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TNO report

STB-02-51

Effectiveness of innovation policies: biotechnology in Greece (1994-2001)

Date 17 January 2003

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Copy no
No. of copies
Number of pages 24
Number of appendices 3
Sponsor European Commission DG Research
Project name Epohite
Project number 017.11055.01.02

Contents

1 Introduction

The EPOHITE project explores the effectiveness of biotechnology innovation policies in the EU Member States. EPOHITE applies an actor-based approach for studying the policy impact on the performance of important components in the innovation system. A selected group of various actor types, which are relevant for a successful innovation system and which are therefor the subjects of innovation policy in most countries, are analysed in detail using a mix of quantitative and qualitative indicators.

In the EPOHITE project, we distinguish between 4 types of actors: large firms, successful small and medium sized enterprises (SMEs), high performing start-ups, and public sector research organisations. Large firms are both national firms and multinationals, which are not dedicated to biotechnology, but have biotechnology research activities in the country. They are present in the biopharmaceutical and/or agro-food sector. Successful SMEs have left the start-up stage and have the main goal to manage consolidation and growth. They usually have been established before 1996 and have already received a third tranche of investment. High performing start-ups are new biotech firms that are mainly dealing with managing the start-up stage, but are also planning or have already experienced growth. Public sector research organisations include university research groups, academic hospitals, public research institutes and charity research organisation that receive at least 25% of their budget from public funding and that carry out a considerable part of their basic and/or applied research in biotechnology.

In order to assess the performance and success of the four actor groups, national case studies in 14 EU Member States are conducted. Based on the national case studies, clusters of countries performing at the same level will be defined and analysed for their policy effectiveness. The website http://www.epohite.fhg.de gives more information about the methodological aspects of the EPOHITE project.

In this national report, the Greek case study is presented. The general structure of this report is applied to all EPOHITE country reports. First of all, in chapter 2 an overview of the Greek policies affecting the innovation system in the Netherlands is provided. In chapter 3, the performance of the Greek biotechnology innovation system is discussed, based on the results of the assessment using quantitative performance indicators like publications and patents. Based on the interviews with the Greek respondents, the respondents' perspectives on the policy effectiveness are summarised in chapter 4. Finally, chapter 5 presents the main conclusions on the policy effectiveness in Greece.

2 The Greek biotechnology policy profiles: 1994-2001

2.1 Introduction

With approximately 10.5 million inhabitants Greece belongs to the smaller countries in the EU. Greek GDP has been increasing with an average growth rate of 2.4% since 1991 to USD 188.8 billion in 2001. Gross expenditures on R&D amounted to 0.67% of GDP in 2000, which is far below the EU average. However there is a strong increase compared to the 0.51% in 1997. The R&D expenditures performed by Greek industry (BERD) are the lowest in Europe. In 1997, BERD as % of GDP amounted to 0.13%. However, since 2000 the Greek government is making strong efforts in order to reverse the situation of low innovation input.

Support of science and technology in Greece during the 1990s was mainly realised through the so-called Operational Programmes for Research and Technology, i.e. the EPET-I (1989-1993), EPET-II (1995-2000) and EPAN (2000-2006). Several schemes under EPET-II were still running in 2001. EU funding through structural and framework programmes plays a very important role in Greek S&T support. The EPET and EPAN programmes are to a large extent financed by EU structural funds (Caloghirou et al, 2000).

The major organisation responsible for the support of S&T and innovation in Greece is the General Secretariat of Research and Technology (GSRT), an administering agency under the Ministry of Development. This ministry is a merger of the Ministries of Commerce, Science and Technology, Tourism and Trade in 1996. The GSRT has the general responsibility for designing R&D policy and setting priority areas and target goals. The Ministry of Agriculture is responsible for the support of agricultural research. The executive body under the Ministry of Agriculture is the NAGREF, which co-ordinates the management of the Greek research institutes in agriculture and allocates budgets for agricultural research.

In this chapter we present an overview of the policies affecting the biotechnology innovation system in Greece in 2001 and its changes since 1994. We distinguish between so-called vertical policies, which are directly aimed at influencing the biotechnology system, and horizontal policies, which mostly have an indirect influence.

1.2 Vertical policies in the Greek biotechnology innovation system in 2001

In the period 1998-2000 there has been the 'Sectoral Programme in the Agricultural Biotechnology' with a € 5.25 million budget. The aim of the programme was to bolster the activities and infrastructures of technological research and the development in the sector of agricultural biotechnology. The administering agency for the programme was the GSRT. For 2001 however, no specific public biotechnology programmes or instruments have been identified in the field of knowledge base support, commercialisation support or with an socio-economic and ethical dimension.

2.3 Horizontal policies in the Greek biotechnology innovation system in 2001

2.3.1 Support of the knowledge base, including mobility of researchers

The knowledge base in Greece is mainly supported by horizontal S&T policies. These programmes are mainly managed by the GSRT:

- 'Enhancing Human Capital' - *PENED* (part of EPET II) (€ 44.03 million)
- 'Enhancing R&T activities' - *EKVAN* (part of EPET II) (€ 116 million)
- 'Promotion of Excellence in Technological Development & Research' (part of EPAN) (€ 13.3 million)
- 'Human Resources in Research and Technology' (part of EPAN) (€ 100.4 million)

All programmes are open to all S&T areas. The EKVAN programme supports research on productive areas of high economic interest for Greece including biosciences. PENED supports doctoral or postdoctoral research by financing 100% of the research costs of young researchers. The programme for the promotion of excellence in R&D aims to support research institutes to become centres of excellence. The Human Resources Programme aims to support the training of young researchers and inclusion of researchers from abroad.

In addition to these programmes, the National Agricultural Research Foundation (N.A.G.R.E.F.) runs one science and technology programme which is called DIMITRA (€ 1.1 million annually).

2.3.2 Support of commercialisation of technologies

The GSRT manages most programmes for the support of commercialisation of technologies:

- 'Enhancing R&T activities' – *EKVAN* (part of EPET II) (€ 116 million)
- The Programme of Co-financing - *SYN* (part of EPET II) (€ 5.8 million)
- 'Targeted Research Fellowships' - *YPER* (part of EPET II) (€ 7.5 million)
- 'Research Centres Development and Service Providing Projects with User Participation' - *AKMON* (part of EPAN)
- 'Development of Industrial Research & Technology' – *PAVET-NE* (part of EPAN) (€ 17.61 million)
- 'Encouragement of Research and the Transfer and Spread of Technology in Businesses' (part of EPAN) (€ 82.51 million)

Also the Ministry of National Economy provides support in the area of commercialisation by running the programme 'Continuing Investment: the creation of New Technology Based Firms' (part of EPAN) (€ 205.89 million).

Each programme is open to all S&T areas. Programmes like EKVAN and SYN especially support co-operation between research institutes and industry. The YPER programme aims to support young researchers in completing research on industry-specific subjects. The AKMON programme aims at improving the research infrastructure by means of co-operations between research institutes and users of the research results. The PAVET-NE programme supports start-ups in developing industrial research and exploiting research results. The programme "Continuing Investment" supports private investments in industrial R&D. Technology transfer, international co-

operation and industrial research in general is supported by the programme "Encouragement of Research and the Transfer and Spread of Technology".
In addition, € 44 million is available for restructuring of public business support organisations in Greece.

2.3.3 Firm creation

The programmes that support firm creation, which are mainly managed by the GSRT of the Ministry of Development, are:

- 'Development of Incubators and S&T Parks in Greece' - *ELEFTHO* (part of EPAN) (€ 223 million)
- 'Development of Industrial Research & Technology' *PAVET-NE* (part of EPAN) (€ 17.61 million)
- 'Market Exploitation of Research Results through the Establishment of Academic Spin-offs' - *PRAXE* (part of EPAN) (€ 36 million)
- 'Centres of Entrepreneurial and Technological Development' - *KETA* (part of EPAN) (€ 21.34 million)
- 'Support for the Competitiveness of SMEs and VSEs[1]' (part of EPAN) (€ 96.87 million)

Moreover, the programme "Continuing Investment: the creation of New Technology Based Firms" (EPAN) under the Ministry of National Economy is especially targeting the creation of new firms.

The ELEFTHO and KETO programmes both aim to support the development of S&T centres. The ELEFTHO programme by supporting existing and new incubators and S&T parks, the KETO programme by supporting advisory and information activities. The PAVET-NE programme supports start-ups in developing industrial research and exploiting research results. The PRAXE programme aims to stimulate the establishment and development of new entrepreneurial activities aiming at exploiting the knowledge produced in research institutes. The programme 'Support for Competitiveness of SMEs and VSEs' supports integrated business plans for innovation and promotes networking. The programme "Continuing Investment" supports private investments in New Technology Based Firms.

2.3.4 Regulation matters for the biotechnology industry

Regulations are merely based on the implementation of the EU directives concerning biotechnology.

2.3.5 Legislation on IPR

IPR matters are no specific element of attention within the Greek S&T policies. Most IPR legislation is implemented according to the EU directives on IPR.

2.3.6 Availability of financial capital in high growth sectors

The Ministry of Development recently initiated various schemes to assure the availability of financial capital in high growth sectors like biotechnology:

- 'Market Exploitation of Research Results through the Establishment of Academic Spin-offs' - *PRAXE* (part of EPAN) (€ 36 million)
- 'Finance credit support for SMEs and VSEs' (part of EPAN) (€ 146.67 million)

[1] VSEs = Very Small Enterprises

Moreover, the Ministry of National Economy initiated a new capital investment fund called 'New Economy Development Fund S.A.' - *TANEO* with a € 300 million budget.

The PRAXE programme provides both seed capital and a 50% public grant for spin-offs. The programme 'Finance credit support for SMEs and VSEs' supports start-ups by providing guarantee for grants for financial capital. In addition the Capital for High-Tech Business Participations organisation is created, with the aim of encouraging professionals and young entrepreneurs to develop business initiatives. TANEO aims to support venture capitalist to develop venture capital funds for investments in new technology based firms.

2.4 Changes since 1994

Since 1994, the support of biotechnology has been subject of Greek S&T policies only to a very a limited extent. In the period 1994-1998, the amount of public funding allocated to biotechnology research and development amounted to approximately € 19.7 million (Enzing et al, 1999). Until 2001, only one biotechnology specific support programme has existed, i.e. the 'Sectoral Programme in Agricultural Biotechnology' that ran from 1998-2000 with a budget of € 5.25 million.

Regarding the generic S&T policies, the main framework in Greece to support research activities is the Community Support Framework. This framework is valid for a period of 5 years and is managed by the Ministry of Economy. The present framework is the 3rd Community Framework (2000-2006). It consists of several large Operational Programmes, of which one, "Competitiveness" (EPAN) is relevant for the stimulation of R&D. This EPAN programme was preceded by the Operational Programme for Research and Technology I and II (EPET I-II), of which some instruments were still running in 2001. The General Secretariat for Research and Technology co-ordinates the EPAN programme. The basic aims of this programme is to enhance the competitiveness of the Greek economy, mainly by promoting the adoption of new technologies, supporting strong public and private (collaborative) R&D and by stimulating the creation of new companies. In relation to previous Operational Programmes, support is increasingly focused on the creation of new companies, availability of financial capital to SMEs and start-ups, and the commercialisation of research results.

Since 1994, especially firm creation and availability of risk capital have gained attention in the Greek S&T policies. Specific biotechnology policies are still lacking.

Policy types	Importance (1-5)	
	2001	**Trend 1994-2001**
Vertical Policies in the biotechnology ASI		
A. Policies for knowledge base support		
1. Instruments to encourage basic research	1	0
2. Instruments to encourage industry oriented (and applied) research	1	0
3. Instruments for strengthening academic co-operation among PSROs and disciplines	1	0
B. Policies for commercialisation support		
1. Instruments to build up technological capabilities for the industry	1	0
2. Instruments to encourage the commercialisation of scientific results from PSROs	1	0
3. Instruments to encourage the collaboration between public and industrial research	1	0
C. Policies with a socio-economic and ethical dimension	1	0
Horizontal Policies in the biotechnology ASI		
D. Science and technology policies		
1. Instruments to support the knowledge base, including mobility of researchers	4	0
2. Instruments to support the commercialisation of technologies	5	0
3. Instruments to support firm creation	4	++
E. Regulation matters for the biotechnology industry	1	0
F. Legislation on intellectual property rights (IPR)	1	0
G. Measures to assure the availability of financial capital in high-growth sectors	4	++

Table 2-1 Overview of biotechnology policy profile in Greece

The policy measures are evaluated with an ascending scale from 1 to 5 based on the emphasis given by the policy system to the specific instruments and programmes. To evaluate the changes since 1994 a "0" is awarded to those instruments and programmes that have not experienced significant change in the emphasis received since 1994, "+" and "–" indicate increasing or decreasing significance.

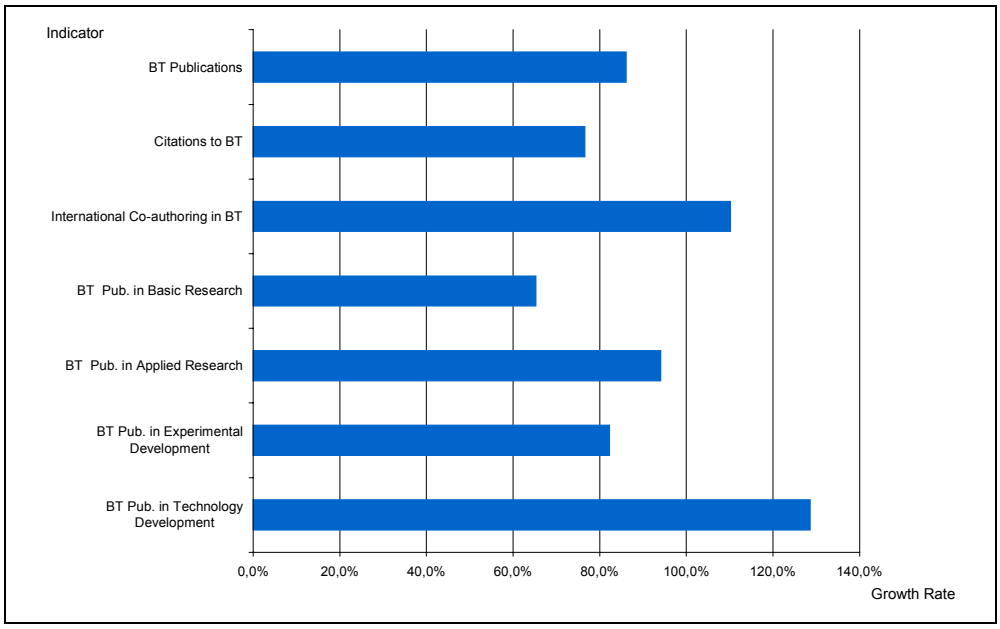
3 The performance of the Greek biotechnology innovation system

In this chapter we discuss the performance of the Greek biotechnology system. More specific the Greek biotechnology knowledge base and the commercialisation of biotechnology in Greece. We do this by using data concerning scientific publications, patents, venture capital, IPOs and firm creation. Moreover, a comparison is made between these indicators for Greece and the rest of the EU. The graphs in this chapter concern Greek growth figures and national shares in EU perspective. The absolute data on the Greek performance are to be found in Annex 1 and Annex 2.

3.1 Greek knowledge base in biotechnology

The total number of Greek scientific publications has increased with 86% from 294 in the period 1995/1996 to 545 in the period 1999/2000 (figure 3-1). This is largely above the average growth rate for the total of EU publications (45.4%). Whereas 0.87% of all biotechnology publications in the EU in the period 1995/1996 were Greek publications, in 1999/2000 this increased to 1.11% (figure 3-2).
In 1995/1996, Greek biotechnology publications were cited 870 times (figure 3-2). This increased with almost 77% in 1999/2000 to 1536 citations. This increase is again above the average growth rate for all citations to EU biotechnology publications (67.9%). The number of citations to Greek publications represented 0.65% of all EU citations to biotechnology publications in 1995/1996. This increased to 0.73% in 1999/2000 (figure 3-2).
The number of international co-publications in the field of biotechnology with at least one Greek author showed an increase with more than 110% (EU average growth rate: 66.6%) (figure 3-1). In 1995/1996, 108 international biotechnology co-publications were produced (0.89% of all EU biotechnology co-publications). In 1999/2000 this was 227 (1.12% of the EU) (figure 3-2).
In the European context, it can be concluded that Greece belongs to the absolute rearguard concerning the biotechnology knowledge base. Greece only leaves Portugal and Ireland behind.

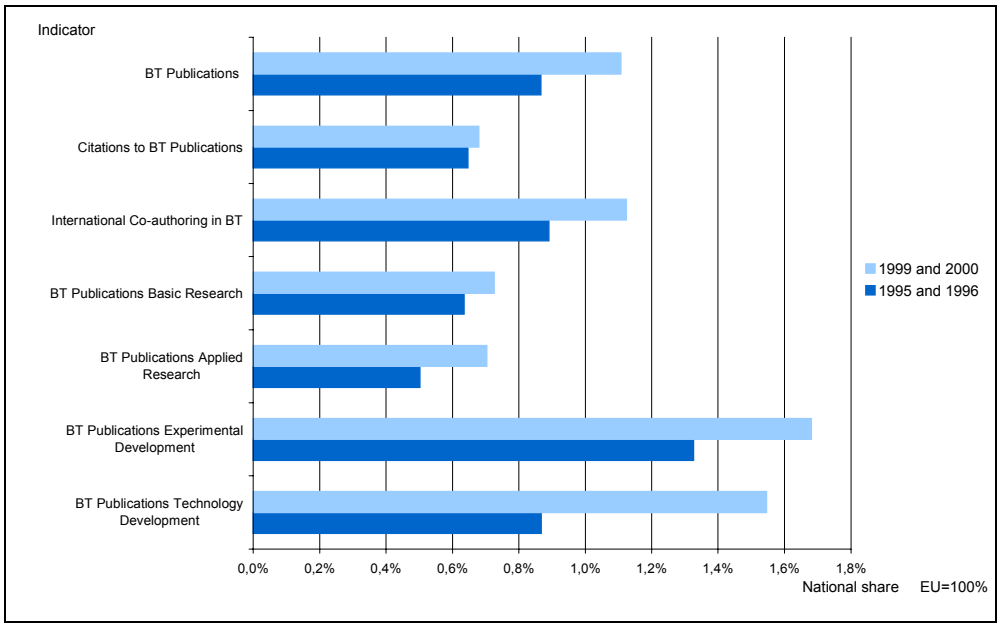
When taking into account the different stages of the innovation process, it can be concluded that the later stages of the innovation process show the highest growth figures when it concerns the number of publications (figure 3-1 and figure 3-2). However, the number of publications in basic biotechnology research still represents the majority of all biotechnology publications in Greece.



Source: EPOHITE Research

Data: Science Citation Index

Figure 3-1 Biotechnology (BT) knowledge base indicators for Greece, Growth rates between 1995/1996 and 1999/2000.

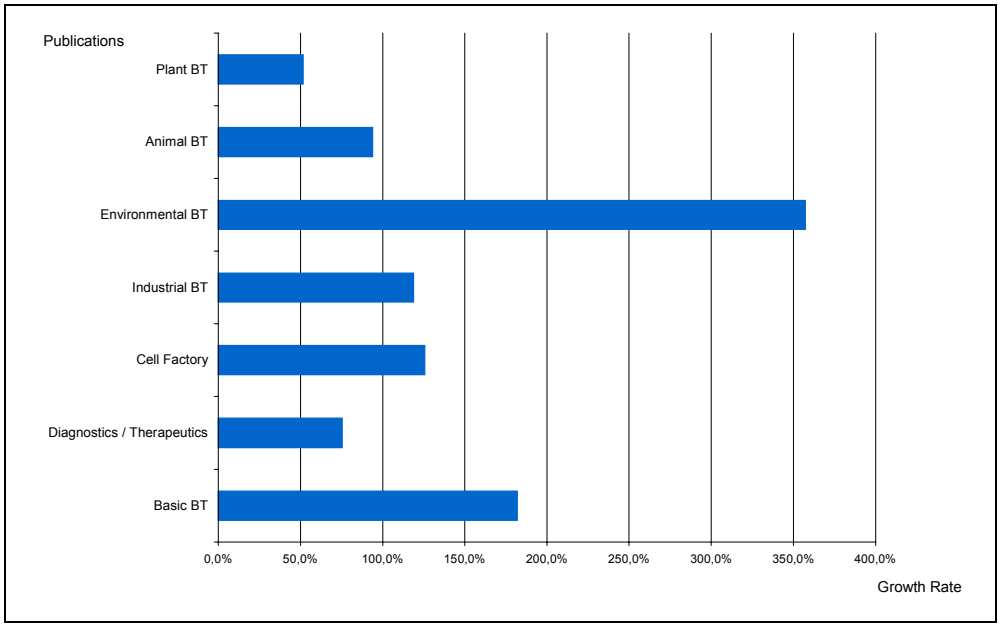


Source: EPOHITE Research

Data: Science Citation Index

Figure 3-2 Biotechnology (BT) knowledge base indicators for Greece, National share in the European Union, a two period comparison

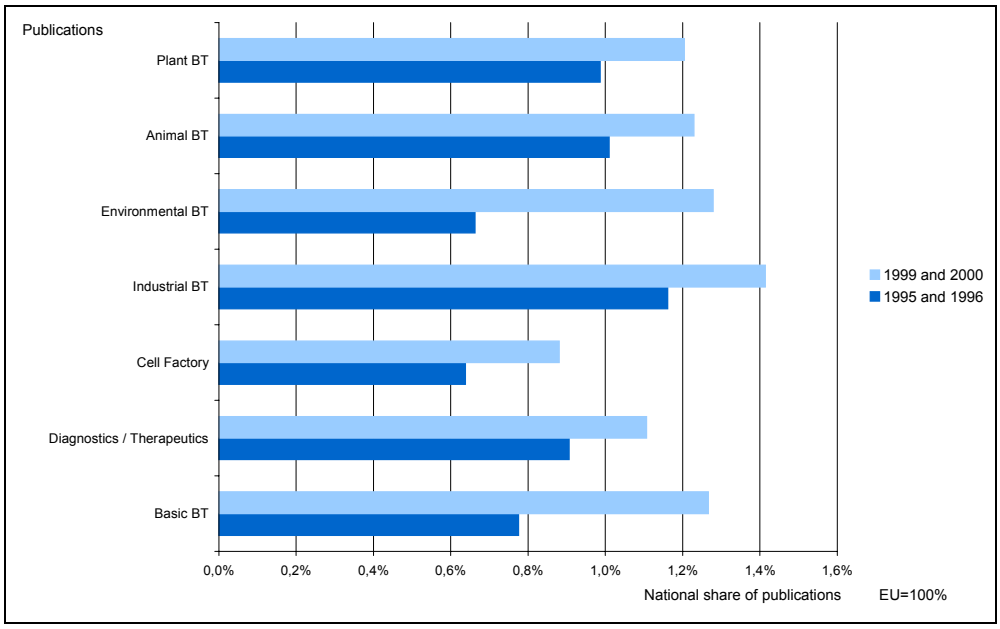
Since 1995/1996, the number of Greek publications increased in all biotechnoloy subfields (figure 3-3). Especially the fields of environmental (+357%) and basic (+160%) biotechnology showed high growth rates. The subfields of cell factory and diagnostics/therapeutics have a backlog compared to the other biotechnology subfields. Although the share of Greek publications in all EU biotechnology publications increased in each subfield (figure 3-4), the Greek share with industrial biotechnology as the most prominent field in the European context (1.41% of the EU in 1999/2000) is still very modest.



Source: EPOHITE Research

Data: Science Citation Index

Figure 3-3 Biotechnology subfields, growth rates of Greek publications between 1995/1996 and 1999/2000



Source: EPOHITE Research

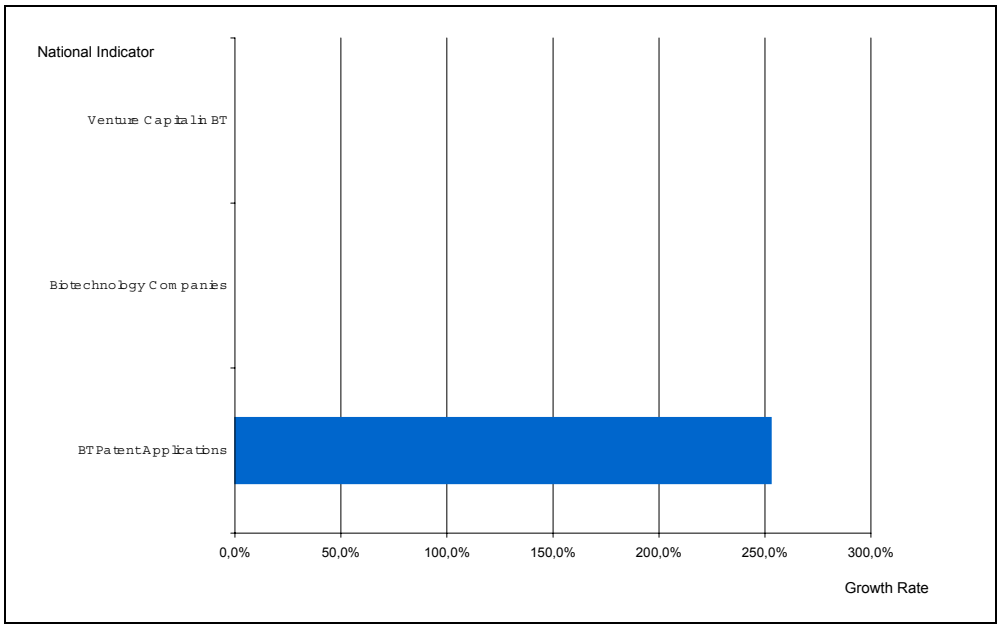
Data: Science Citation Index

Figure 3-4 Biotechnology subfields, Greek share of publications in the European Union, a two period comparison.

3.2 Commercialisation of biotechnology in Greece

Commercialisation of biotechnology knowledge clearly has been marginal in Greece in the period 1995-2000. Since 1994 no biotechnology firms have been created (figure 3-5), resulting in a serious absence of some kind of a biotechnology industry[2]. Moreover, no venture capital has been invested into biotechnology in the period since 1994 (figure 3-5). When taking into account the biotechnology patenting activities in Greece, we can observe a very limited activity according to the number of EPO applications: 2 applications in '95/'96 and 7 in '99/'00 resulting in a growth rate of +250% (figure 3-5). The number of Greek patent applications account for less than 0.2% of all the EOP biotechnology patent applications in 1999/2000 (figure 3-6). In the European context, Greece is the country with the smallest number of patent applications, both in absolute numbers as per capita (Annex 1 and Annex 2).

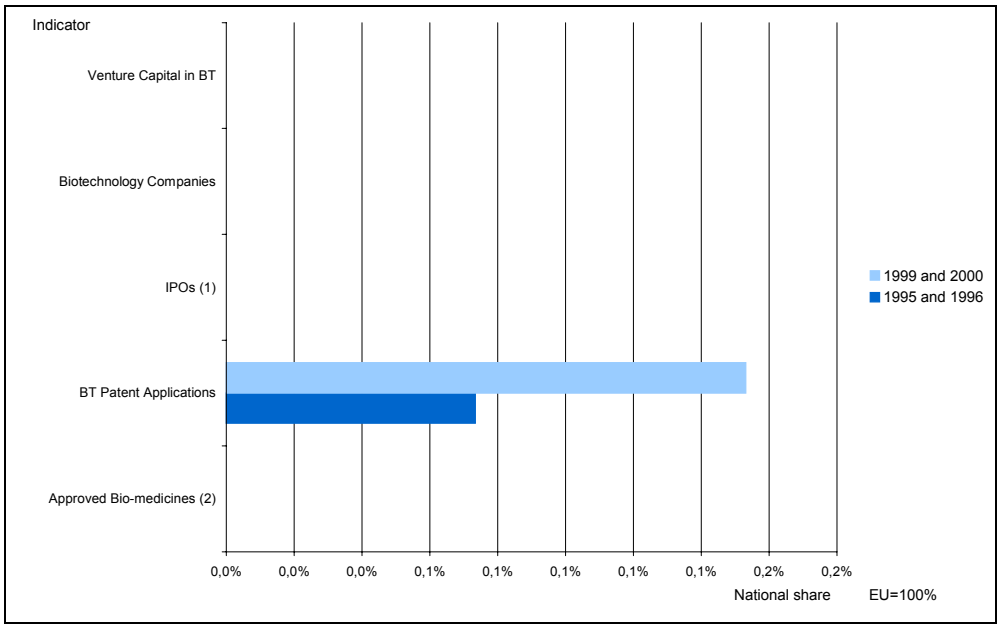
[2] The Ernst & Young reports mention a total absence of biotechnology firms in Greece. However a small number (<5) of Greek biotechnology firms have been identified by the EPOHITE team. Only one of them counted more than 10 employees.



Source: EPOHITE Research

Data: European Venture Capital Association (EVCA), Ernst&Young Annual European Life Sciences Reports, Nasdaq, Neuer Markt, London Stock Exchange and Euronext's websites, European Agency for the Evaluation of Medicinal Products (EMEA), Database of International Patent Applications (PCTPAT), Database of European Patents (EPAT).

Figure 3-5 Indicators for the commercialisation of biotechnology in Greece. Growth rates between 1995/1996 and 1999/2000.



Source: EPOHITE Research

Data: European Venture Capital Association (EVCA), Ernst&Young Annual European Life Sciences Reports, Nasdaq, Neuer Markt, London Stock Exchange and Euronext's websites, European Agency for the Evaluation of Medicinal Products (EMEA), Database of International Patent Applications (PCTPAT), Database of European Patents (EPAT).

Notes: The figures for each period result from adding up the figures of the given years. Note 1: due to low absolute numbers the two periods correspond to 1995-1997 and 1998-2000. Note 2: Due to low absolute numbers the two periods correspond to 1995-1997 and 1998-2001.

Figure 3-6 Indicators for the commercialisation of biotechnology in Greece. National share in the European Union, a two period comparison.

4 Policy effectiveness: An assessment from the Greek actors' perspective

In this chapter, we present the main findings from the interviews with a selection of actors in the Greek biotechnology system. Main purposes of the interviews were to find out about the actors' experiences within the Greek biotechnology system and the effects of Greek public biotechnology policies on their activities. The goal was to interview representatives of all four types of actors as defined in Chapter 1. However, due to the limited presence of a Greek biotechnology industry, the majority of the interviewees are with actors from the public sector. In total, 3 public sector research organisations and 1 SME have been interviewed (see Annex 3). The main findings are presented according to the different policy types.

4.1 Policies to support the knowledge base in biotechnology

4.1.1 Instruments to encourage research

All interviewees make us of the programmes issued by the Ministry of Development (GSRT), mainly the EKVAN and PENED programmes, and some also of programmes from the Ministries of Education and of Health. To some extent (international) industrial partners fund the research within the public research organisations.

Except for the PENED programme, all programmes have a strong emphasis on applied research, where involvement from industry is preferred. As the size of the Greek biotechnology industry or biotechnology using industry is rather marginal, it limits the possibilities for application. According to the interviewees, the applications in which industrial partners are substantially involved seem to be honoured in favour of projects without this substantial industrial contribution but with a better scientific quality. One of the consequences is that proposals are written with an important industrial orientation, while the money is essentially spent on basic fundamental research.

All interviewees mention the heavy burden of bureaucracy and the lack of vision in the programmes: the research themes change too often, flexibility and overlap regarding these themes is lacking, different procedures exist for different types of research organisations, too much reporting demands, there are not enough openings (calls), etc… There is also a general feeling of a lack of continuity in the research focus of the national programmes. The research themes themselves are judged positively.

In general, the interviewees judge the programmes as beneficial as they provide funding possibilities for young scientists and additional funding for their research activities. Also the fact that the programmes stimulate the application of larger research projects, instead of many smaller and diverse ones, is judged favourable. However, these beneficial aspects are often outweighed by the disadvantages of bureaucracy, the overemphasis on industrial orientation and the relatively small budgets of the national programmes (Greek researchers make more use of EU funding, national funding comes in second place).

4.1.2 Recruitment of researchers

Especially the interviewed Greek universities have difficulties in attracting qualified research staff: many Greek researchers go abroad for their PhD or for employment. Moreover, it is difficult to attract foreign researchers to come to Greece. Another problem is the remoteness of several research organisations in Greece, which makes it less attractive for researchers to settle themselves near these locations. It is especially difficult to attract researchers in the new technological fields e.g. bioinformatics as training of Greek researchers in these new technologies is very limited.

4.1.3 Collaboration

Public-private collaboration is highly stimulated in Greece, as most of the national funding programmes have a strong industrial orientation. Of course, research collaborations between public sector research organisations occur as well, but are mostly not part of the application criteria for national funding (and are not stimulated with that intensity as the public-private collaborations).

The proportion of all interviewees' research activities that is done in collaboration varies from 70% to 100%. The reasons for collaboration with public sector research organisations are to get access to complementary expertise in fundamental research, to create mobility and transfer of knowledge and to realise networks that can be used for applying for funding. The reasons for collaboration with industry vary. Only one interviewee mentioned active collaboration with companies in order to further develop their technologies. Another interviewee only collaborates with industry, as it is an important criterion by the Greek government for receiving research funding. To this interviewee's opinion the collaborations themselves are useless, they are just a means for receiving funding.

All the interviewees' collaborations are supported by national programmes, especially PENED and EKVAN. As mentioned before, serious disadvantages are experienced with these programmes, i.e. bureaucracy, a lack of flexibility and continuity, a very tough competition and small budgets. Moreover, in many cases the programmes seem to cause remarkable situations because of their demands for industry involvement. Research organisations are forced to involve industry, which is almost non-existent for biotechnology in Greece. Realising collaboration agreements with the few biotechnology companies in Greece is therefore a highly competitive and time consuming process. In addition, just for the sake of increasing their chances for receiving funding, PSROs even engage into partnerships with less relevant industrial partners, what often leads to inefficient collaborations without any synergetic effects. This criterion of industrial orientation also makes PSROs writing their research proposals as being applied or industry oriented, but they allocate a major part of the funding to fundamental research activities.

In addition to the national programmes like PENED and EKVAN, so-called bilateral research programmes provide additional funding, although very limited. These programmes, introduced in 1964 under the name 'Bilateral co-operations for research and technology', aim at increasing the international research collaborations of Greece. All interviewees make use of these programmes mainly due to their attractivity: most of the criteria are clear, there is not much bureaucracy and there are better chances for having the proposals granted.

Concerning the process of finding research partners, all interviewees answered having no problems in finding them. The only difficulties are encountered when looking for

partners outside their own networks and in new or emerging scientific fields. Most of the time they make use of their own networks. The use of external (public) assistance occurs only incidentally, mainly without any results.

4.2 Policies to support the commercialisation of biotechnology

The extent to which the interviewees commercialise their research results varies. Mainly the interviewed organisations that are internationally active and collaborate with foreign public and industrial partners are actively patenting their research results. One organisation also is engaged in a small number of international joint ventures in the field of biotechnology. In general, patenting research results has not been prioritised in the Greek research system in the past and is just now coming on the agenda of the public research organisations.
Public support concerning intellectual property rights, in specific for biotechnology, is almost non-existent. The existing Greek Industrial Property Organisation offers rather limited support. In addition, public organisations active in commercialisation support (e.g. technology transfer offices and providers of start capital) are judged as being insufficient or inadequate. One of the reasons is the lack of specific biotechnological expertise within these organisations. Therefore these (public) organisations are hardly consulted by research organisations or companies.

4.3 Policies with a socio-economic and ethical dimension

All interviewees say to take into account ethical and/or socio-economic considerations when designing and performing their research activities. Most prominent considerations concern all research activities involving GMOs and the consequences of using biotechnology on safety (environmental, food applications and health). These issues are taken account of mainly because of societal pressure and the several laws and regulations. All interviewees agree that neglecting these issues could seriously hinder further research in biotechnology, although most researchers want to be more progressive in research than the general public.
Most interviewees also participate in events on socio-economic and ethical issues, e.g. debates, committees and interviews.
None of the organisations is actually performing themselves research on socio-economic and ethical issues related to biotechnology. All interviewees say that this kind of research is not part of the research activities within a technological research organisation or company with R&D activities.

Public policies or incentives concerning the socio-economic and ethical issues of biotechnology are absent. None of the interviewees sees this as a problem.

4.4 Regulation matters for the biotechnology industry

The main categories of regulations that influence the research activities of the interviewees are those concerning good laboratory practices and safety of working conditions. Furthermore, all regulations for working with GMOs are influencing the research activities. Most of the regulations are judged as being necessary and as having positive impacts on the activities. The regulations provide the legal context within which research can be performed. Moreover, they provide researchers/employees clear criteria according to which they should perform their research resulting in a better awareness of the risks and in safer working conditions. Most of the interviewees even

plead for stricter regulations (especially for safer working conditions) and a better enforcement. Only two organisations rely on advice on regulatory matters by external (foreign) parties.

Lacking European harmonisation is not perceived as a problem for each of the above categories of regulations.

4.5 Legislation on intellectual property rights

As mentioned above, patenting is something that is not highly prioritised within the Greek research system. Only one research organisation is pro-actively stimulating patenting activities by helping the researchers to file and test the patents and by providing prizes for those researchers that develop technologies and successfully patent them. Moreover, this organisations offers special courses for graduate students about the management of research results.
Some of the organisations interviewed try to patent their research results but encounter the disadvantages of the lack of attention for IPR matters in Greece. All organisations experienced difficulties in the stages of patent drafting and filing. This was mainly due to a lack of expertise in biotechnology matters by the Greek patent attorneys and the Greek patenting office, i.e. Industrial Property Organisation. The interviewees also experienced a lack of legal expertise within their organisations. Moreover, the relevance of national patents is very limited as most of the patents are being applied for and filed at the EPO. One of the strategies of those organisations that wish to apply for an international patent is attracting foreign support in these matters. Another strategy is to rely on the knowledge/expertise of their research partners.

Further European harmonisation on IPR related to biotechnology is desired by the interviewees, as it will make it easier to apply for international patents, diminish the costs of patenting and diminish the number of procedures.

4.6 Measures to assure the availability of financial capital in high growth sectors.

The interviews did not provide relevant information on this subject.

5 Policy effectiveness: conclusions and recommendations

From an international point of view, biotechnology has clearly not been an area of major importance within the Greek S&T policies over the period 1994-2001. Only one specific national programmes has existed, i.e. 'Sectoral Programme in Agricultural Biotechnology'. The public support for biotechnology takes place under the generic S&T programmes. For the period 1994-1998, this resulted in a total investment of € 19.7 million in biotechnology research (of which € 16.7 million through the EKVAN programme) (Enzing et al, 1999).

Main elements of the Greek innovation system that have been addressed already since 1994 by the Greek generic S&T policies are in specific the stimulation of the knowledge base and the commercialisation of technologies. This is mainly realised through the industry/application-oriented programmes.
Over the period 1994-2001, attention for firm creation and the availability of financial capital gained importance in Greek S&T policies as new schemes and programmes addressing these were initiated. Although these are programmes for all S&T-areas, we expect this to have positive influence on the development of the biotechnology sector in Greece.
Indicators like patents and publications show increases since 1994. Nevertheless, the Greek knowledge base in biotechnology and the commercialisation of biotechnology in Greece is still very limited compared to other countries in the EU. A major problem, especially in the field of industry, is the lack of critical mass in the field of biotechnology in Greece.

An important omission in Greek S&T policies is to be the lack of systematic attention for IPR-matters, not only in the field of biotechnology. Greece became an official member of the European Patent Office in 1986, which led to the establishment of the Greek patent office 'Organisation of Industrial Property' (OBI) in 1987.
Although a few organisations are present in Greece that provide legal support in IPR matters, they are not in a position to provide this support to biotechnology researchers and biotechnology companies due to a serious lack of biotechnology expertise. Moreover, many researchers feel that their organisations fail in providing adequate support of patenting activities because they are not able to appreciate correctly the value of patents. Therefore, those researchers that consider patenting their findings find it more useful to do this under the European or US patenting systems and to ask for legal advice from abroad. Although the costs are significantly lower when applying for Greek patents, they are considered by researchers as of little value and mainly as a first step for a patent at the EPO or USPTO (Caloghirou et al, 2000)

Another finding has been the remarkable influence of the application-oriented character of most of the national programmes. Applying for financial support for research has become a highly competitive process as most of the national programmes providing financial support to research are in applied sciences and mostly request the participation of industry, which is almost non-existent in Greece for biotechnology.
As a result, research organisations engage into collaborations with foreign companies or even less biotechnology relevant Greek companies. In addition, the amount of funding for basic research is low compared to the funding possibilities of applied research. We

have seen that this can lead to situations in which research organisations apply for applied research funding but in reality invest the funding received in their basic research activities.

In an interview with CORDIS, the Greek Minister of Development recently expressed the ambitions and challenges that the Greek innovation system is facing in the light of the European Research and Innovation Area (ERA). As the Minister stated, Greece is obliged through its national strategy to serve the European Union's ambitions. Biotechnology has been selected as one of the priority sectors in the ERA. However, this report shows the limited Greek activity in biotechnology and especially in industry. Moreover, we have identified a number of serious problems in the Greek biotechnology innovation system, which impede the development of both the knowledge base and the commercialisation of biotechnology. Therefore, Greece would need to address these issues if it is also taking up the challenge of the ERA in the field of biotechnology.

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