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The IPTS REPORT

EDITED BY THE INSTITUTE FOR PROSPECTIVE TECHNOLOGICAL STUDIES (IPTS)
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EUROPEAN COMMISSION
Joint Research Centre

ENGLISH VERSION

ABOUT THE IPTS REPORT

The IPTS Report was launched in December 1995, on the request and under the auspices of Commissioner Cresson. What seemed like a daunting challenge in late 1995, now appears in retrospect as a crucial galvaniser of the IPTS' energies and skills.

The Report has published articles in numerous areas, maintaining a rough balance between them, and exploiting interdisciplinarity as far as possible. Articles are deemed prospectively relevant if they attempt to explore issues not yet on the policymaker's agenda (but projected to be there sooner or later), or underappreciated aspects of issues already on the policymaker's agenda. The long drafting and redrafting process, based on a series of interactive consultations with outside experts, guarantees quality control.

The clearest indication of the report's success is that it is being read. An initial print run of 2000 for the first issue (00) in December 1995 looked optimistic at the time, but issue 00 has since turned into a collector's item. Total readership rose to around 10,000 in 1997, with readers continuing to be drawn from a variety of backgrounds and regions world-wide, and in 1998 a shift in emphasis towards the electronic version on the Web has begun.

The laurels the publication is reaping are rendering it attractive for authors from outside the Commission. We have already published contributions by authors from such renowned institutions as the Dutch TNO, the German VDI, the Italian ENEA and the US Council of Strategic and International Studies.

Moreover, the IPTS formally collaborates on the production of the IPTS Report with a group of prestigious European institutions, with whom the IPTS has formed the European Science and Technology Observatory (ESTO), an important part of the remit of the IPTS. The IPTS Report is the most visible manifestation of this collaboration.

The Report is produced simultaneously in four languages (English, French, German and Spanish) by the IPTS; to these one could add the Italian translation volunteered by ENEA: yet another sign of the Report's increasing visibility. The fact that it is not only available in several languages, but also largely prepared and produced on the Internet World Wide Web, makes it quite an uncommon undertaking.

We shall continue to endeavour to find the best way of fulfilling the expectations of our quite diverse readership, avoiding oversimplification, as well as encyclopaedic reviews and the inaccessibility of academic journals. The key is to remind ourselves, as well as the readers, that we cannot be all things to all people, that it is important to carve out our niche and continue optimally exploring and exploiting it, hoping to illuminate topics under a new, revealing light for the benefit of the readers, in order to prepare them for managing the challenges ahead.

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EDITORIAL

Dimitris Kyriakou, *IPTS*

Discount rates are the 'interest' rates at which we discount future benefits to obtain their net present value, i.e. how much one would be willing to pay today to get a certain benefit in the future. Participants in the sustainability debate have on occasions used clever examples of the ability of discount rates and long term compounding to produce absurd results as a way of shocking their audiences. Let us see if these examples make sense, and perhaps unmask in the process some of their problematic assumptions, or even fallacies.

For instance, assuming world GDP grows at an average 3% over the next 200 years then world GDP will have a value of US$8 quadrillion (8,000,000,000,000,000) in 2200. Now, using a 7% real (net-of-inflation) long term discount rate the net present value of this amount is about US$10 billion (10,000,000,000). This means that, at these rates, given the choice, one should not pay more than ten billion US$ today in order to enjoy the world's output in 2200. A more sustainability-relevant interpretation of this is that the present generation, assuming it cares sufficiently about the GDP of its descendants (this is an issue for another editorial) should not spend more than ten billion US$ to prevent the loss of all output in 2200, an absurd situation for any reasonable observer.

What is wrong with this picture? Is there a sleight-of-hand that leads to this paradoxical result, making discounting look silly? Indeed there is. Discounting at 7% implies that you can find alternative investments paying you an average 7% return for those 200 years, so that at the end of those 200 years you can have more than the foregone 8 quadrillion, thus presumably justifying your original decision to forego world output at 2200. But there is the rub. If there is no output at all at 2200, who will be able to give you your capital and accumulated interest? If you are paid back in assets (cash, bonds, etc.) what is their value if there are no goods to purchase with them? Since you forewent the entire world's GDP there are no goods in which to translate your paper earnings. The source of the fallacy is to ignore the link between utility, goods, and money income. All the analyses of rational decision-making (discounting included) are on the basis of utility derived from the consumption of goods (in the most general sense of the word). Since money incomes determine consumption potential, money incomes are used as imperfect proxies for utility. In our case however the link **money income -> goods consumption -> utility** is broken because we have allowed goods to disappear, hence even huge money incomes are useless – they cannot be turned into utility. It is therefore not discounting that is absurd, but the way it is used in this specific example.

Note that this covers only one pitfall (albeit a basic one) relating to the use (or abuse) of long-term discounting. There are several others. What determines the magnitude of an appropriate discount rate? Is human impatience to gratify wants and needs (the technical term for it is 'pure time preference') a part of it? People do not live forever, and it is not clear how much they do or should care for the well-being of their distant descendants. Is there a way to treat intergenerational optimization issues rationally? Values and preferences as well as income patterns can change substantially over the centuries. How can this be accounted for? We are already however treading the waters of larger issues, and perhaps the topics of future editorials.

Globalization, Digitization and the Changing European Context: impacts on regional economies

Matthias Weber, *IPTS*, Luc Soete, *MERIT*

Regional Development 3

Issue: Globalization and the growing digitization of the economy have changed the operational context for economic and political entities. Within Europe, EMU and the enlargement process are additional parameters of this transformation process. These changes will bring about new competitive conditions for Europe's regions, particularly affecting the less-favoured ones.

Relevance: With globalization and digitization, new location-related choices open up for internationally oriented firms, thus changing the patterns of regional comparative advantage in Europe and worldwide. As a result there will be new opportunities for their economic development, calling for new policy responses to exploit benefits from regional advantage and specialization.

The global context is changing...

"Globalization" has become one of the catchwords of recent years. It has been attributed a role in both heightening economic competition and as a source of wealth. Today, it undoubtedly operates as one of the main drivers of economic change affecting all industrial economies.

Globalization is tangible in measures of trade and foreign direct investment flows. Trade data show that the global economy is emerging through a process of regionalization into three main trading blocs: the EU, ASEAN and NAFTA. In Europe, for example, in the mid-Nineties between 60% and 70% of trade flows took place inside the EU. About half of these intra-EU trade flows were based on "vertical" product differentiation, with trading partners specializing on complementary quality levels within the same product class, or on different links in the production chain. Foreign direct investment (FDI) flows also seem to reflect the consolidation of these global-regions. Again, European FDI peaked in anticipation of the Single Market in 1993 and was largely made up of intra-EU investments. In this case, the investments aimed to secure a presence in the world's largest consumer market. Current drivers are the prospects of further gains from investment, mergers and acquisitions resulting from the planned deregulation of public utilities and the greater transparency brought about by the single currency.

Globalization also has an "intangible" dimension in the form of the internationalization

Globalization is tangible in measures of trade and foreign direct investment flows. Trade data show that the global economy is emerging through a process of regionalization into three main trading blocs: the EU, ASEAN and NAFTA

The intangible dimension of globalization is the internationalization of information and knowledge flows brought about by the internationalization of the media and scientific communities, greater personal mobility, increased international contact between firms, etc.

Information and Communication Technology (ICT) networks not only permit access to information worldwide, but also provide the nervous system for the internal coordination and logistic control of widely dispersed production sites

of information and knowledge flows. Several different intangible flows can be distinguished (Soete, 1999):

- Financial flows, perhaps the most influential intangible;
- Intermediate service flows within and between firms, enhanced by the deregulation of markets worldwide;
- Formal international cooperation on joint ventures, strategic alliances or collaborative research;
- Global knowledge flows in scientific communities and across the media;
- Transfers of tacit knowledge through greater personal mobility and exchanges in industry, politics, science and culture.

Global exchanges of both intangible and tangible flows are facilitated by "digitization". Information and Communication Technology (ICT) networks not only permit access to information worldwide, but also provide the nervous system for the internal coordination and logistic control of widely dispersed production sites. Products and services are themselves also increasingly informational in nature and therefore transmissible over ICT-networks.

Taken together, globalization and digitization are significantly affecting the geography of innovation and choice of location. This could mean radical changes to market allocation and incentives, with implications for patterns of growth, employment and income (Box 1). Intangible factors of growth, also, are particularly salient in some of the most economically and technologically dynamic industries such as ICTs, and the life sciences.

...and Europe is undergoing major transformations

European regions on the other hand are facing further significant changes in their context due to

Box 1. Intangibles and markets

Markets for intangible goods and services challenge traditional assumptions about how markets operate. This can be illustrated through the example of software:

- Software can be easily copied, which means that it is difficult if not impossible to make sure that producers get paid for their efforts (i.e. property rights are weak).
- Where strong property protection is introduced, there is a risk of monopolistic behaviour exercised through proprietary standards, a situation typical of software products.
- Exchanges of information-based goods and services are subject to strong asymmetries between seller and buyer. Often, this calls for trusted intermediaries as deal brokers or the offer of free trial versions.

It seems that markets for intangibles are different, strong property protection can suppress the "non-rival" nature of many intangibles (i.e. that one person's enjoyment does not diminish any one else's enjoyment of the good). Protecting exclusivity (to guarantee that producers are paid for their work) without inhibiting non-rivalry in use is a crucial issue for dynamic efficiency and incentives to innovate. The issue is whether these conditions constitute a market failure calling for intervention in the form of property protection and competition policy.

Source: Soete (1999).

political developments. Economic and Monetary Union (EMU) and enlargement to the east were political decisions, but they reinforce the process of economic integration in Europe. EMU will have a number of beneficial consequences. It will expand the effective market size within the Euro zone, through the greater transparency of prices, the disappearance of exchange-rate risk and the imposition of stability-oriented economic policy, which tends to reduce capital costs. Also, with trends towards liberalization and competition in the financial sector, sources of investment capital should become more flexible and cheaper (see Tsipouri 1999).

These advantages accrue to firms right across the EU from rich to poor, pointing towards greater inter-regional competition. But, firms located in the more advanced areas are likely to be better rewarded by EMU than firms in less favoured regions. Many firms in less favoured regions, especially the large numbers of smaller ones, lag behind in terms productivity, technology and organizational techniques. Such firms might find themselves under increasing pressure from the greater accessibility of their markets to competitors from elsewhere in Europe.

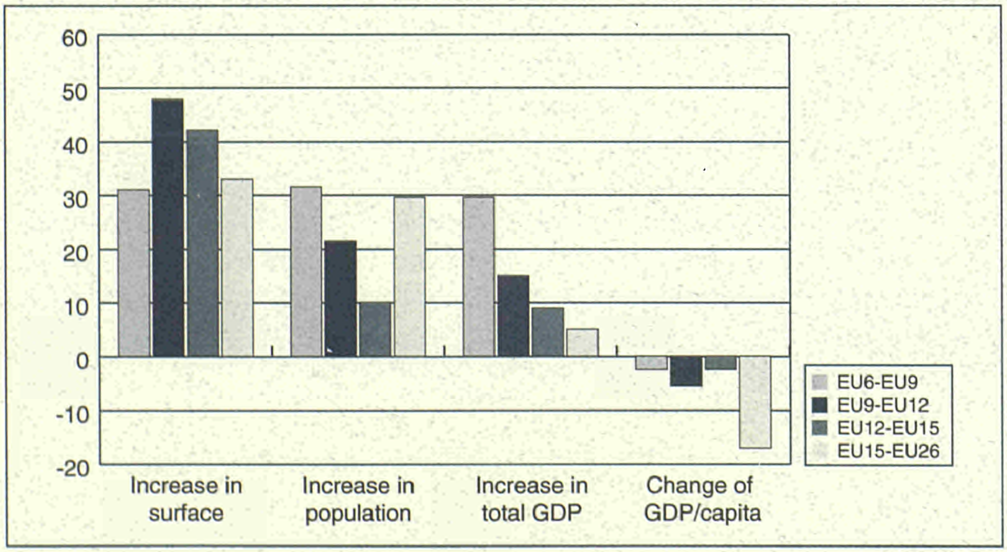
Meanwhile, the economic convergence process in Europe is likely to raise labour costs in the medium to longer term. This is likely to reduce the scope for lagging regions to compete with non-European competitors on the basis of labour costs. Moreover, EMU means that monetary policies (e.g. currency devaluation) can no longer be used to improve the competitiveness of domestically produced goods. Overall, the EMU will put less favoured regions under a dual pressure, from both in- and outside of the Euro zone.

The enlargement process further complicates the situation for the less favoured regions. One of the most important consequences is a widening of the wealth gap in the EU (see Figure 1). In essence this means that regions that are today regarded as "less favoured" will define the new average wealth level, with the consequence that they no longer qualify for structural support. There is some time to adjust to these new conditions, but time is quite short.

The larger effective market ushered in by the euro will benefit firms of all sizes across Europe, although firms located in more advanced areas are likely to be better rewarded by EMU than firms in less favoured regions

The less favoured regions face the additional difficulty that the widening wealth differences in an expanded EU will mean they are no longer eligible for structural support

Figure 1. Impact of successive EU-enlargements



Source: Eurostat 1998, IPTS 1999.

Although ICTs reduce geographical barriers, factors such as access to skilled labour, good infrastructure and institutions will mean some regions still have an advantage over others

In addition, the attractiveness of regions to investors is influenced by factors such as local purchasing power (GDP per capita), the quality of local infrastructures, working conditions, a dynamic and entrepreneurial climate, and access to specialized centres of excellence

Regional impact: issues and opportunities

ICTs can imply the "death of distance", i.e. bringing down the geographical barriers to economic development and hence allowing peripheral regions to overcome some of the physical barriers they have faced. But there will be countervailing concentration effects, with some regions better able to exploit location-related advantages than others. Thus, it is true that, with digitisation and dematerialisation, proximity and physical factor endowments become less crucial economic constraints. But, there are still substantial barriers to decentralization of the economy, especially through economies of agglomeration in intangibles. These include access to large pools of highly skilled labour, good infrastructures and institutions and the impossibility of downloading crucial tacit know-how. In fact, specific location-related characteristics and comparative advantages are likely to become accentuated rather than diminished. This can be illustrated through four examples:

Regions in the digitized economy: First, the *sine qua non* of the digital economy is the information infrastructure of physical networks and nodes. Firms in less favoured regions in Europe still lag behind in terms of access to advanced ICT-infrastructures and value added services tend to be more costly. Second, to exploit the new technologies, people must be willing and able to use them. There is a need for computer and communications specialists and a general ICT-literacy. A knowledge base of higher education and research institutes and professional training capacity which matches the industrial specialization profile of the regions is also needed. Many less favoured regions do not yet meet these conditions. In addition, the attractiveness of regions to investors is influenced by factors such as local purchasing power (GDP per capita), the quality of local infrastructures, working conditions, a dynamic and entrepreneurial climate, and access to specialized centres of excellence. The quality of life (e.g. climate, leisure amenities, etc.) and social stability are also important to skilled workers. Finally, regions and their firms have to learn to deal with the intellectual property issues and information asymmetry problems of intangible markets.

Customization of products and services: The trend towards the customization of products and services tailored to local demands, even down to the individual, offers scope for decentralized growth. On the one hand, final assembly of products and packaging of services according to local habits and traditions is becoming more widespread in all areas from food (e.g. "*produits du terroir*") to fast growing client-based business services. With quality, timeliness and flexibility becoming key dimensions of competitiveness, multinationals are often seeking a local presence so as to understand local preferences and operating constraints and to track localized changes in demand. Complex or uncertain transactions or those depending on the tacit quality dimension, place a premium on the spatial proximity of the producer and consumer. Thus, even in the digital economy, local human, social and institutional conditions matter. For regions this means that the more sophisticated and differentiated the local demand the less likely it is that disembodied electronic commerce will substitute for physical presence and the investment and jobs such a presence might bring.

Specialization and complementarity: In the longer-term European and global competition will probably lead to greater regional specialization. Except in niche markets, regions are unlikely to be able to maintain world class, price competitive industry and services on their own. Few regions will have the strength to maintain a comprehensive industrial portfolio. The main difficulty, of course, is to identify in which areas a specific region should specialize. Examples of successful strategies are legion: the industrial districts of Italian textiles firms; innovative biotechnology firms in Portugal; the clustering of call-centres in Dublin or the Randstad in the Netherlands; and of course the computer industry in California's Silicon Valley. But success stories are not easy to copy, not least because by definition these niches are already occupied. Moreover, a success story can hardly be built overnight.

Another possible option for firms in less favoured regions is to try to become complementary to activities elsewhere in Europe. For example, by sub-contracting or collaborating with more advanced firms in a core region. Synergies can be exploited through "virtual clustering" using ICTs to connect firms in less favoured regions directly into the epicentres of innovation. This depends on excellent logistic capacity for the physical coordination and good communication links (transport and ICT). Lead sectors in such 'virtualization' strategies are automotive manufacturing, electrical engineering, and agrofood, with investment and collaborations in less favoured regions in both the EU15 and candidate countries for EU enlargement. In fact, driven largely by integration into the supply chains of major European industrial firms, the economies of the Central and Eastern European Countries (CEECs) are already showing signs of convergence to the industrial specialization profiles of the Northern EU countries, (OECD 1998). However, these kinds of vertical complementarities leave both CEECs and Less Favoured Regions (LFRs) in a

There are many stories of regions acquiring dominance in niche markets, but such success stories are not easy to copy, not least because by definition these niches are already occupied

Table 1. Specialization patterns in peripheral regions

First wave Central and Eastern European countries (CEEC1)				
Hungary	**Czech Republic**	**Poland**	**Slovenia**	**Estonia**
Food & drink	Food & drink	Food & drink	Food & drink	Electrical machinery
Electrical machinery	Electrical machinery	Electrical machinery	Electrical machinery	Textiles
Transport equipment	Transport equipment	Automobiles	Transport equipment	Chemicals
Radio/TV	Medical instruments	Radio/TV sets	Mineral products	Wood & paper
Chemicals	Basic and fabricated products	Wood & Paper	Optical equipment	
Coke/petro-leum	Chemicals		Chemicals	
Wood & paper	Mineral products			
	Wood and furniture			

EU-15 less favoured countries/regions				
Ireland	**Spain**	**Portugal**	**Southern Italy**	**Greece**
Pharmaceuticals	Food & drink	Textiles	Food & drink	Food & drink
Biomedical equipment	Transport equipment	Wood and cork	Textiles	Textiles
Office machinery	Fabricated products	Software development	Transport equipment	Mineral products
Recorded media	Chemicals	Biotechnology	Mineral products	
	Consumer goods			

Source: CEC (1998), EIU (1998), Tsipouri (1999) and OECD (1998).

Globalization will erode the competitive position of EU firms producing low-skill, labour-intensive commodities. New strengths need to be sought in more knowledge-intensive markets rather than saturated traditional ones

The regions need adequate information infrastructures and training and education initiatives if they are to stay in tune with the digital age

dependent or secondary economic position relative to the most developed countries of the EU.

Cooperation and competition among regions: In combination, the Single Market, EMU and enlargement increase competitive pressures on EU15 less favoured regions, whilst at the same time signalling a reduction in financial support. However, all EU firms have privileged access to world markets, which means that the longer-term perspective could, on balance, be positive overall. But, meanwhile, the urgent need is to modernize and to build relations with partners elsewhere in Europe in order to use the window of opportunity to strengthen their industries and institutions. With globalization, the competitive position of EU firms producing low-skill labour-intensive commodities will be eroded. New strengths need to be sought in more knowledge-intensive markets rather than saturated traditional ones. As both LFRs and enlargement countries need to restructure and target key sectors, it is of concern that they do not all target the same sectors, as this could lead to intense regional level competition for markets and investment between them. The specialization profiles of first-round Eastern European enlargement countries and the main EU countries with less favoured regions indicate that this is generally not the case, with the exception of transport equipment (Table 1). But, there is competition for foreign direct investment. Recent trends in the distribution of FDI indicate a decline in the Southern Member States, and a sharp increase in the Eastern enlargement countries (IMD). Countries like Hungary and the Czech Republic seem to be already equally well, if not better, integrated into global production networks than some regions in the current EU.

Preparing for the future...

The current phase of rapid change both in- and outside Europe represents a good opportunity for less favoured regions to develop economically. Digitization will not make location-related disadvantages disappear. Geography will continue to matter because the global and digital economy is a space of flows that are drawn towards poles of attraction such as a high quality infrastructure and appropriately skilled labour. The result will be that favoured regions will continue to be a strong magnet to these flows but a number of countervailing trends are also in operation which act in favour of more distant and less favoured regions.

1. An appropriate *information infrastructure* is needed so that regions can connect to the digital and global economy. Equally important are training and education initiatives to develop a workforce (and culture) which is in tune with the digital age. Also, the new economic rules in markets for intangibles call for a regional response. With globalization, governments (at national and EU level) have lost direct influence over multinational firms. Their leverage now tends to be on framework conditions such high-quality knowledge infrastructure and the institutional base. Much of this leverage is actually enacted at regional level, thus making regional level policies and actors more crucial and giving them a higher profile in national wealth generation. As Storper (1997) and Lundvall (1998) in particular have emphasized, the implication is a new wave of policies to build "learning regions", in which the knowledge base of the region (schools, colleges, research, industrial and innovation support) come together to support innovation and maintain the attractiveness of the region to investors.

2. Regionalization is also apparent in industrial structures. There is an overall trend towards specialization of regional industrial structure. EMU and the enlargement process is

likely to enhance trends towards new local agglomeration effects (see Krugman, 1995). Regions can respond by being selective in targeting "foreign" investment and exploiting synergies and spill-overs from existing industrial strengths. A key component of such strategies is to foster a match between the research and training infrastructure and the specialization profile. This implies analysis of educational sector services and appropriate incentives to develop the right courses at the technical and university level.

It is also important to match goods and services with local market demands, because customization is now a key axis of competition. This tends to draw economic activities towards establishing a physical presence in the regional market, so long as the sophistication and level of demand makes it worthwhile. Somewhat in contrast to the image of a standardized single market, the implication is a preference for regional growth models based on systematic exploitation of proximity and variety. Europe's regional diversity surely offers much scope such local matching strategies.

3. Coordinating activities at European level could help develop complementarities to support these regional specialization strategies. An ideal division of labour can be imagined between Centre, East and South, with interconnection between centres of specialization rather than head on competition. Such ideas raise fundamental questions about the future of Europe and suggest a renewed role for the European Commission, under the general principle of "subsidiarity", less as provider of structural funds than as coordinator of regional policies.

4. Such coordinated regional specialization strategies may sound promising, but they also imply qualitatively different prospects and roles for different regions. This conflicts with the objectives of cohesion and convergence. Even more problematic, there may be regions that fail to find a successful niche. Again this points towards a regional structural policy less focused on monetary transfers and more on assisting regions to build the effective institutional and industrial systems that attract investment in the new digital and global economy.

Regional specialization might benefit from coordination at European level

Keywords

globalization, digitization, European enlargement, regional development

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Openness in Scientific Advisory Committees

Josephine Anne Stein, *University of East London/PREST*

Issue: Scientific advisory committees can have enormous influence on setting new governmental policies and regulations, as well as on the administration of programmes for research and technological development. Pressures to democratize deliberative policy-making are leading to various mechanisms to increase openness and public participation in scientific advisory systems.

Relevance: The benefits of openness, including systematic, balanced expert input, more efficient progress through independent external review, and public confidence-building, are widely recognized. However, it is also considered legitimate to protect privacy for certain advisory committee functions, for example in conducting scientific peer review or for reasons of national security or commercial confidentiality. Implementing appropriate openness regimes depends on national, political and institutional contexts and must be tailored to circumstances.

Introduction

Scientific advisory committees are an important feature of governance in many industrialized countries, and they are also used by the European Union at supra-national level. Not only do such committees give governments access to high-quality, current expertise in highly technical areas, formalized external advice helps to ensure that governments do not become captive to the in-house interests of national laboratories or the civil service, or vulnerable to excessive or inappropriate political influence.

Advisory committees are not, of course, the only way in which governments receive scientific information and opinion. Scientific advisory systems typically consist of a complex set of internal governmental advisors, and departmental and inter-departmental committees, often with a chief scientific advisor responsible both for coordination and for briefing high-level politicians. These internal, executive mechanisms are complemented by national academies of science and engineering providing advice to government, consultancy contracts with outside bodies and less formal input from individual experts or groups of experts.

However, scientific advisory committees with external expert members are of special interest for two main reasons. Firstly, scientific advisory committees are used widely as a well-recognized,

As well as giving governments access to high-quality current expertise in highly technical areas, scientific advisory committees help ensure a measure of independence from specific interests

Scientific advisory committees tend to have formalized terms of reference and responsibilities that lead to a specific set of recommendations on policy matters, however, in Europe they tend to work behind closed doors

The apparently tight relationship between science and government and the crises of confidence have provoked calls for greater openness

In the US the Federal Advisory Committee Act (FACA) grew out of public distrust of some parts of the scientific 'establishment' and a general crises of confidence in the aftermath of Vietnam and Watergate

effective forum for bringing independent expertise to bear on matters relevant to policy-making and administration. Secondly, such committees tend to have formalized terms of reference and responsibilities that lead to a specific set of recommendations on policy matters. Scientific advisory committees are not only an institutionalized means for transmitting knowledge, they represent a mechanism for opening governmental decision-making to direct input from the scientific community. In other words, scientific advisory committees can be viewed as a democratic extension to executive government, by bringing scientists in to participate in decision-making processes.

The flip side of the coin, of course, is that with the exception of a few committees made prominent by public controversies, scientific advisory committees in most governmental systems conduct their business in private. To those outside the ranks of science and government, there appears to be an already tight relationship between the two; much research is funded, and indeed carried out, by the government. Priorities for public investment in R&D are largely set through the science/ government dynamic (including science-based industry) without wider consultation. Private industrial interests affected by national innovation policies and science-based regulation seem to enjoy ready access to, and influence upon, government by virtue of their economic importance. What of the public interest, more generally?

Crises in public confidence in traditional democratic institutions often provoke demand for the greater public accountability of governments. Privileged access to government by any special interest group – such as science is increasingly perceived to be – is viewed by some with suspicion. When public confidence is also shaken over science-based policies, such as those concerned with "mad cow" disease (BSE) and genetic engineering, it is natural that this demand for greater accountability is extended to scientific advisory processes. The most obvious way to achieve this is to extent the idea of open government to greater openness in scientific advisory committees.

In countries as diverse as Australia, Germany, Japan, New Zealand, the United Kingdom and the USA, and in the European Community, there is a clear trend towards greater openness in scientific advisory committees, though the extent and the mechanisms differ. Openness is being implemented both through formal procedures and informally, by more careful attention to stakeholder representation on committees, for example, by developing rules on conflict of interest, or by publishing information about the committee's membership, deliberations and findings. Public participation is increasingly common, often using the Internet, and often at the initiative of the scientists themselves.

We will look here at the implications of these trends with special reference to the European Union, where recent developments in the organization and operation of scientific advisory committees are breaking new ground in democratizing the policy-making process.

Scientific advisory committees in the United States

The United States has by far the longest and most comprehensive tradition of openness in its scientific advisory committees. In the aftermath of Watergate and the Vietnam War, a number of reforms were instituted in the USA in the 1970s to improve Congressional oversight and control over the activities of the Executive Branch of the US Government. This period of American history was also characterized by mounting public distrust of the medical, industrial and nuclear "establishments" and the scientific enterprise underpinning them. One reform to arise from this dual public disquiet was the Federal Advisory Committee Act of 1972 (FACA), which stipulated that each expert advisory committee serving Federal Agencies must:

- have a charter specifying its purpose, term and mission objectives
- be certified as balanced by the Federal Agency to which it is responsible
- be opened and adjourned by a Federal official
- publicize its meetings in advance
- meet in public with certain well-defined exceptions which must be made public
- publish agendas in advance and publish minutes of all meetings
- report its activities annually to Congress
- make public recommendations.

The emphasis of the FACA is on openness but under the 1976 "Sunshine" provisions, committees can hold closed or partially closed meetings for discussions concerning:

- trade secrets (commercially confidential information)
- national security or foreign policy
- personal privacy (including conflict of interest)
- agency personnel rules.

However, FACA committees are still required to give notice of the meeting and to specify in advance which portions of the meeting will be closed and why. In addition, the minutes of all meetings must be made public, and ultimately, so must the conclusions and recommendations of the committees.

Although not required to do so, many FACA committees reserve time for public input on their meeting agendas. Committees often give the address of an agency contact person or provide a feedback link on the Internet. Public participation is significant in many instances, but is not systematic and is not always welcomed by committee members.

Federal Agencies with responsibility for national security tend to have more secretive cultures, and this extends to the scientific advisory process. The Department of Energy, with responsibility for nuclear weapons, has come in for persistent criticism for its reluctance to engage with the public. This secretive culture was even criticized in the DOE's "Openness Panel", reporting to the Secretary of Energy Advisory Board, which chose to comply with FACA even though not required to do so. The Openness Panel organized a series of Workshops where members of the public could express their views. The public raised concerns, for example, that the membership of the Panel was dominated by pro-nuclear industry interests, recommending the appointment of a "public advocate".

In some cases, US scientific advisory committees can have an explicit mandate to reach out to the public. For example, the Presidential Advisory Committee on Gulf War Veterans' Illnesses was as active in promoting health services and benefits to veterans as in investigating the epidemiological and medical aspects of military service in the Gulf War. The seven subcommittees were not technically subject to FACA, but sought public involvement through written submissions, attendance at regular meetings, and at dedicated meetings with veterans and other members of the public.

A controversy in 1997 over FACA's applicability to the US National Academies advisory committees was resolved successfully by enacting new legislation, but it prompted a re-examination of the underlying principles and practices pertaining to FACA. It is generally acknowledged that FACA needs some updating

In the US openness has been enshrined in committee rules, particularly those covered by the FACA, although there is resistance to it in some areas

It is generally acknowledged that FACA needs some updating and reform to reflect experience gained over the past quarter century, and the possibilities afforded by advances in information technology

There are moves towards greater openness in a number of countries, but particularly in those which have recently suffered crises of confidence

and reform to reflect (1) the experience gained over the past quarter century, and (2) the possibilities afforded by advances in information technology.

The main unresolved issues (and some would say, unresolvable issues) all concern the *practice* rather than the *principle* of applying FACA. Thus, dissatisfaction has been expressed with the use of Congressional exemptions, perceived circumvention of FACA or misuse of committees by US Federal Agencies, and the implementation of appropriate balance in committee membership. On the other hand, discretionary compliance with FACA, and voluntary initiatives to improve public participation in S&T advisory processes, are very common, and demonstrate a commitment to openness that goes well beyond formal, legal requirements.

Twenty-five years of experience of FACA openness provisions have reached a state of maturity that, to a first approximation, satisfies the needs of the government, the expert community and citizens. Americans have come to expect and to rely upon openness in S&T advisory committees as an established feature of democratic governance. Rather than trusting the government, or trusting the experts, they have come, for the most part, to trust the FACA regime itself.

Experience in other countries

In countries such as Australia, Germany, Japan, New Zealand, and the United Kingdom, steps are being taken to improve openness in scientific advisory committees. Beyond that however, many countries are formalizing committee membership criteria, including non-scientific attributes such as sectoral, institutional or geographical representation in addition to scientific expertise, and some make informal reference to gender balance.

Countries are also publishing more information, such as the names and affiliations of scientific experts on committees, committee reports, and national S&T data and policies that form a common basis for decision-making. Some, most notably the smaller countries, provide for international review, and a number of countries are developing guidelines on conflict of interest for committee members[1].

The greatest impetus towards increased openness is observed in countries like Japan and the United Kingdom, where there have been crises of public confidence in the integrity of government officials (often over financial matters or conflicts of interest), and over science-based policies (nuclear energy in Japan; BSE in the United Kingdom).

Voluntary measures to increase openness in scientific advisory committees are common in many countries. Some are initiated by governments, by individual officials, or by the scientific advisory committees themselves. Some committees organize public consultation meetings or invite public participation in regular meetings. Others publicize their activity through the press. But the most common means to increase openness is through the development of Websites, many of which not only include information and contact points but allow for public submission of evidence or questions to the committees.

Science advisory committees in the European Community

Scientific advisory committees made up of independent experts are often used to advise the European Commission on "upstream" policy development, for example to help set research priorities in the Framework Programme. However, some expert committees, most notably in DG-XXIV (Consumer policy and protection of the consumer; see below), provide independent scientific advice on the development of regulation, a downstream activity.

In addition, the European Commission is advised by a set of committees with formal responsibility for representing the interests of the Member States. These "institutional" committees consist of "comitology committees", such as those associated with the Framework Programme, and committees moderating between the Commission and the Council of Ministers (CREST, COREPER).

There are three main types of "comitology" committee serving the European Commission (based on a 1987 Decision that is currently under review): "management", "regulatory", and, somewhat confusingly, "advisory" committees (see table 1), which in this context has a technical, legal meaning. Those associated with the Framework Programme are variants of "regulatory" committees, known as "IIIb"; however, many others advising on highly scientific or technological issues, such as the Standing Veterinary Committee and the Committee for Proprietary Medicinal Products, operate under a different set of rules. The legalities are exceedingly complex, but in general, these committees have traditionally operated behind closed doors, with minimal information concerning their work accessible to the public.

In practice, the functional delineations of these committees are not always clear. The distinction between upstream and downstream are necessarily blurred. One cannot advise on future research activities without taking into account the scientific achievements and evaluations of current research programmes; recommendations on management of the present and the future cannot be separated neatly.

More controversially, however, in some committees, especially the "comitology" committees, the distinction between advisory and executive functions can become blurred, especially where policy on research programme management and regulation is concerned.

The European science advisory system is shown schematically in Figure 1.

Little systematic information has been made available on the membership, mandates or deliberations of European scientific advisory committees. Meetings are normally closed to the public. Examining the links between the Commission, other European institutions and outside expertise (as shown in Figure 1) reveals the flow of information to be almost entirely *inward*. Links to the Parliament, the wider policy community and the public are almost entirely limited to publication of some final reports, special discussion meetings in the Member States and occasional European policy forums.

The European Commission has recently taken a number of initiatives concerning EC scientific advisory committees. A July 1997 Decision established a set of eight Scientific Advisory Committees and a Scientific Steering Committee to advise DG-XXIV on consumer health and food

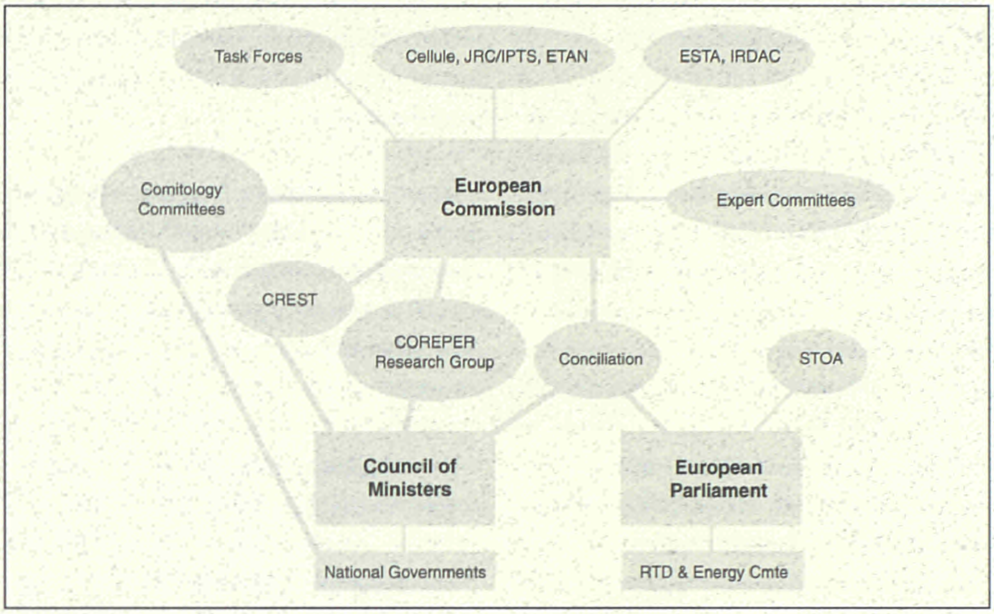
In Europe, scientific advisory committees are often used to advise the European Commission on "upstream" policy development. There are also a series of committees with formal responsibility for representing the interests of the Member States

European Commission committees have tended to be fairly restrictive about citizens' access to information, moreover the distinction between advisory and executive functions can sometimes become blurred

Table 1. European Commission S&T Advisory Committees

	Upstream	Downstream
Consultative, independent	DG-XII Expert Committees	DG-XXIV Scientific Committees
Institutional	CREST, COREPER Research Group	FWP Programme Committees: "comitology" committees

Figure 1. European Community S&T Policy "Trialogue"



Key:
Cellule [Cellule de Prospective (Forward Studies Unit), European Commission], COREPER [Committee of Permanent Representatives], CREST [Comité Scientifique et Technique], ESTA [European Science and Technology Assembly], ETAN [European Technology Assessment Network], IPTS [Institute for Prospective Technological Studies], IRDAC [Industrial R&D Advisory Committee], JRC [Joint Research Centres], RTD [Research and Technological Development], STOA [Science and Technology Options Assessment, European Parliament].

The European Commission has recently taken a number of initiatives concerning EC scientific advisory committees. The proposed reforms would create a more systematic, open and transparent framework for their activities

safety. These nine downstream committees have unprecedented provisions for openness in the European science advisory system.

In June 1998, the Commission announced the formation of 17 new research advisory groups to advise on the research to be carried out through the "key actions" of the Fifth Framework Programme. These new committees operate under a much more open regime than earlier expert committees advising on previous Framework Programmes, with information about the new committees publicized and posted on the Internet. Also in June, the Commission announced a proposal for a Council decision to update the 1987 "comitology" Decision.

Under these reforms, both main types of scientific advisory committee serving the European Commission (i.e. (1) consultative, independent committees; and (2) institutional, "comitology" committees) would operate under more systematic, open and transparent rules. However, the detailed roles of these committees, and the institutional bodies such as CREST and COREPER with respect to both "upstream" and "downstream" decision-making, remain to be clarified.

Conclusions

Greater openness in scientific advisory committees is often instituted primarily in response to public distrust of government and/or science. Openness is also stimulated by general demand for more responsive democracy and/or the possibilities for public participation afforded by advances in information and communications technologies.

To focus on scientific advisory committees, rather than on scientific advisory systems as a whole, can be justified on the basis that any non-executive advisory committee given a formal mandate to provide recommendations to government can be held separately accountable in the interests of more robust democracy.

The benefits of openness, including systematic, balanced expert input, more efficient progress through independent peer review and public confidence-building, are now widely recognized. However, approaches to openness that are too invasive or prescriptive could exacerbate the incentive to bypass formal mechanisms to obtain expert advice, and might inhibit governments from seeking outside advice altogether. Clearly, demand for openness must be balanced with the need to avoid overly burdensome procedures, and the need to protect legitimate aspects of privacy and confidentiality.

Although the characteristics of scientific advisory systems differ from country to country, certain issues underpin the management of the balance between openness, effectiveness and confidentiality in scientific advisory committees. These include, for example:

- Definition of mandate and impacts of recommendations
- Independence of expertise and avoidance of conflicts of interest
- Balance of expertise and stakeholder representation
- Protection of confidential information (personal, national and commercial)
- Compliance with openness provisions, exemptions and sanctions
- Publication of membership, minutes, working papers and recommendations
- Public involvement in deliberative processes
- Management of research policy as it relates to S&T-based regulation
- Role of external advice in "upstream" vs. "downstream" governmental functions
- Parliamentary role and inter-institutional relations

The American experience has demonstrated that openness in scientific advisory committees, with a carefully designed set of exemptions and protections, increases public confidence in both the scientific advisory process and in government itself. A number of other countries, in Europe and beyond, are increasing openness, most commonly by formalizing stakeholder representation on scientific advisory committees. Public participation in deliberative exercises conducted by scientific advisory committees is everywhere becoming more common, especially through interactive Websites.

The use of Websites is still experimental even in the USA where there has been the greatest use of the medium. A truly interactive, Web-based deliberative exercise involving the public has yet to be organized. The extent to which this type of activity would represent a true expansion of democracy or an extension of influence to select elites or unrepresentative interests cannot yet be determined without dedicated research. Furthermore, the extent to which large volumes of public information related to scientific advisory committees (such as detailed minutes of all meetings and comprehensive postings of evidence submitted by the public) is genuinely enlightening is also open to question.

At the European level, recent initiatives and proposals by the European Commission provide a good basis for systematizing and developing openness in all types of European scientific advisory committees. However, the all-important details are far from resolved.

European research support, as it takes into account socio-economic as well as scientific

Approaches to openness that are too invasive or prescriptive could exacerbate the incentive to bypass formal mechanisms to obtain expert advice, and might inhibit governments from seeking outside advice altogether

The American experience has demonstrated that openness in scientific advisory committees, with a carefully designed set of exemptions and protections, increases public confidence in both the scientific advisory process and in government itself objectives, has separated "purely scientific" deliberations associated with peer review from decision-making on project funding, in which "comitology" committees play a role. Also, committees advising the European Commission on science and technology policy issues are not "purely executive" as they include external experts. There is thus strong justification for openness provisions to apply uniformly to all types of European scientific advisory committee.

Public participation in European deliberations may be difficult to implement simply through making scientific advisory committee meetings more open, due to the many geographical, cultural and linguistic barriers involved. It is also not clear that it would be appropriate to open such meetings to the public, as many expert members might be intimidated by the idea of speaking a second or third language in the full glare of public and media attention. However, deliberative exercises work best if there is adequate time for information-gathering, analysis, and the interchange of ideas. As the Internet becomes more accessible to ordinary citizens, its potential as a transmission medium that can accommodate different languages through translation could potentially bring participation within reach of citizens anywhere in Europe.

The climate is propitious for the implementation of greater openness in European scientific advisory committees. The successful development of the European Union depends upon the responsiveness of European institutions to the citizen; overcoming public concern over issues such as biotechnology implies a need for better flows of information between the scientific community, government and the citizen. Greater openness in scientific advisory committees is one way to address both needs simultaneously.

About the author
Josephine Anne Stein is a Principal Research Fellow at the University of East London, and a lecturer in the European ESST inter-University Association offering coordinated post-graduate education in STS. She received a Ph.D. in Mechanical Engineering from the Massachusetts Institute of Technology, and has worked as a science and technology policy analyst/researcher in Princeton, Washington, London, Manchester and Brussels. Her main research interests are in democratization of S&T policymaking and expert-lay interaction in S&T-related civic affairs.

Keywords

science advice, openness, expert committees, public participation, policy

Note

1- Consensus conferences or similar exercises have been conducted in Denmark, France, Germany, Japan, the Netherlands, Switzerland, the United Kingdom and the USA. These exercises, in general, reverse the roles of expert and lay citizen by locating the deliberative process in the lay panel, which is informed by expert testimony. These exercises, while not technically part of the scientific advisory process, nevertheless indicate a growing tendency to engage the public in highly scientific or technical policy issues.

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Education and Training for Innovation: individual and organizational learning

Peter Senker, *SPRU/IPRA*

Issue: Efforts to remove barriers to the widespread uptake of information and communication technology products (ICTs) have tended to concentrate on skills shortages. However, particularly in the less prosperous regions, another significant problem is failure of SMEs in traditional industries to modernize their products and processes to exploit the potential of the wide range of new scientific, technological and management techniques which would allow them to increase productivity and improve quality.

Relevance: Education and training policy proposals for the Information Society emphasize the need to educate people to fill the enormous number of vacancies in ICT producing industries. The Commission also has several important programmes and proposals which will help less prosperous regions. But most such programmes operate by increasing the supply of suitably educated and trained workers. In addition, programmes are needed to address another key issue bringing to the surface the latent demand among SMEs for highly qualified people needed to stimulate innovation.

Trade liberalization is creating an environment in which competitive pressures are constantly intensifying. The skills and training of their employees will be decisive for firms' continued survival

Introduction

Recent advances in technologies - ICTs in particular - have accelerated already rapidly changing skill requirements. Such trends require policies of continuous upgrading of the skills of the labour force – i.e. the "lifelong learning imperative". They also require programmes to ensure that companies, especially the enormous number of SMEs in traditional sectors, are capable of innovation so as to be able to modernize their products, production processes and/or services to take full advantage of the productivity and quality improvements made possible by ICTs.

Trade liberalization is creating an environment in which competitive pressures are constantly intensifying, and in which firms - including SMEs - have very strong incentives to employ more skilled and trained workers in order to remain competitive. Indeed, the future looks bleak for firms that fail to do so. European policies aimed at encouraging SMEs to employ more skilled workers could help them to prepare for more intensively competitive market conditions, thereby alleviating future pain.

Current European Commission proposals

The European Commission is striving to develop programmes to meet the rapidly growing demand for educated people with ICT experience which seems likely to continue to afflict this important and rapidly growing sector. It has called for a new strategy for jobs in the Information Society:

"The rise of information and communication technologies is the defining socio-economic development of the late 20th. century, influencing not only jobs, industrial output and the relative economic performance of nations, but also the way people live."

The ICT sector created 400,000 new jobs between 1995 and 1997 - about one in four of the total of new jobs created in the EU(ESF, 1999). Trends such as the rapid expansion of mobile telephone usage and growth in the audio-visual sector indicate that there continue to be major opportunities for employment expansion.

Over 500,000 IT job vacancies are currently unfilled in the EU because employers cannot find staff with the appropriate skills. This figure could rise to 1.2 million by 2002 unless the problem is addressed as a matter of urgency (ESF, 1999). As a consequence of these skills shortages, firms do not derive the full benefits available from their ICT systems and have to postpone new technology projects.

Individuals need to learn - but so do firms

Before considering how to increase firms' capacity to acquire knowledge and skills, it is necessary to consider why firms need to learn, how they learn, and the principal priorities in their needs for new knowledge to help them to innovate effectively.

In addition to measures designed to ensure that individuals learn, it is also necessary to ensure that firms learn. Research has shown that it is not enough for individuals to learn about ICT: indeed, it has been found to be dangerous for a firm to place excessive reliance on individual ICT experts (Dale, 1986). The organization as a whole must learn to use ICT, so that it can draw upon its employees' complex blend of skills and talents. A key part of the learning process is the identification of information which can add value to the business, and integrating new knowledge into a company's existing accumulated knowledge (Tiler, 1991).

Most firms in the less advanced regions of the EU are SMEs, and most operate in traditional sectors. Indeed, in the EU as a whole, small firms employing less than 50 people account for about half of total employment - some 50 million jobs, and SMEs employing up to 250 people account for about 65% of employment (Eurostat, 1997). Increasingly, such firms can only remain competitive if they learn to innovate. Often this involves learning to use ICT equipment and systems in their production processes, and/or in their products or services.

There are huge opportunities for SMEs to use new technology to increase both productivity and quality - just a few examples are the application of Computer-Aided Design in foundries, the use of computer-controlled cutting in garment production, the use of production control in food and drink production and in crockery manufacture, and the use of computers to control stocks in retailing.

Where firms in traditional sectors do use new technology, they often use technology that is produced by their materials and equipment suppliers, and sub-contractors rely on their customers for precise specifications. But there is extensive evidence that firms which do not employ qualified scientists or engineers have great difficulty in absorbing knowledge from such external sources. Most firms in traditional sectors such as construction, food, plastics,

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clothing and mechanical engineering were founded by practical people, few of whom yet recognize or understand the need for graduates or technicians in scientific, technological or management disciplines. If there is nobody in a firm who can understand the knowledge generated in universities and Research Institutes, then the firm cannot use such knowledge. Firms cannot innovate effectively unless they employ staff who understand science, technology and modern management methods, and are able to apply them. But it is not sufficient for a firm to gain access to useful knowledge. It has also to organize methods for the internal diffusion of new knowledge and skills, to ensure that knowledge which is received from external sources is communicated and utilized effectively throughout the organization. In the absence of the knowledge needed to be able to use new machinery, the provision of financial support for modernization of machinery by itself cannot provide firms with the capability for effective innovation. If firms do not have appropriately educated and trained workers, financial support cannot ensure that they acquire the ability to use new machinery effectively, or to modernize products, services or production processes.

Providing the financial support for modernization of machinery cannot provide firms with the capability for effective innovation if they do not have the skills and knowledge necessary to use the new technology

The principal factor constraining firms' demand for scientific and technological knowledge is their own lack of scientific and technological capability. Universities play an important role in producing new knowledge and in educating students. But firms can only gain access to such knowledge if they employ people capable of reading the textbooks, journals and manuals in which it is published, and communicating directly with the people who produce it. There is a considerable amount of empirical research data which demonstrates that this capability is related to the educational level of a firm's staff - in particular to the employment of qualified scientists and engineers able to understand the output in terms of books and papers produced by the universities and Research Institutes which generate new technology (Entorf 1997, and IRDAC 1991). Qualified staff can also participate in personal discussions with people who generate new knowledge. In principle, the higher the level of knowledge and understanding within the company (the more elevated its skills profile) the more aware the staff is that new knowledge could help their business; and the better they are able to use new knowledge to improve the company's competitiveness.

EU and individual Government policies primarily focus on encouraging individuals to learn throughout their working lives. This is very necessary to encourage economic development, but it is not sufficient by itself. Increasing the capacity of SMEs to locate useful new knowledge and technology and to apply it appropriately to their businesses has been relatively neglected. Particularly in less prosperous regions, one of the principal problems detracting from the European Union's competitiveness is the failure of SMEs in traditional industries to modernize their products and processes by means of new technology. The Commission has programmes and proposals aimed at helping such regions, the vast majority of which operate by increasing the supply of suitably educated and trained people. However, the failure of SMEs to demand highly qualified workers is of at least equal significance to their capacity to innovate.

In view of the enormous size of the SME sector in terms of employment; and in view of the very large share of overall employment in SMEs in traditional sectors, sustaining and increasing this employment by enabling SMEs to use new science, technology and management methods effectively deserves high priority.

How firms' learning capacity can be stimulated

Effective innovation, leading to improvements in productivity and quality, is the key objective of enhancing firms' learning capacity. This involves learning to use new science and technology in their products, processes and services, and learning to use new management methods. To do this, it is necessary to encourage firms to recruit new categories of staff, in particular technicians, graduates and postgraduates in scientific and technological disciplines such as ICT which are relevant to development of new activities. Such recruits have greater capability than existing less qualified staff for acquiring the knowledge needed to implement new technology. It is true that, in addition to universities, several Research Institutes in European countries offer scientific and technological knowledge to firms. But such Institutes' efforts to promote innovation are relatively ineffective because far too few SMEs employ sufficient people with the capability or knowledge to permit them to take full advantage of their services.

One example of an attempt to address this issue directly is given by the British Teaching Company Scheme (TCS). TCS sets up partnerships between academic institutions and companies to benefit industry through the development of a group of high quality, young, technical managers. The Scheme operates through programmes in which academics in universities team up with companies to contribute to the implementation of strategies for technical or managerial change. Each partnership, called a TCS programme, involves academic participation with company managers in the joint supervision and direction of the work of at least one young graduate in a relevant discipline. A high proportion of these programmes have involved the application of ICTs to the development of better products, services and production processes, but they have also been effective in many other areas including new materials and biotechnology.

In firms which have not previously recruited graduate scientists or engineers, a TCS programme can put in place an organizational mechanism which initiates knowledge transfer from academia. It can also play a significant role in creating more favourable attitudes to the recruitment of such graduates (Senker, 1994). Firms can enhance their capability to learn and innovate by recruiting the graduate Associates who work for them on Teaching Company Schemes. Their education and training also provides these graduates with the competence and contacts necessary to continue to 'network' outside the firm - with university staff and with personnel from other firms. In this way, they can acquire knowledge which can help their firm to continue to innovate.

Similar schemes have also been run in other European countries - in EUNET club member countries - Denmark, France, and Ireland. Agencies in these countries joined forces with agencies in Austria, Germany, Norway and Sweden (with observers from the Czech Republic) to cooperate in 'T3net' a two-year project funded by the European Commission which ended recently. Their principal activities included international technology transfer fellowships, further promotion of the technology transfer and training concept; and provision of familiarization courses for officials of agencies wishing to establish similar programmes. It was suggested that "Given their almost universal success, it is not unreasonable to foresee the spread of programmes combining technology transfer and training throughout Europe and beyond" (Monniot, 1998).

SMEs' capacity to absorb new science, technology and management methods needs to be stimulated. This can be achieved by increasing their willingness to recruit people with the necessary

A number of initiatives have been run in Europe to set up partnerships between academic institutions and companies so as to develop a group of high quality, young, technical managers

As well as recruiting people with the right skills, firms need to learn how to organize themselves so as to spread new knowledge internally and ensure that knowledge received from external sources is communicated and utilized effectively throughout the company

One approach is to apply the concept of 'extension' to manufacturing, as has been done in the United States - appropriately educated and trained workers go out to manufacturing firms and help them to reshape their organizations to facilitate learning

education and training in relation to science, technology and new management methods. At the same time, they need help in learning how to organize themselves so as to spread new knowledge internally and ensure that knowledge received from external sources is communicated and utilized effectively throughout the company.

Some organizations, such as the British Teaching Company Scheme, fulfil this function, and similar organizations operate in several other European countries, mainly the more prosperous ones. But the success of specific organizational mechanisms depends on the culture and institutions of the particular countries in which they are located. For example the capabilities and motivations of those who work in higher education and in Research Institutes vary between countries. There are variations between countries in the ways in which universities are run and financed. For this reason, and because of differences in culture between countries, it is much easier to persuade academics in universities in some countries to devote their time and attention to the needs of manufacturing industry than it is in others. Moreover, in some countries, it is very difficult - perhaps impossible - for Governments to establish, foster and sustain organizations with the high degree of autonomy enjoyed by the Teaching Company Directorate which runs Teaching Company Schemes in Britain.

For such reasons, it is not always possible simply to transfer organizational mechanisms which work well in one country to every other European country. For organizations to be effective, they need to be tailored to the culture and political institutions of the countries in which they operate. This highlights the need for organizational innovation on a European scale. Organizational innovation is as necessary to economic development as are scientific progress and technological innovation.

To meet the needs identified would involve resource-intensive programmes and actions to develop, design and pilot new types of organization. One possible approach could be to seek to apply the concept of "extension" to manufacturing, and perhaps to service sectors in Europe. Agricultural extension workers have been highly successful in modernizing agriculture in several countries including the United States by going out to farmers to promote the use of new technology actively. There are schemes to apply the concept of 'extension' to manufacturing in the United States - appropriately educated and trained workers go out to manufacturing firms and help them to reshape their organizations to facilitate learning. The Manufacturing Extension programme was developed to support the innovative capacities of SME manufacturers within a region. Support included individual project engineering, training courses and assistance in selecting software and equipment (Crow, 1998). Such approaches could be adapted to suit some countries in Europe, and could provide the basis for the design of effective organizations on the scale necessary to meet the needs outlined here.

There is, therefore, an urgent need for research and development followed by pilot schemes to establish organizations able to fulfil such functions in member countries, especially in those where conditions are unfavourable for application of Teaching Company type approaches.

Conclusion

In order to stimulate the European economy it is important to increase the ability of SMEs to innovate. This requires them to learn about new scientific, technological and management developments so that they can apply them effectively. This need cannot be met solely by the provision of appropriate education and training to individuals - although it will become even more necessary for individuals throughout Europe to be better educated in particular fields if SMEs' demand for people with knowledge of new scientific and technological developments is stimulated by measures such as those proposed here.

Keywords
ICTs, skills, life-long learning, learning organizations

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European Agriculture and Future World Food Demand

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Issue: There is a consensus among experts that world demand for agricultural food products will grow significantly over the next few decades and some estimates even suggest it will double over the next twenty years. This is creating strategic challenges for European agriculture with consequences for European food production, transformation and trading structures. With its capacity to generate large food surpluses and to manufacture high quality food products, the European agrofood sector is well placed to take a leading position in the world against strong international competition.

Relevance: In the context of Agenda 2000, the European Common Agricultural Policy (CAP) is being reshaped to address the challenges of the next century. Significant factors to be taken into account on the world scene are local and regional conflicts, migrations, globalization and the WTO constraints, the eastward enlargement of the European Union, sustainable development and increased world food demand. In such a complex situation, short-term considerations must not prevent actors and policy-makers from succeeding with CAP reform and ensuring the sustainable competitiveness of European agriculture.

Introduction

In the past, the so-called "Green Revolution", based on a combination of plant breeding, use of fertilizers and pesticides, better agricultural know-how and irrigation, has enabled mankind to keep up with a rapidly increasing food demand. Today, whether one agrees with the optimists (Dyson, 1996) or the pessimists (Brown, 1994) about the predictions for food needs in the 21st century, it is absolutely essential that we keep up the rate of increase in food production seen in the past if we are to stand a chance of feeding the world population in the decades to come. Unfortunately, most easy gains in agricultural productivity have already been achieved and a slowdown in agricultural yield gains is already being registered.

While 840 million people are estimated to go hungry in the world today –despite the fact that overall production would suffice for all– the USDA (1998) forecasts that 1,140 million people could be facing starvation by 2007. This means there is more than food production at stake. Distribution infrastructures, political stability and economic development are also major factors.

This article intends to highlight the main trends impacting food demand and address the capacity of agriculture to respond to the pressure.

Factors increasing world food demand

- *Population growth and demographic changes*

Studies by leading scientists and organizations such as the UN, the World Bank and UNESCO have forecast significant increases in world population. These estimates suggest world population will increase from its present 5.7 billion to about 8 billion in the next 25 years, with further increases expected thereafter (see Figure 1). Some estimates put the world population at 11 or 12 billion by 2050! This fact automatically implies increased demand for food. Additionally, this increase in population will not be uniform around the world, but will be concentrated in the tropics and subtropics, which are home most of the world's biodiversity and where agricultural land is already limited, meaning that bringing more land under cultivation is likely to be at the expense of forest areas.

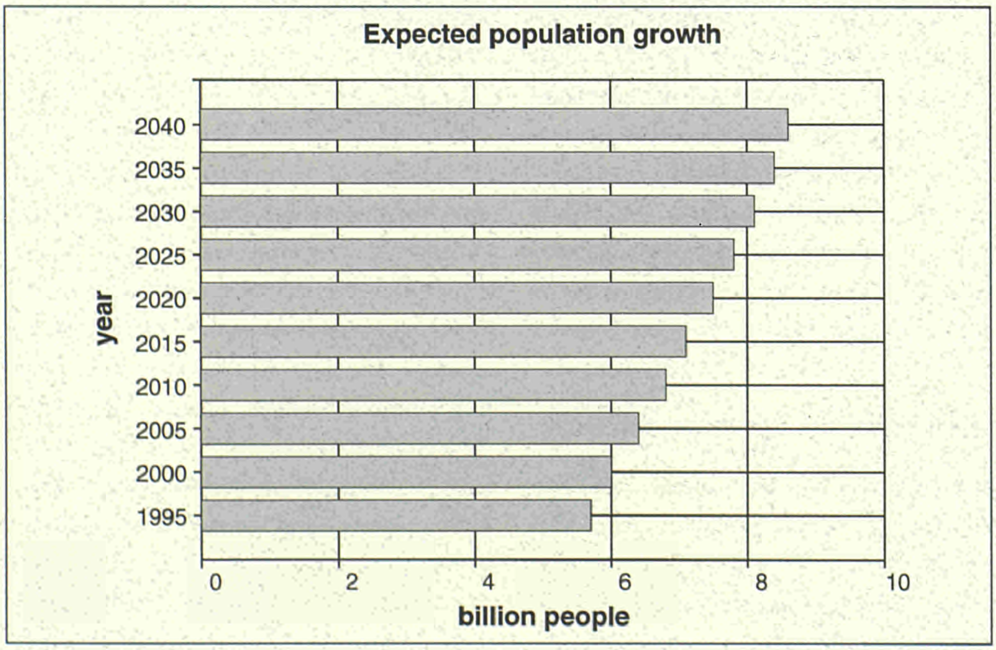
- *Income growth*

About a hundred years ago Americans and Europeans began to step up meat production. Cereals for direct consumption were gradually replaced by cereals for animal feed. In post-war Germany, for example, the general rule was meat once a week if possible, whereas it is now meat every day. In all industrialized countries, every increase in GDP over the last century has been accompanied by a parallel increase in meat consumption. High meat consumption has become a reality for about 500 million people worldwide and is one of the signs of economic success.

A further two billion people currently live in countries which have enjoyed sustained economic growth and are well on their way up the economic ladder. Throughout the world, it is therefore likely that eating habits will continue to shift from primarily vegetarian

Growth in world population will automatically boost demand for food. However, the fact that growth will be concentrated areas where agricultural land is limited will generate even greater pressure

Figure 1. Expected world population growth over the next 40 years (in billions of people, estimations from the World Bank, 1998)



In all industrialized countries every increase in GDP has brought with it a parallel increase in meat consumption. Throughout the world, it is likely that eating habits will continue to shift from primarily vegetarian diets to high-calorie, meat-based ones as economies prosper

The concentrated nature of animal raising industries makes them vulnerable to epidemics sometimes leading to large-scale culls, and as a result to large losses of high value food raw material

The shift in consumption patterns compounds the problem of an overall increase in demand as, for example, it takes around 7 calories in the form of cereals to produce each calorie in the form of beef

According to FAO estimates, improvements in agricultural production in the former Soviet countries could turn them into net exporters by 2010

diets to high-calorie, meat-based ones as economies prosper. These preferences will sustain the important growth of the livestock sector in developing countries and this will continue to drive rapid growth in the consumption of cereals as feeds, which will perhaps double by the year 2010. The US Department of Agriculture expects an increase in world animal products demand from 77 Mt in 1970 to about 250 Mt in 2007.

- *Consumer preferences and other factors*
  Beyond the general trend towards consuming more meat as GDP grows, other socio-economic factors influence change. High-income consumers in OECD countries want to devote less time to the purchasing and preparation of food and are willing to pay for convenience. Wealthy customers also demand freshness and prefer the best cuts of meat, possibly leading to wasting of second choice or low status pieces.

A preference for meat in countries able to afford it gives rise to intensive animal raising industries. The concentrated nature of these industries makes them vulnerable to epidemics, sometimes leading to large-scale culls, and as a result to large losses of high value food raw material. Human health risks can at the same time be significant, as the recent examples of porcine encephalitis in Malaysia, chicken flu in Hong Kong and bovine spongiform encephalopathy (BSE, or "mad cow disease) in Europe have revealed.

Meat consumption, a compounding factor

The increasing number of people to feed is in itself a cause for concern, but when it is compounded with the shifting trend in eating habits, the issue of feeding the world's population becomes a major challenge. The main reason is that as a rule of thumb, for example, around 7 calories in the form of cereals are needed to yield 1 calorie in the form of beef. The ratios are slightly more favourable for chicken and pork, but they do not change the picture radically. Therefore, while average per capita direct (human) consumption of cereals for the world as a whole remains roughly stable, demand for cereals as feed for livestock (indirect consumption) is increasing sharply. This is the main driving force behind the projected growth in aggregated per capita cereal consumption.

Indirect per capita consumption of cereals is projected to increase by about 80 per cent worldwide in the next 20 years (estimates from the International Food Policy Research Institute, 1995), i.e. it is expected to rise from 38 kg per capita to 57 kg. South Asia and Sub-Saharan Africa, the regions with the highest rates of increase in their net cereal imports, are the two regions that face the greatest challenge in meeting food demand. Net imports in sub-Saharan Africa could be multiplied by as much as 4 and in South Asia by as much as 10 over the same period. Overall, it is generally agreed that world food supplies will have to more than double by 2025 to cover demand in terms of both quantity and quality.

Economic issues

The ability of developing countries to finance these rising cereal import costs depends on an increase in their export earnings or "import capacity", and on food aid. Export earnings are linked to general prospects of economic growth and trade liberalization in developed countries, their main export markets. The future of food aid depends on the availability of food surpluses in food-exporting developed countries, such as those of the European Union, and on their willingness — in the face of competing demands — to provide food aid under the rules of the Uruguay Round regime. Furthermore, we have to consider the available global cargo capacities to see whether food distribution on the implied scale will be possible. According to Daimler Chrysler Aerospace AG (1998), air cargo capabilities will increase by a factor of 2.25 between now and 2015.

In this context, the FAO has predicted a major change in the net trade position of the countries of Eastern Europe and the former Soviet Union. By 2010, they are likely to become net exporters of cereals because of more efficient use of cereals as animal feed and of a reduction in the prevailing high level of post-harvest losses. As a consequence, they may be able to offset part of the increased demand from developing countries. A special mention needs to be made of China whose very size is such that its behaviour can drastically alter world supply and demand.

Considering current capabilities, growth in production and net exports from developed countries are expected to be adequate to meet the rising import needs of developing countries over the next ten years. The annual growth rate of food production in developing countries is expected to range from 1.8 to 2.1% against a rate of increase of 2.2-2.4% in domestic consumption (assuming the continuation of current yield growths and the regulatory system). If these trends hold, they will lead to an increase in needs for imports from about 90 million tonnes in 1989-91 to more than double this volume by 2010. After 2010, both the absolute volume of net imports and the ratio of imports to domestic production are projected to rise further in developing countries.

An important aspect to take into account is the elasticity of land use with respect to food prices. If demand rises quickly and prices go up, marginal land may be cultivated to increase output, exerting a downward pressure on prices. This is a compensation mechanism which works well but with some delay because of crop rotation times.

Options for increasing agricultural output

So far, agriculture has always been able to meet the global challenges of increasing food demand by increasing the cultivated surface area, breeding better crop varieties, using fertilizers and pesticides, improving agricultural know-how and developing irrigation.

- *Increasing the cultivated surface area:*
  Today, the most fertile lands in the world are already under cultivation. As the population continues to increase, urban areas grow, new roads are built and factories are constructed. Very often, this occurs at the expense of productive agricultural lands (e.g. Paris, Bangkok and Shanghai). As a result, the potential for increasing the cultivated surface area worldwide is now limited.

- *Using fertilizers and pesticides:*
  Agrochemicals have been the workhorse of the last major yield increases in agriculture. While they are already used to their full potential in industrialized countries and a number of developing countries, some gains can still be expected in the remaining areas. However, the long-term use of agrochemicals is beginning to show adverse environmental and health effects and the trend is towards curbing the reliance of agriculture on them. Again, potential productivity gains are therefore limited.

- *Improving agricultural know-how:*
  Scientific research and technology transfer to farmers have enabled every farmer to feed more and more people over the last 50 years. This has resulted in a drastic decrease in the farming population in many areas of the world, mostly in industrialized countries. Spreading this know-how would undoubtedly bring significant increases in the agricultural productivity of the less favoured areas, but cultural and economic barriers make this very difficult.

Growth in production and net exports from developed countries are expected to be adequate to meet the rising import needs of developing countries over the next ten years

So far, agriculture has always been able to meet the global challenges of increasing food demand by increasing the cultivated surface area, breeding better crop varieties, using fertilizers and pesticides, improving agricultural know-how and developing irrigation

The prospects for biotechnology's providing a significant breakthrough in yield in the next 10-15 years are limited: its major near-term contribution will be to provide greater resistance to pests and diseases and enhanced stability by reducing periodic decline in yields

The agrofoods industry in Europe is facing the dual challenge of Agenda 2000 reform, preparing the way for eastward expansion of the EU, and adaptation to WTO agreements

- *Developing irrigation:*
  In many areas of the world (e.g. Spain, California), irrigation accounts for more than three quarters of total water consumption. In other areas (e.g. the Middle East), water resources are so scarce that little water is available for irrigation. Additionally, large tracts of land cannot be irrigated economically. This means that most of the improvements to be gained by irrigation depend mainly on improving irrigation technology. The area available for additional irrigation is estimated to be limited to 50 percent above the currently irrigated area, 80 percent of which is located in developing countries. Once again, the scope for increased productivity is therefore limited.

- *Breeding better crop varieties:*
  Ever since agriculture appeared, man has applied selective pressures to obtain the desired crop varieties. Breeding techniques have played a major role over the last century to enable agriculture to respond to increasing demands. However, every additional improvement is more difficult and there is a question-mark as to whether the gains in productivity will be able to satisfy increasing expectations.

In view of the challenges of the 21st century (see Box 1), current efforts may be inadequate.

Biotechnology, a possible breakthrough?

The five approaches described above have been able to provide huge improvements, but there is no longer any assurance of their being sufficient to feed the world in the 21st century. A new breakthrough is delivering fresh hopes: biotechnology. This new area includes the design and production of better plants and animals, using modern biological and genetic engineering methods particularly aimed at providing resistance to pests, improving nutrient and water use and developing interesting crop features such as improved nutritional characteristics. This promises to enlarge the scope for use of marginal lands, increase yields on the existing cultivated areas (where most of the effort is concentrated) and reduce the pesticide-related environmental burden of agriculture, enabling it to sustain an increased population.

However, the prospects of biotechnology's providing a significant breakthrough in yield in the next 10-15 years are limited: its major near-

Box 1. Issues to be addressed by the agriculture of the 21st century

- Increasing population and increasing urbanization
- Changes in consumption patterns
- Scarce water resources
- Price swings in food commodities
- Levelling off of agricultural productivity gains
- Decrease in available arable land
- Slowing down of crop yield improvements through conventional seed development
- Changing climate
- Pressure on biodiversity
- Increasingly global economy
- Risks of hunger-related conflicts

term contribution will be to provide greater resistance to pests and diseases and to enhanced stability by reducing periodic decline in yields. Moreover, thorough risk assessment may delay technology transfer to developing areas in need of higher food production. Note however, on the other hand, that such technology transfers may increase technology dependence for less developed countries.

Biotechnology alone is not sufficient to achieve the required productivity improvements. Integrated Pest Management (IPM), Integrated Crop Management (ICM) and finally, Plant Production Management (PPM) are the strategies necessary to achieve sustainable agriculture, and therefore sustainable development.

Optimized and integrated use of all available technologies must be implemented at farm level. Extreme positions, whether organic farming or intensive GMO farming may provide inappropriate solutions. An integrative approach viewing agriculture as an industrial ecosystem may be the best way to safeguard enough food for all in the future.

Opportunities for European agriculture

Agenda 2000, the European policy document preparing the way for the enlargement of the European Union, summarizes the challenges raised by future food demands: *"According to the major forecasting institutes world-wide, the long term outlook for the main agricultural markets is favourable for exporting countries. Prospects for increased food consumption, mainly in developing countries, combined with the limited possibility of a proportional growth in domestic production, are expected to boost world trade and sustain world prices over the next decade."*

European agriculture is now undergoing a major policy-driven transition to adapt to agreements signed under the World Trade Organization (WTO), to prepare for enlargement and to face increasing international competitive pressures. This restructuring must stimulate European farmers and policy makers to look ahead together and identify the opportunities for European agriculture in the 21st century. These opportunities may appear in the form of new markets for European products, smoother harmonization of European agriculture, a positive trade balance, excellence in logistic systems and increased cargo capacities.

The time has come for a substantial discussion of European agriculture to define what agricultural model European society wants to adopt for the 21st century - an agricultural model based on social, economic or ecological factors, or perhaps an integrative model defining different strategies for different European regions.

Conclusions

It is generally agreed that food related agricultural production worldwide will have to more than double by 2025 to meet demand, not only because of the increase in population but also because of a widespread shift in diets towards increased meat consumption. This is creating vast opportunities for those regions of the world able to produce in excess of their needs, such as the EU and the USA. It is also likely to increase the pressure to use biotechnology in agriculture. The policy decisions taken now are therefore crucial to enable European agriculture to seize these opportunities. The future model of European agriculture must fit into a broad European vision which can rally all the actors concerned for the long-term benefit of all. This includes long-term assessment of world food needs and strategies to address them.

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Keywords

food demand, European agriculture, biotechnology

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Biotechnology R&D Policy: Bridging Commercial Interests and Environmental, Distributive and Ethical Concerns

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Issue: In a number of European studies public acceptance has been cited as a key factor for the development of new biotechnologies such as genetic engineering. Governments and private companies who have recognized the importance of acceptance have included information activities in their company strategy and public technology policy. However, the effect on public acceptance of providing more information, creating greater understanding, or even establishing regulations is not always clear cut.

Relevance: It seems to be a prerequisite for biotechnology development that governments, companies and European and international authorities initiate debate on environmental and ethical concerns, and ensure that they are reflected in decisions on biotechnology R&D and technology development. Whilst public inputs to R&D and technology strategy do not guarantee the acceptance of biotechnology in general, they can play a role in limiting the uncertainty related to R&D and development decisions.

The backdrop to technology policy

Since the late 1970s and early 1980s, following the first successful and commercially viable gene transfer between two different organisms in 1973, new biotechnology[1] development, including genetic engineering, has been the subject of R&D and technology policy in most industrialized countries, and the EU-countries are no exception. National and international policies have reflected an optimistic science-push conception of technological development and a view of biotechnology as an important international competitive factor for industry. Thus national public biotechnology R&D has been regarded by these countries as a potential means of boosting competitiveness.

Since 1973 both the scientific and commercial development of new biotechnology and national, European and international regulations governing it have been an issue high on the political agenda. Scientific breakthroughs have also stimulated public debate on the subject. Regulation has been concerned primarily with the environmental and health risks and, to a lesser extent, with other environmental, health and nutritional consequences. Although not specifically regulated, the ethical

The biotechnology industry tends to be understood on a science-push model of technology development and is seen by many countries as an important factor in competitiveness

The potential identified for biotechnology has meant that large government-backed R&D programmes have been set up in a number of countries. Meanwhile, the debate on the issues raised has at times become heated

consequences of new biotechnology are also to some extent covered by other regulations.

The debate is a complex one and has often cut across traditional groupings. In this article we will look at the way in which Danish biotechnology developed up until the mid 1990s.

An example: biotechnology policy in Denmark

As is clear from a large number of scientific, economic and policy reports, biotechnology development has been regarded as science-based and a text book example of "science" and "technology push", i.e. science and technology have been considered to drive forward economic developments in the field. This view has been an underlying factor in the public policy approach of a number of Western industrialized countries, including Denmark. The modest military interest in biotechnology, and the absence of direct public procurement, have been further arguments for public R&D investments to promote new biotechnology. In parallel with the R&D programmes, environmental regulation in Denmark has taken the form of a law on environmental and genetic engineering and a government order on working conditions.

Debates on the risks and consequences of biotechnology have taken place in both the US and most European countries, although they have emphasized different aspects of the field in different countries. The debates have involved groups of various sizes and have varied in intensity, with demonstrations in Germany, the United Kingdom, the US and the Netherlands being some of the stronger manifestations. This atmosphere of protest has been seen by some industrialists and policy-makers as putting a brake on the growth of the sector, and greater information and promoting understanding was suggested as a way of countering perceived public scepticism. In Denmark, the Parliament therefore insisted that information and educational activities be included in the large biotechnology R&D programmes.

The R&D programmes, regulations and the setting up of an Ethical Council were debated between 1986 and 1987, around the same time as the first two companies applied for permission to produce human growth hormones and insulin.

More recently this part of the debate has come to the fore in Denmark and elsewhere as genetically engineered crops and food have become a reality. The focus of public concern has therefore shifted over the course of the 1990s, reflecting new developments in biotechnology. R&D results from released plants and more extensive diagnostic potentials[2] have raised new issues for discussion and questions on regulation. When the EU regulation was introduced in 1991 only a small part of the public participated in the discussions. Furthermore, the discussions did not pay much attention to the regional disparities regarding the consequences of applying new biotechnology and differing agendas for the debate[3].

An example: Danish biotechnology R&D programmes and regulation

In 1987 the Danish Parliament agreed on a concerted action in the form of a large-scale biotechnology R&D programme. The first programme was followed by further government programmes, covering the periods 1987-90, 1991-95 and 1995-99.

In addition to the original programme proposal, information activities and technology assessment activities were included. This was a consequence of a relatively widespread recognition in Parliament that public understanding and acceptance were prerequisites for development. Different interest groups participated in a public enquiry and also the public debates contributed to Parliament's recognition of the scepticism regarding biotechnology's social and ethical consequences.

The Danish biotechnology-related environmental regulation and regulation of working conditions were initiated simultaneously with the first applications for permits to incorporate genetic engineering into production techniques or R&D programmes.

The discussions on regulation largely mirrored events in the US. By the 1980s the ethical dimension of the debate was less prominent than in the 1970s[4], the focus having shifted to environmental risks and consequences. The discussions in Denmark also followed those taking place on regulations at European level, but Denmark introduced its own regulation in 1986, which was then revised in 1991 to comply with EU directives. The Law of 1986 envisaged a voluntary registration procedure, which both the registration committee and a number of different interest groups found to be inadequate because of more widespread use of new biotechnology and because of the fact that some commercially interesting research and applications were not being registered under the voluntary scheme (Statens Jordbrugs, 1982).

Much of the debate seems to have concentrated on regulation and control, with the suggested regulations being focused primarily on environmental safety. Perhaps because of the presence of the legal profession (at least on the ethical council) discussions have focussed on proposing regulation for activities already being carried out or on the point of being carried out. The prioritizing of control has brought with it a focus on the possibility of measuring the suffering of animals by means of technology and natural science-based methods. Regulation of other concerns has been left without a forum. Although the industry argues that the ethical and distributive concerns are not specific to new biotechnology, a number of the debates regarded as essential by diverse interests and individuals have not been included in any framework, either for discussion or regulation.

The debates and their consequences for public perception and acceptance

The notion underlying the public's view of biotechnology is a rather deterministic perception of technology development as something either positive or negative. A positive perception of new biotechnology is accordingly regarded as essential for its competitive development. This was formulated, for example, in Eurobarometer 46.1 (Commission of the European Communities, 1997): *"These changes will bring about many new opportunities, but they will also require that we learn, understand and adapt to the new paradigms they present. For this reason, information, education and a broad discussion of the issues by society must accompany biotechnology's development."*

The notion of public perception can thus be criticized on two grounds: Firstly for disguising the conflicting interests inherent in a deterministic trajectory; and secondly, for presenting a picture of a technology as following a predetermined trajectory indifferent to both scientific, social, public and political influence.

The debate both before and after the setting up of the regulatory regime, in the Danish example above, has revealed conflicts in the assumed trajectory. Despite this, the regulation of both environmental and ethical consequences has to a

Discussions on regulating biotechnology mainly focused on environmental issues, tending not to address ethical and distributive issues

The debate has tended to assume that the technology will follow a fixed trajectory, which must be either approved or not, rather than the idea that this trajectory can itself be modified

Regulation was sought by industry in order to create a stable framework in which firms could operate. However, it has not ensured universal public acceptance of the technology

large extent been regarded as an isolated reaction towards a defined trajectory with predictable consequences. Altering or relaxing the existing regulation of environmental risks and working conditions were predicted only if risks in the adopted regulation turned out to be overestimated.

It was, however, not considered that more radical change in the regulation or new biotechnology strategy could be a possible response to unanticipated or undesirable developments in biotechnology. These unwanted developments or consequences might be both health and environmental risks and more far-reaching environmental consequences, as well as structural, distributive[5] and social consequences.

This regulation appeared not to ensure acceptance. This could be interpreted either as distrust of the regulation and its scope or a failure to address the variety of concerns expressed. In the Danish case, several large companies (particularly pharmaceuticals companies) have claimed that early and strict regulation of genetic engineering benefited competitive advantage in biotechnology by securing acceptance and a stable regulatory regime early on. However, neither in the food and beverage industry, nor in the agricultural sector, has regulation led to public acceptance of the use of new biotechnology. Uncertain or unwanted negative consequences rather than public perception seem to have limited acceptance and consequently potential application.

The influence of the debates that preceded the approval of the large R&D programmes into new biotechnology was exemplary in acknowledging diverse interests in new biotechnology, and in reflecting them in the programme. The actual grant system, however, hampered a more pluralistic influence on the rate and direction of new biotechnology research.

The impression given by a number of indicators is that the effect of debates can be ambiguous and that increasing knowledge and information can lead to a more varied attitude to new biotechnology, but not to general acceptance. Information gives the public insights not only into the technological developments and their applications, but also into the commercial interests behind them, and into their structural conditions and implications. Insight into the role of large firms and the possible strengthening of their economic and political power through the development of new biotechnology may contribute to scepticism.

The European dimension

The Eurobarometer surveys (Commission of the European Communities, 1993 and 1997) and national surveys, such as for example the Dutch SWOKA (Hamstra, 1993) and the Danish Teknologinævnet (Borre, 1991) indicate similar findings of an increased degree of reflection and more nuanced attitudes towards biotechnology as a result of increased knowledge and information. That is, more information and more knowledge cannot be said in general to increase acceptance. In Eurobarometer, 1996 (Commission of the European Communities, 1997) objective knowledge is found to have increased in the 15 European Union countries. At the same time the surveys (Commission of the European Communities, 1993 and 1997) indicate that despite increasing knowledge about new biotechnology, optimism with regard to the benefits in general and within certain areas of new biotechnology has decreased. This finding applies to a number of countries in both northern and southern Europe. That is, also within technological areas which have been and are still viewed fairly positively by the public, optimism has decreased despite a general increase in the level of knowledge.

It should be obvious that the opposite conclusion with respect to information and regulation cannot be drawn: Lack of information and lack of regulation will certainly not lead to acceptance. The claim advanced here is that "public perception" cannot be applied as a general condition for further development of new biotechnology. There are conflicting interests that need to be addressed. Regulation needs to guide private and public biotechnology in socially and politically acceptable directions. Access needs to be given for alternative interests to define research and development paths and ensure variety - at the industrial as well as at the science and technology policy level.

Increased knowledge, wherever it comes from, will entail increasing perception of the risks as well as the benefits, and so may strengthen scepticism and criticism as well as support. However, neither benefits nor other consequences are unambiguous for any of the stakeholder groups. Involving environmental, distributive, economic, social or ethical reasoning might mean it is necessary for new biotechnology development to move at a different pace or in a different direction. However, this gives no guarantee of general acceptance: The potential social and technological outcomes move in parallel with increasing knowledge and changing perceptions, thus both the technology, and the environment which shapes it, evolve.

Instead of regarding questions, criticism and demands as barriers to development, it is sometimes suggested that policy-makers and industry should view these dimensions as contributions to reducing uncertainty in the selection of biotechnology activities to be included in policy-making and strategy formation. The initiatives may include regulation, but more importantly they may change the rate and direction of technology development, and in particular that of biotechnology.

Conclusion

The example of the development of Danish biotechnology policy described here suggests R&D policy is able to make a potential contribution to reducing uncertainty and also to making technology development a more democratic process. It also suggests that regulation and public discussions of controversies potentially reduce uncertainty for industry. At the same time the account also demonstrates that regulation and public discussion are necessary but not sufficient conditions for public acceptance and that political intentions are not necessarily enough to ensure democratic technology development.

In Europe, in general, the debates on new biotechnology development have addressed a variety of factors: environmental risks and consequences and their distribution; distribution of the economic and other benefits and costs between companies and consumers, and between countries; structural consequences and ethical concerns. Predictions and controversies over conditions and consequences of biotechnology development make the debate more than a question of acceptance with a few modifications.

Technology analyses, technology assessments and information activities contribute to the debates and to actual R&D policy and regulation. To some extent they may be regarded as isolated activities rather than part of a continuous process. The account above suggests, however, that both the conditions assumed and the scientific developments are changing, and so assumptions about outcomes must be modified accordingly. It is therefore suggested that democratic debate and better informed policy decisions should be based on continuous technology analyses and technology assessments - with public access to information and knowledge as prerequisites for these analyses, assessments and debate.

Although information does not guarantee acceptance, clearly lack of information and lack of regulation will certainly not lead to it. Conflicting interests need to be addressed and regulations need to help guide the technology in socially acceptable directions

Involving environmental, distributive, economic, social or ethical issues might mean biotechnology development moves at a different pace or in a different direction

Keywords

biotechnology, technology policy, public political influence, technology assessment

Notes

1- The distinction between classical, modern and new biotechnology has been used among others by the OECD (OECD, 1989). The box below is inspired by the OECD's classification.

- *Classical biotechnology*
  Technologies that have been used for thousand of years for the production of beer, cheese, wine, bread etc. mainly on the basis of experience.
- *Modern biotechnology*
  The more science based development of the classical biotechnologies, a development which started in the 19th century.
- *New biotechnology*
  The technologies which developed since the late 1970s including genetic engineering and cell fusion.

2- Though the possibility of gene transfer between released plants and other species was discussed in the preparation of the Danish regulation, it was the actual releases and research documenting the transfers that brought the question of regulation into focus. Also the potential of extensive new diagnostics and treatments had been foreseen in the 1970s, but the actual appearance of the techniques made the discussions of their regulation more pressing.

3- Regarding the release of organisms into the environment, the risk of transfer of genes from specific modified plants to other plants might vary with the flora of the country. Regarding the differences in public discussions, the "problem" that genetic engineering is meant to solve in specific contexts, might be more severe in some countries than others, and people thus more willing to taker greater risks.

4- The discussions of ethics included both the researchers' ethics amidst scientific and commercial interests in an area with potentially large commercial benefits, and the ethical concerns regarding a technology that could transgress biological barriers.

5- The concentration in large (multinational) companies of seed production, for instance, and farmers' dependence on seed and pesticide packages are examples of the distributive consequences mentioned – these issues were raised early on by, among others, the environmental group NOAH and development researchers (see for example NOAH, 1988), and the debate continues with the latest EU marketing approvals (see for example Danish press debates, winter 1998).

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