Indicators for benchmarking biotechnology innovation policies

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1. Introduction

The relevance of biotechnology as a major contributor to economic growth in various industries and its impacts on the quality of life explain the high priority of biotechnology on the political agenda in the fifteen old Member States of the European Union (Enzing et al. 1999, Senker et al. 2001, Reiss et al. 2003). Also in several new Member States there are various efforts to develop biotechnology (Menrad et al. 2003).

Policy makers face the challenge of dealing with sophisticated representations of how the production and application of knowledge works in biotechnology innovation system. Since the 1980s science and technology policy recognizes that scientists and innovators are part of a larger network of organisations and institutions (Freeman 1988, Lundvall 1988, Nelson 1993). Accordingly, there is an increasing demand for empirical tools to benchmark national science and technology policy from a systems perspective (as expressed e.g. in the 2001 Lisbon ministerial meeting).

The general aim of this contribution is to elaborate a benchmarking concept from a systems perspective to provide policy-makers with a set of tools that will assist them in their policy-making regarding biotechnology.[1] The policy benchmarking approach put forward in this contribution provides:

(1) tools to map national policy in biotechnology;

(1) tools that facilitate monitoring of dynamic changes of policy portfolios;

(2) a set of output indicators reporting the achievement of certain policy goals set in previous years.

2. Policy benchmarking from a systems perspective

This contribution proposes a benchmarking approach to biotechnology policy. Three key aspects are considered in this context:

- the systemic nature of the innovation process in biotechnology;
- the different policy areas involved in its promotion; and
- the time lag between policy action and potential policy outcomes.

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1 The benchmarking concept presented in this contribution was elaborated in the framework of the project "Benchmarking of public biotechnology policy" commissioned by the European Commission Enterprise Directorate General, Contract no. FIF.20030837 (Reiss et al. 2005). This contribution is largely based on the final report of the project.

From a systemic perspective of the innovation process, four broad sub-areas for potential policy intervention in biotechnology innovation systems can be identified (Senker et al. 2001):

(1) the development of the knowledge base and human resources;

(2) knowledge transmission and application;

(3) the market; and

(4) industrial development.

These four sub-areas provide the framework for key processes of the innovation system. In order to support these processes, specific policy goals can be formulated for each sub-area.

The following paragraphs describe briefly the sub-areas of the biotechnology innovation system and derive policy goals to support the processes involved in each area.

Due to its science-based character, biotechnology relies on a strong **knowledge base**. Additionally, many different scientific disciplines contribute to the development of biotechnology so that interactions between disciplines are important. This implies that the generation and maintenance of a suitable knowledge base with a balance between basic and applied research is a key condition for the strength of a biotechnology innovation system. Accordingly, four main policy goals can be defined for supporting this sub-area of biotechnology innovation systems: 1) the promotion of high-level basic research, 2) the promotion of high-level industry-oriented and applied research in biotechnology, 3) the support of knowledge flow between scientific disciplines and 4) securing the availability of qualified human resources.

Public support for biotechnology is mainly driven by the expectation that the **exploitation of biotechnology research** results can provide economic, social and environmental benefits. Therefore, the transmission of biotechnological knowledge from the sites of its generation to possible loci of application is a key process in the biotechnology innovation system. This process functions mainly via collaboration between industry and academia and through the creation of academic spin-off companies. Considering the processes involved in the transmission and application of biotechnology knowledge, three policy goals can be identified: 1) to facilitate the transmission of knowledge from academia to the industry and its application for industrial purposes, 2) to provide incentives for the adoption of biotechnology for new industrial applications, and 3) to assist company start-ups.

The **market** sub-area of the innovation system covers those elements of the innovation process that are responsible for the full integration of biotechnology into economic sectors. The relevant markets for biotechnology-based products at present are the markets for pharmaceuticals, chemicals and agro-food products. In addition, the market for biotechnological processes in various industries needs consideration. On the demand side, the attitude of potential consumers towards the application of biotechnology has an impact on the success of the innovation process. Furthermore, the strength of relevant economic sectors determines the ability of certain industries to adopt biotechnology approaches, thereby increasing demand for such solutions. In this context, the experience of countries with a strong biotechnology innovation system has shown that presence of large industry leaders (in pharmaceuticals, agro-food and chemicals) is beneficial for the innovation process. On the supply side, the regulatory framework plays an important role in setting conditions for market access. Four main policy goals describe the potential policy contribution to this sub-area: 1) to monitor and to improve the social acceptance of biotechnology, 2) to facilitate the access of biotechnology-based products to the market, 3) to strengthen the economic sectors exploiting biotechnology and 4) to keep and attract industrial leaders in these sectors.

Industry actors such as SMEs play an important role in the development of biotechnology innovations. They have important system functions such as exploring knowledge, using discoveries for industrial purposes and building interfaces between public sector research organisations and large firms. The success of biotechnology SMEs depends to a great extent on their innovative performance and their ability to identify and interact effectively with the necessary resources (universities and research institutions, venture capitalists, investors, etc.) to undertake R&D activities. In this context, policy goals are: 1) to support business investment in biotechnology R&D, 2) to improve the competitiveness of biotechnology-based companies and 3) to exploit regional potentials and synergies.

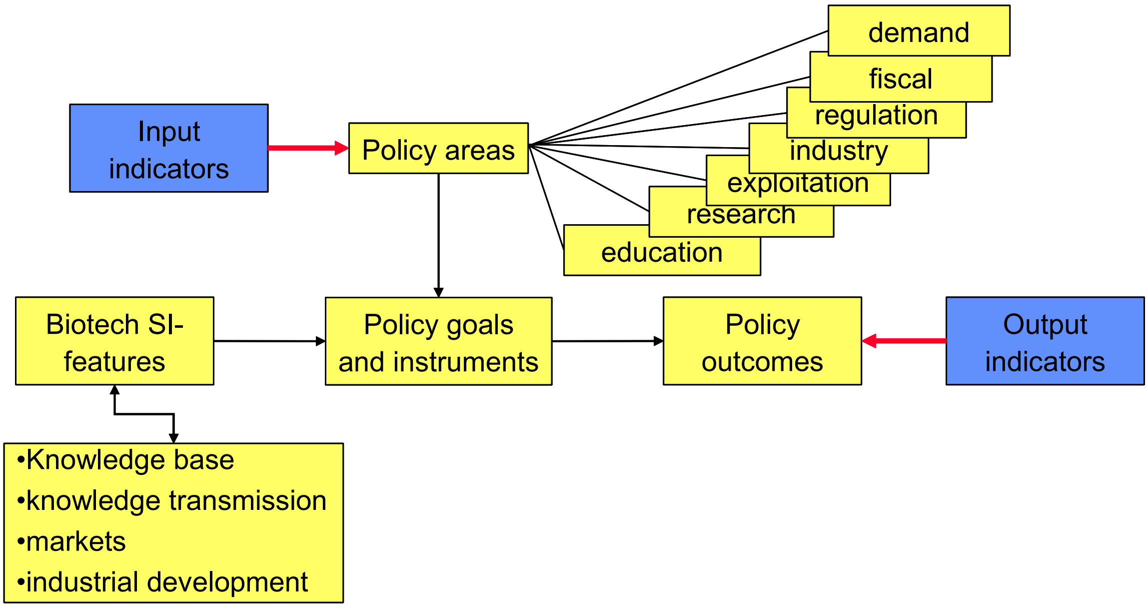
European policy making systems usually aim at reaching these goals more or less explicitly by assigning tasks and responsibilities to different ministries. Even though national policy systems may differ considerably in their governance structure, traditionally we can identify the following policy areas in the design and implementing of policy instruments to promote innovation:

1) Education policies,
2) Research policies,
3) Exploitation policies,
4) Policies related to industrial development,
5) Fiscal policies,
6) Regulation,
7) Demand-oriented policies.

The challenge of a biotechnology policy benchmarking exercise is firstly to map policy activity in these policy areas targeting the policy goals stated above (what we could call the input). Secondly, to evaluate policy effectiveness by deriving output indicators. However, due to the time lag between policy activity and policy effects, output indicators are only able to assess the achievement of policy goals set in previous years.

An overview of the benchmarking approach is presented in figure 1.1.

Figure 1: Overview of the benchmarking approach (SI: system of innovation)



Moreover, table 1 gives an operational picture of the relationships between sub-areas of the innovation system, policy goals and policy areas. The grey fields indicate the relevance of the policy areas to reach the policy goals theoretically identified for each sub-area of the innovation system. In some of these fields a differentiation is necessary between generic policies and biotechnology-specific policies. In such cases light grey represents generic, while dark grey stands for biotechnology-specific policies. Finally, to each sub-area of the innovation system selected output indicators are proposed to assess the achievement of policy goals. An important feature of the benchmarking concept is the fact that the output indicators aim at assessing effectiveness of a set of policies in each sub-area and not individual policy areas, instruments or programmes.

Table .1: The benchmarking concept

Sub-areas of the Biotechnology Innovation System	Policy goals	Policy Area: Education	Research	Exploitation	Industrial development	Regulation	Fiscal measures	Demand	Output Indicators
Development of the knowledge base and human resources	1. To promote high level of biotechnology basic research		X[1] X			X			1. Number of biotech publications per capita (pC) 2. Number of citations to biotech publications 3. Number of PhD graduates in life sciences per million capita (pmC)
	2. To promote high level of industry-oriented (and applied) research		X X						
	3. To support knowledge flow between scientific disciplines		X X						
	4. To assure availability of human resources	X							
Knowledge transmission and aplication	5. To facilitate transmission of knowledge from academia to the industry and its application for industrial purposes			X X		X			4. Number of BT[4] patent applications pC 5. Number of BT companies pmC
	6. The adoption of biotechnology for new industrial applications						X	X	
	7. To assist firm creation	X			X X	X	X		
Market	8. To monitor and improve the social acceptance of biotechnology							X	6. Average responses to Eurobarometer 58.0 (2002) Questions 12, 13, 14 7. Number of drug approvals pmC 8. Number of field trials with GMO crops pmC 9. Volume of production in relevant industry sectors
	9. To facilitate the introduction of new products					X			
	10. To strengthen the economic sectors exploiting biotechnology					X	X		
	11. To keep/attract large firms (important market, important for firm development: tacit knowledge etc.)					X	X		
Industry	12. To encourage business investment in R&D				X		X		10. Number of BT IPO per number of BT companies[2] 11. Number of public BT companies per number of BT companies. 12. DVC[3] invested in biotechnology companies pC 12'. DVC invested in high-technology companies pC 13. DVC investments pC
	13. To improve firm's competitiveness	X				X	X		
	14. To exploit regional potentials				X				

1 X represents the "intensity" of respective policies.
2 IPO stands for Initial Public Offerings of biotechnology companies.
3 DVC stands for Domestic Venture Capital.
4 BT: biotechnology

3. Implementation of the Benchmarking Concept

In order to map national policy portfolios with relevance to biotechnology, it is necessary to identify those policy activities that influence the development of biotechnology by targeting the different sub-areas of the innovation system as indicated in table 1. Thereby an important part of the input side to the innovation system can be captured. For identifying policy activities in these seven policy areas and important features of the policy-making process we proposed a policy questionnaire to be completed by policy-makers. By combining dichotomous (yes/no) questions with multiple choice and differential scale questions, the questionnaire aims at evaluating the engagement of each policy area in reaching relevant policy goals.

From the data gathered through the questionnaire a qualitative and a quantitative assessment of the policy input can be carried out. The qualitative assessment draws on the dichotomous questions and gives a picture of the policy areas active in promoting biotechnology. In other words, it allows carrying out a general analysis of the policy areas involved in promoting biotechnology. The framework to present the results of the quantitative assessment follows the scheme shown in table 1 where the "x" corresponds to the extent of engagement (in a five-point scale) of the national policy in the correspondent area (defined in the top of the table) to reach the related policy goal (defined on the left side of the table). The value measuring the national policy engagement is calculated during the evaluation of the policy questionnaire. Questionnaires were evaluated in a standardised form by using predefined scoring rules to rate the engagement of a policy area in reaching a certain policy goal on a 5 point scale. In some policy areas we differentiate between generic and biotechnology-specific policy activities. In these cases generic activities are indicated by light grey in table 1, all specific activities by dark grey.

As presented in table 1, to capture the achievement of policy goals a set of indicators has been selected. The selection of indicators draws on two main criteria: availability of data and comparability across countries. It is important to point out that the output indicators capture the performance of the whole sub-area of the innovation system to which they have been assigned to according to table 1. Accordingly they aim at assessing the achievement of a *set* of policy goals relevant for each sub-area of the innovation system. Furthermore, the time lag between policy activity and potential outcomes of any policy measures needs to be considered. Since it takes several years until potential policy effects can be detected, the potential outcomes of current policy activities in the various countries cannot be assessed now. Rather, based on an historical analysis of policy input and performance output data (Reiss et al. 2005) we estimate that it will take between three and five years until a comparison between current policy profiles and policy effects will reveal meaningful insights. This implies that it is important to consider the benchmarking exercise as a continuous process which needs to be repeated in the future and which will be enriched by additional analyses of output indicators during future rounds of benchmarking.

4. Validation of the benchmarking concept using historical data

The approach to benchmarking and the practicability of the benchmarking concept have been tested by using historical data. For the old European Member States and in addition for the United States and Canada, policy input data for the period 1994/95 were elaborated according to the structure of the benchmarking concept. These input data were compared to output indicators describing the situation in the various countries in 2002 (or in 2000 depending on data availability). Thereby the time lag between policy activity and potential policy effects was taken into account.

The historical analysis provides a proof of concept of the benchmarking approach. In particular it shows that:

- it is feasible to elaborate the suggested policy input factors on a country level by using the policy questionnaire; and that
- the proposed output indicators provide meaningful information on the achievement of certain policy goals.

The next paragraphs discuss the performance of the national biotechnology innovation systems in 2002 (see table 4) and the respective policy settings based on the country analyses sketched in tables 2 and 3.[2]. Due the time lag between policy activity and potential outcomes of any policy measures the potential outcomes of current policy profiles in the various countries can not be assessed now. Therefore the following discussion considers the relation between policies in place at the mid 1990s and biotechnology performance in the period 1995-2002.

2 Please note that the analysis draws on the policy profiles for each country elaborated for the period 1994/1995. Tables 2 and 3 give only the qualitative results of the policy profiles. For detailed information on the analysis see Reiss et al. (2005).

Table .2: Overview of biotechnology policies in old EU Member States in 2004 (national policy-maker's assessment)

Policies	AT	BE	DE	DK	ES	FI	FR	IL	LU	IT	NL	PT	SE	UK
1. Education														
1.1 biotech curricula	√	√	√	√	√	√	√	√		√	√	√	√	√
1.2 business issues	√				√	√	√	√		√	√	√	√	√
2. Research														
2.1 biotech promotion	√	√	√	√	√	√	√	√	√	√	√	√	√	√
3. Exploitation														
3.1 entrepreneurship/spin-offs	√	√	√	√	√	√	√	√	√	√	√	√	√	√
3.2 industry/PSRO collaboration	√	√	√	√	√	√	√	√	√	√	√	√	√	√
4. Industrial development														
4.1 availability of capital	√		√	√	√	√	√	√	√	√	√	√	√	√
4.2 business supp. f. start-ups	√	√	√	√	√	√	√	√	√	√	√	√	√	√
4.3 industrial research (bt specific)		√	√	√	√	√	√	√	√	√			√	√
4.4 clusters	√	√	√	√	√		√	√		√	√			√
5. Fiscal														
5.1 tax incentives for innovation	√	√		√	√		√	√		√	√	√	√	√
6. Regulation														
6.1 task innovation	√		√	√	√	√	√	√	√	√	√	√	√	√
7. Demand														
7.1 explore bt benefits	√	√	√	√	√	√	√	√	√	√	√	√	√	√
7.3 adoption				√	√	√	√	√					n. d.	√
8. Policy processes														
8.A Impact assessment			√			√	√	√		√	√		√	√
8.B Policy coordination	√	√		√	√	√	√	√		√				√

√ = policies in place, n. d. = no data, blank = no such policies in place.

Table .3: Overview of biotechnology policies in the new EU Member States in 2004 *(national policy-maker's assessment)*

Policies	CZ	EE	HU	LT	PL	SK	SI
1. Education							
1.1 biotech curricula	√	√	√	√	√	√	√
1.2 business issues					√		√
2. Research							
2.1 biotech promotion	√	√	√	√	√	√	√
3. Exploitation							
3.1 entrepreneurship/spin-offs		√	√	√			√
3.2 industry/PSRO collaboration		√	√	√	√		√
4. Industrial development							
4.1 availability of capital		√	√	√			√
4.2 business supp. f. start-ups		√	√	√			√
4.3 industrial research (bt specific)			√				
4.4 clusters							√
5. Fiscal							
5.1 tax incentives for innovation			√			√	
6. Regulation							
6.1 task innovation			√		√	√	√
7. Demand							
7.1 explore benefits	√	√			√	√	
7.3 adoption		√		n. d.			
8. Policy processes							
8.A Impact assessment		√					
8.B Policy coordination							

√ = policies in place, n. d. = no data, blank = no such policies in place.

Table 4: Normalised output indicators[3] for the old EU Member States, US and Canada. Historical Analysis 1995–2002

	BT Publications 1995-2000	Citations to BT publications 1995-2000	Number of PhD graduates in life sciences 2001*	BT Patent applications 1995-2002	Buitechnology companies 2002*	Acceptance Index Eurobarometer 2002**	Bio-medicines (Approvals) 1995-2002	Number of trial-traits 1996-2001	Production*** 1995-1999	IPOs 1995-2002	Public Companies 2002*	Bio Venture Capital 1995-2002	Total Venture Capital 1995-2002
AUSTRIA	88	116	53	102	109	100,89	0	11	76	0	0	12	27
BELGIUM	118	117	128	166	99	100,59	0	193	128	46	44	206	69
DENMARK	190	110	85	317	207	101,18	1190	134	13	211	202	279	56
FINLAND	142	120	62	112	217	100,18	0	122	141	42	40	104	103
FRANCE	103	111	29	83	60	101,12	98	193	120	93	76	93	142
GERMANY**	89	126	52	124	65	**	49	36	84	158	109	190	61
GREECE	26	63	n.a.	7	n.a.	101,05	0	61	120	0	0	0	3
IRELAND	80	83	301	74	133	100,28	0	30	n.a.	91	173	30	66
ITALY	52	90	77	25	13	100,58	0	122	101	249	178	8	89
LUXEMBOURG	28	54	n.a.	29	n.a.	101,58	0	n.a.	n.a.	0	0	n.a.	n.a.
NETHERLANDS	148	127	34	154	78	101,29	0	77	117	149	107	155	183
PORTUGAL	30	58	n.a.	3	30	99,35	0	25	87	0	0	4	24
SPAIN	60	72	92	14	9	98,67	0	135	166	0	0	9	60
SWEDEN	204	119	81	176	298	100,34	65	191	31	89	152	192	222
UK	143	134	306	113	83	98,11	98	69	116	373	420	119	294
US	121	171	171	170	75		231	698	65	411	656	575	321
CANADA	132	129	196	91	197		37	834	94	198	616	928	267
EU Average	100	100	100	100	100	100,29	100	100	100	100	100	100	100

*** or latest availiable year**

**** For Germany the Acceptance index can only be calculated for the Old Fedearl States (OFD) and the New Federal Sates (NFS) separetly: 101.70 (West) and 100.41 (East)**

***** Production includes only the per capita volume of those industrial sectors that are relevant for the application of biotechnology**

3 The indicators have been normalised with respect to the EU average (EU average = 100). All indicators are based on relative figures which take into account different sizes of the various countries Figures for drug approvals in Denmark (bio medicines) reveal a strong specialisation of that country. However, there is also a statistical artifact due to several approvals in 2002.

This comparison allows discussing the effectiveness of various policy approaches. However it should be noted that simple correlations between policy input and national performance are not adequate because policy is only *one* among several factors (such as specialisation and performance of the industry, traditions, institutional settings) having an impact on performance.

The following areas will be considered in this section:

- policies supporting the creation and maintenance of the knowledge base
- policies supporting the exploitation of biotechnology research
- policies aiming policies supporting market access for biotechnology products and at improving social acceptance of biotechnology
- policies aiming at improving industrial development of biotechnology.

Knowledge base policies

In terms of performance as measured by publication and citation indicators (table 4) we observe that Sweden, Denmark, the United Kingdom, the Netherlands and Finland as well as the USA and Canada are clearly above the European average. Belgium, Germany and France are performing a little better compared to the average value.

Looking at policies in place supporting the knowledge base firstly reveals the effect of financial commitment to supporting biotechnology. Support for research related to biotechnology has a high priority in most well performing countries as indicated by high shares (> 5 %) of biotechnology R&D in GDER. A second issue concerns the relation between biotechnology-specific and generic policies. Having in place specific policies for biotechnology pays off in a stage where biotechnology is at the verge of a pronounced take off, as was the case in Europe during the mid 1990s. Sweden, Denmark, The United Kingdom and Belgium present examples for such approaches. Having only (or mainly) generic instruments during such a stage as was the case for example in France, Austria, Ireland or Spain is less effective. The balance between support for basic and applied research is another policy variable having impact on performance. Most well performing countries (e. g. the Netherlands, Belgium, Germany, the USA and Canada) gave equal emphasis to both areas or had some stronger focus on supporting basic research (e. g. Sweden, Denmark and the United Kingdom).

Support for international mobility of researchers was not highly ranked on the political agenda. However, where it has been implemented (e. g. Sweden, Denmark or Finland) it seems to be beneficial to the output. This observation is in particular important for smaller countries which might depend to a greater extend on an external input due to (natural) limitations in the diversity of their domestic knowledge base.

Considering the supportive function of regulation is an additional complementary asset when building up a good knowledge base (e. g. Sweden and the Netherlands). However such an approach alone without suitable instruments to support research directly is not sufficient as indicated by the experience in Italy and France.

Policies to support exploitation of biotechnology research

As measured by the intensity of firm creation and patenting activities Denmark, Sweden, Finland, Belgium, the Netherlands as well as the USA and Canada are performing above the European average. Ireland has a good performance in firm creation, the United Kingdom and Germany in patenting.

The analysis of policies to support knowledge transmission firstly indicates that having only generic exploitation policies is not sufficient (e. g. France, Italy). Well performing countries (e. g. Denmark, Sweden, Finland, Belgium, and the Netherlands) have implemented a mix of generic and biotechnology-specific measures. The USA and Canada seem not to comply with this observation; they have followed mainly generic approaches. This difference might be related to the advanced stage of development of the sector in these countries, where generic approaches might be more appropriate.

A second observation relates to the combination of different policy instruments aiming at supporting exploitation. It seems to pay off to combine infrastructural instruments with support measures. For example in the case of building up technology transfer structures providing support for patenting via financial incentives (e. g. Finland) or education measures (e. g. Denmark) seems to be superior to approaches providing just infrastructures. A similar observation is made for policies supporting industrial development. Support for infrastructure alone (e. g. facilities in bio parks) is not very effective. Adding service functions such as advice on IPR, management, financing and regulatory issues contributes to enhancing the effects of infrastructural measures considerably. Positive examples for such approaches include Ireland, Sweden, Finland and Denmark but also the USA and Canada.

Comparing European countries with the USA and Canada reveals some interesting differences in their approaches towards exploitation. In particular the latter two countries seem to have paid more attention to creating supportive framework conditions for exploitation. Regulations related to IPR at universities, IPR in general, company creation, access to private capital, and hiring foreign staff have been important fields of policy action in the USA and Canada. In addition fiscal instruments supporting SME and spin-offs (and large firms in the USA) have been common there.

Policies to improve social acceptance of biotechnology and market access for biotechnology

Many biotechnology firms do not develop any products for end consumers. Rather they provide technologies and intermediate products for other, mainly large, firms. Therefore the presence of strong industrial sectors where biotechnology could be utilized is an important market dimension for biotechnology firms. The output analysis based on production volume per capita figures indicates that Finland, Belgium, the Netherlands, Spain, France and the United Kingdom have well developed industry sectors with relevance for biotechnology. Italy and Canada are performing at average; all other countries are below the European average.

Except the United Kingdom and Finland all high performance countries had fiscal instruments in place during the mid 1990s which aimed at supporting innovative activities of large firms. Countries not performing that well in this respect did not have such instruments. Canada and the USA also used such instruments, however at least in the USA no positive correlation to output could be observed.

This mismatch could be explained firstly by a size effect. Due to the large size of the American industry, potential technology markets for biotechnology firms are large enough in absolute terms even if the relative size as measured in our output indicator is small. Other explanations take into account the well known lead of the American biotechnology industry compared to Europe. Accordingly American biotechnology firms have a more international orientation their European counterparts so that their technology markets are not restricted to the USA. The high number of cooperations of European pharmaceutical firms with American biotechnology firms supports this notion (Reiss and Hinze 2004). Furthermore, American biotechnology firms are using direct market access strategies more intensively. They offer a number of products (e. g. biopharmaceuticals) and not just technologies reflecting the more advanced state of the American industry. The biomedicines indicator of the USA (table 4) which is highest among all countries supports this notion.

In summary this analysis shows that fiscal measures to facilitate innovative activities of large firms seem to work and contribute to generate a large domestic "technology market". Such instruments are in particular important in early stages where product based revenues are low for biotechnology firms.

In what concerns the policies to improve social acceptance of biotechnology, the performance indicators for social acceptance (table 4) present best values for Luxembourg, the Netherlands, Denmark and France. The analysis of policy approaches in these countries compared to other countries with less positive outcomes (e. g. Ireland, Finland, Portugal or the United Kingdom) allows the following conclusions. It seems to pay to develop a comprehensive policy approach in this field which includes a broad variety of different measures (technology assessment, foresight, workshops, and infrastructures) as was the case in Denmark and the Netherlands. In this context it is important to include all potentially affected stakeholders and to have a rather broad view of issues to be considered.

Policies to improve industrial development

With respect to indicators measuring the success of the biotechnology industry at stock markets (IPO, market cap) the United Kingdom, Canada and USA are performing exceptionally (table 4). Italy and Denmark also present good performance. Limited data availability for European countries, especially for market capitalisation, makes it difficult to identify any relationship between policy and performance in this area. However, the experience of the USA and Canada points to the importance of regulations and fiscal measures in facilitating going public.

The venture capital indicators reveal a very good performance by Sweden, the United Kingdom, the Netherlands and Denmark. However the USA and Canada are performing even better. Belgium, Germany, France and Finland are also above average; all other countries are performing rather weakly. The policy analysis reveals only few hints on successful strategies. The American example points to the significance of fiscal approaches which seem to pay in the USA.

5. Conclusions

This contribution puts forward a policy benchmarking approach from a systems perspective. Accordingly, the benchmarking concept explicitly incorporates the systemic nature of the innovation process in biotechnology by considering policy activity in all different sub-areas of the biotechnology innovation system: knowledge base, knowledge transfer and exploitation, the market and the industry. Furthermore, the systems perspective guides the identification of theoretically relevant policy goals for the support of a well functioning biotechnology innovation system.

On the other hand, the benchmarking approach combines quantitative and qualitative indicators in order to assess policy activity in relevant policy areas and the achievement of policy goals. Accordingly, the benchmarking exercise can provide policy makers with information on the evolution of their policy portfolios and the changes in performance. This information is very valuable in order to identify the processes of the innovation system that are working and what could be improved.

The comparison between the performance of national biotechnology innovation systems and their respective policy approaches in the past allows discussing the effectiveness of various policy approaches. The empirical results relate to policies implemented in 14 EU Member States, the USA and Canada in the mid 1990s and their performance in the period 1994-2002. Using these results we have identified best practices in biotechnology policy.

However, the approach has limitations that need to be taken into account. These concern the lack of comprehensive data to derive output indicators for all policy goals. Moreover, the policy profiles derived to assess policy activity using quantitative and qualitative indicators do not give a complete picture of the national policy approaches and of the national specificities. Such limitations oblige to be cautious when deriving best practices.

A first round of biotechnology policy benchmarking concept was conducted among interested countries in 2004 (Reiss et al 2005). The participating countries (14 old EU Member States and 7 new Member States) were very positive about the results, especially about the usefulness of elaborating policy portfolios. The policy questionnaire used to derive the policy profiles appears to be an effective information retriever; it enhances awareness on the possibilities of policy instruments and seems to function as a feedback tool in the policy design process. This assessment of the participating policy makers gives evidence for the importance of developing tools for effective policy design and policy evaluation from a systems perspective.

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