programs.
3.AIDS Drugs Committee	3.Support to the MHW's research program.
4.Examination of the Supply of Research Resources Committee	4.Research on the supply of resources for research.
5.Human Science Bank	5.Conservation and supply of human biological resources; ethical evaluation of their use.
JBIC	
1.SNP Research Center	1.Analysis of SNPs (government project).
2.Japan Biological Research Center	2.Planning, standardization, and management of databases.
3.Steering Committee	3.Strategy-making, think tank, internal information exchange; analysis of intellectual property rights issues; analysis of government's ethical regulations, political statements; education, training and surveys.
4.Committee for Ethical Examination	4.Ethical evaluation on samples collection for JBIC's research projects.
JABEX	
No internal differentiation by committees	Formation of consensus among industry, elaboration of political proposals, negotiation with government, and promotion of interrelation between government, industry and academia.
JPMA	
1.R&D committee	1.Study of political measures for the promotion of technological innovation, and political statements; symposia, seminars, and surveys.
2.Pharma SNPs consortium	2.Research planning; research on sample standards and sample collection; analysis of SNPs and elaboration of databases; ethical evaluation.
3.Protein Analysis Consortium	3.Research on proteins structure.
APBIK	
1.Secretariat	1.Information exchange, lectures, seminars; relation with foreign regional organizations, study trips.
2.Industrialization Committee	2.Support to SMEs (consultancy), support to venture business creation (advice, assistance in finance searching); cooperation in the creation of a venture fund; technology transfer.
3.R&D Committee	3.Organization of study meetings in order to create new research projects, support to cooperative research projects, project evaluation, assistance in the application for public subsidies.

companies in public research programs, distributing public research subsidies, and so on.

4) Japan Pharmaceutical Manufacturers Association (JPMA)

JPMA is a voluntary association of pharmaceutical companies oriented to research for manufacturing new medicines. Its aim is to promote the interests of the sector, promoting the relationship among companies, and defending the sector's interests in front of the state and the society. At present 81 companies are member of JPMA. Its interests go beyond the biotechnology field, pointing to the whole environment of the pharmaceutical industry. One of its main political objectives is to keep the prices of pharmaceutical products on a level that allows companies to invest in research.[19] The areas object of its activity are very wide, including standards, training, research and development, public relations, international relations, taxes, and so on. JPMA is integrated in the Federation of Pharmaceutical Makers Associations of Japan (FPMA).[20]

In JPMA there are 19 committees and a research center on industrial policy (established in 1998). All the committees are integrated under the General Assembly, except the Ethical Committee, which is under the Presidency. The relationship is quite bottom-up. Except for general services, the committees decide on their activities and manage their own budget. The committee most related to biotechnology is the R&D Committee, which studies measures and policies for the promotion of technological innovation in the pharmaceutical industry. It also organizes surveys, symposia, seminars and so on. There are 21 companies participating in the R&D Committee. Although JPMA does not undertake research projects by itself, 43 members of JPMA, with the support of the R&D Committee, have established two research consortia in order to make research in biotechnology. These are the Pharma SNPs Consortium (PSC) and the Protein Analysis Consortium. 43 companies that invest 1,000 million in three years for a project to analyze the genes related to medicine effects variation compose the PSC. This consortium is managed by the Steering Committee, composed by 10 companies, which utilizes JPMA headquarters. Its specific activities are the planning of research, research on sample standards and sample collections, analysis of SNPs, elaboration of databases,

19) For this reason JPMA has had difficult relationships with the ministry (Howells and Neary, 1991).

20) In the same Federation there are integrated a total of 12 sectoral associations and 26 regional associations of pharmaceutical companies.

and ethical evaluation of the research.

5) Japan Biological Informatics Consortium (JBIC)

12 companies (3 in information technologies and 9 in biotechnology) created a consortium in 1998 in order to develop a research project on bioinformatics. The reason to organize the consortium was to apply for a government contract for the development of electronic commerce, area for which the government had established a specific budget (JBIC, 2001). JBIC became an "incorporated association"to the 4 ministries related to biotechnology, in the year 2000. JBIC's aim is to promote the application of information technology in biotechnology and bio-industry. At present, 86 big companies, the Japan Foundation for Cancer Research, and two individual researchers are members of JBIC. The members come, on the one hand, from the field of biotechnology, especially the pharmaceutical industry; on the other hand, they come from the information technology, electronic and precision instruments industries.

25 members, including the Presidency and the Board of Directors, compose the Direction of JBIC. The Assembly, formed by the regular members, elects the Direction. Under the Presidency there is the Secretariat and 4 sections: the SNPs Research Center, the Japan Biological Information Center (JBIRC), the Committee for Ethical Examination, and the Steering Committee. Under the Steering Committee there are 6 subcommittees: Intellectual Property Rights, Education and Dissemination, Database System, Management of SNPs Research Center, R&D, Strategies and Planning. The Intellectual Property Rights Committee discusses on this topic, and gives opinions to the government. The Education Committee organizes conferences, seminars and so on, in order to increase member's technical knowledge and to disseminate JBIC's research results. The Data Base System Committee establishes plans to develop data systems. The R&D Committee prepares specific research projects, and regulates the participation of member companies in the research contracted with the government. Finally, the planning committee studies and proposes general strategies.

6) Japan Association of Bio-Industries Executives (JABEX)

JABEX is a business association that represents the industry working with modern biotechnology, and acts as think tank and lobby in front of the government and the parliament in order to promote modern bio-industry in Japan (Science and Technology in

Japan, 1999). 64 company presidents and the presidents of the other 5 main associations are the members of JABEX. JABEX has not internal differentiation according to interests or tasks. Five members, who are the representatives from the 5 bio-industry associations, compose the Presidency. Under the Presidency there is a Board of Directors composed by 13 members.

There have been two causes, which also define JABEX's activities, of the establishment of JABEX. One is the feeling of crisis in the biotechnology sector and the will to formulate a general strategy to promote all the sectors. The same day that JABEX was established, it submitted its first political proposal: "Creation of the Japanese Biotechnology Industry and Strengthening of International Competitiveness. Urgent Proposal." After this, other political statements have followed: "Helix Plan", "National Strategies on Bio-industry Development", "Opinion on the State of Genetically Modified Foods", and the proposal of industrial policy for biotechnology "b-Japan". The second reason for the creation of JABEX is the need to establish an organization that unifies the opinion of the whole bio-industry sector, in order to become the representative of the industry in the negotiations with the government, and in order to promote the interrelation between government, industry and academia. These aims are pursued with the organization of several forums, like the "Life Sciences Summit", the "Round Table Conference with Five Ministers Relevant to Biotechnology and Diet Member's Promotion Alliance for Life Sciences", and so on.

7) Regional associations – APBIK

In the second half of the 1980s regional governments and MITI promoted the establishment of regional biotechnology promotion associations. This was an attempt to promote the establishment of biotechnology industry and research as an economic growth engine in the different Prefectures.[21] At present, the main regional associations are the Hokkaido Bio-Industry Association (HOBIA), Association for the Promotion of Bio-Industry in the Kinki Region (APBIK), Association for the Promotion of Bio-Industry in Toyama Region (APBIT), Chubu Bio Forum (CBF), Senri Life Science Foundation, Tohoku Bio-Industry Promotion Association (TOBIN), Chugoku Bio-Industry Techno Forum,

21) In 1988, MITI had identified 73 of such organizations, most of them established between 1986 and 1987 (MITI, 1988: 117-123).

Shikoku Environment Bio Salon, and Kyushu Industrial Technology Center Bio-Industry Forum. In addition there are many other more informal regional “study groups” where industry, academia, and local administration join.

The main activities of these associations are the promotion of information exchange between industry, academia and administration, by organizing conferences, study meetings and so on, the collection of data on bio-industry development, and the promotion of public acceptance. However, one of these associations –the Association for the Promotion of Bio-Industry in the Kinki Region (APBIK) – has increased its activities, focusing now on the promotion of research and development projects, and the promotion of technology industrialization and support to venture companies. For this, I consider the case of APBIK with more detail.

APBIK, with its headquarters in Osaka, was created in 1985 by an initiative of the Dean of Osaka University. Its aim was the promotion of the relationship between biotechnology industry and researchers in the Kinki region. At present, APBIK undertakes presentation meetings to connect industrial needs with technological seeds, cooperates with the formulation of research and development projects by its members, and gives assistance to venture companies. At present, 68 companies, 20 university researchers and 20 local administration officials are members of APBIK.

Four members, elected by the General Assembly, compose the Presidency. Under the Presidency, the Coordinators Committee undertakes the realization of most of APBIK activities. This Committee is composed y 10 members and is selected by the Presidency. This committee is divided in two subcommittees. The Subcommittee for the Coordination of Industrialization organizes conferences, seminars, and so on, in order to promote the relationship, collective study and information exchange between industry and academia, and provides services for venture companies. It also organizes conferences for the presentation of technological seeds. The other subcommittee, the Committee for the Making of Research Projects, organizes study meetings oriented to the creation of cooperative research projects among the membership, and with other external organizations, and also assists them in getting public finance. This committee also coordinates the implementation of cooperative research realized by the members. In addition, APBIK has promoted, together with the Japan Asia Investment Company and METI, the creation of a fund for biotechnology venture companies in the Kinki region, the Jaiku Baio Ichigo Investment, which is provided by the business community in the region and by METI.

4.3 Functions of bio-industry associations

The activities that bio-industry associations undertake can be divided in five groups: think tank and educational activities, technology transfer, promotion of members' research, execution of government's research projects, and representation of the bio-industry. All associations realize think tank and educational activities, involving study groups on possible evolutions of science and industry, study groups on specific topics, training, conferences, surveys, and so on. Associations, except JABEX, also realize technology transfer activities, like technological seeds meetings, databases on technological seeds, support to matching between companies and researchers, and so forth. Associations, except JABEX, promote their members' research with advising, coordination of cooperative research, and assisting in the search of financial sources. They also undertake government's research programs. The realization of government's research projects is remarkable for the 4 incorporated associations and especially in gene-related research. Finally, associations represent the industry in front of the government, society, and foreign organizations. This is the main activity of JABEX in front of the government, and the incorporated associations do the same in front of their respective ministries. Regional associations have a less relevant role in this activity.

Considering the effects, or the functions, that these associations' activities have on the bio-industry sector, I conclude that they have three main functions. First, they promote the adaptation of the institutional environment to the imperative conditions of biotechnology. Associations are developing activities oriented to the improvement of the weak points of the Japanese biotechnology. Thus, they press for more public investment for the life sciences, for reforms to promote the entrepreneurship of researchers, for policies that promote the industry, they also promote the creation of venture capital for biotechnology, the creation of TLOs, realize activities for technology transfer, and the like.

Second, associations create networks in which industry, academia, administration, and financiers can interact. For this, associations use their social capital, which consists on their knowledge on what researchers are working on what topics, what companies have capabilities on what areas, what officials are in charge of what issues, and then associations have the capacity to promote their participation in discussion forums, study groups, technology transfer activities, or in specific research projects.

Finally, associations promote collective learning. In the networks and forums that associations create, actors from different parts of society (industry, administration, academia) and with different resources, needs, values, culture, and the like, join in order to exchange opinions, ideas and demands. In this process they share information, increase their knowledge on each other and on technological and economic topics, they develop cooperative research and so on. In addition, associations combine in the same organization think tank activities and participation in policy making activities. With this, the elaboration of strategies for the development of bio-industry and their presentation to the administration are developed by the same organization. Therefore, policies for the development of bio-industry can incorporate a greater degree of knowledge on the objectives and means needed to reach them, and consequently policies can be more efficient.

5 Conclusions

From the study of the activities of bio-industry associations in Japan I have shown that they undertake 3 functions: promote the adaptation of the institutional environment to the necessities of bio-industry, promote networking among the stakeholders in bio-industry, and promote collective learning. These functions are different from the functions considered in the theory of neocorporatism. For that theory the function of a corporatist associational system is to promote social order. However, the problem in bio-industry is not a problem of social order, but the necessity to join together dispersed actors with complementary resources, and to promote their cooperation in collective learning processes and cooperative research. These associations' functions are promoting the attempts at overcoming the weaknesses of the Japanese institutions for the development of bio-industry. And they show an evolution of the associational system in order to be more functional to the specific characteristics of bio-industry and bio-policy.

From these facts we see, on the one hand, the limitations of theory of neocorporatism to explain the mixed membership of associations established by industry, academia and administration, due to the focus of this theory on conflicting interests and authority relations. On the other hand, Jessop's governance theory offers an explanation that can be applied to these mixed membership associations since the focus of the theory is on the resource interdependencies among actors and organizations in different social subsystems.

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