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The IPTS REPORT

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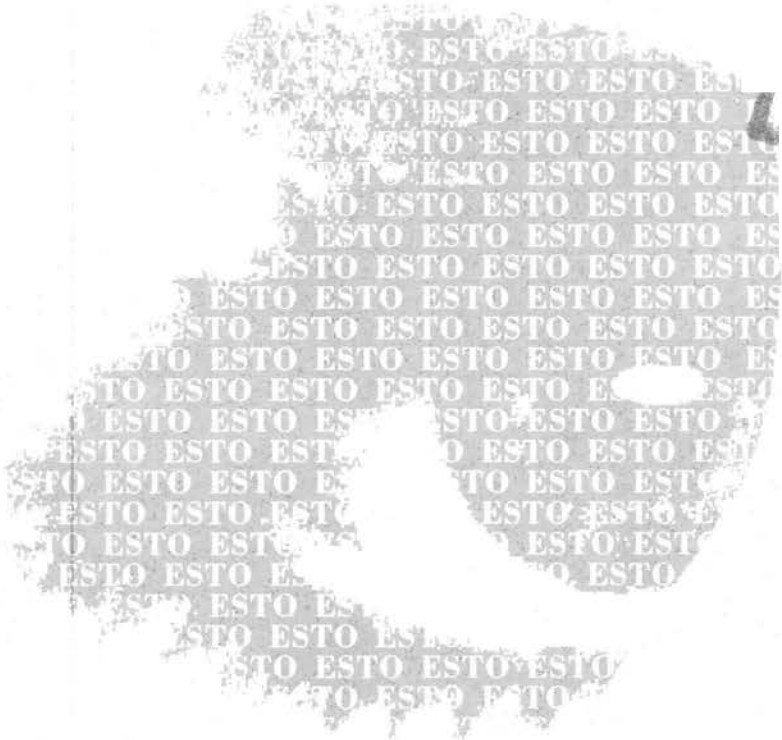

EUROPEAN COMMISSION
Joint Research Centre

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 first, and possibly most significant indicator of success is that the Report is being read. Issue 00 (December 1995) had a print run of 2000 copies, in what seemed an optimistic projection at the time. Since then, circulation has been boosted to 7000 copies. Requests for subscriptions have come not only from various parts of Europe but also from the US, Japan, Australia, Latin America, N. Africa, etc.

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.

Preface

At the beginning of the year, the European Commission approved an initiative to fully exploit the potential of the Common Research Centre (CCR) in technology transfer activities to benefit European industry.

Technology transfer, changing scientific and technical innovation in industrial and commercial successes does, in effect, play a key role in European industrial competitivity

It is a complex process, involving not only technological aspects, but also ones of an economical, financial, legal and social nature.

The action foreseen under this new initiative reinforce the research made in collaboration and encourage network working. It should not be considered as an end in itself, rather as a way of stimulating greater possibilities of exchange opportunities between offer and demand and of promoting innovation, in keeping with the First Action Plan for European Innovation.[1]

This initiative should facilitate access to experience, knowledge and the CCR installations to the benefit of European industry, national organisations and citizens of the European Union.

Erkesson

[1] See the IPTS Report preface no. 12 - March 1997

IMPORTANT

In this issue of *The IPTS Report* we will publish the collective index per issue and in the next we will publish the index by subject of all IPTS Report articles published.

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EDITORIAL

Cloning and interdisciplinarity

Dimitris Kyriakou

We often state at the IPTS Report, ad nauseam one might argue, that interdisciplinarity is part and parcel of our analyses, a term we do not simply pay lip-service to, but rather a non-compartmentalized way of thinking which we cherish and which we believe necessary in order to raise interesting prospective questions. Cloning and the debate it has generated regarding its application to humans will serve here as a test case (admittedly caricaturesque) of drawing from biological and social sciences in order to demonstrate the prospective insights one can produce through exploring issues from interdisciplinary angles. In a sense what we are discussing here is not only ' not seeing the wood for the trees' but rather 'seeing through the forest thanks to the trees'.

The cloning exercise basically involves inserting a cell from a person (e.g. from saliva) into an unfertilised egg, after removing the recipient egg's own genetic material. The recipient egg then performs a reduction operation which is similar to a trip in time: it transforms the DNA of the inserted cell back to as it was when the organism from which the cell was extracted (i.e. the owner of the saliva) was conceived. This way the specialised saliva cell's genetic material becomes 'generalist' genetic material and is able to orchestrate the development of an embryo and eventually a human being. Scientists also suggest that with the right sort of proteins, this development can be directed away from the creation of a human being and towards the creation of specific tissues (e.g. bone marrow genetically identical to its 'parent', and thus easily transplantable).

Note that what is really absolutely necessary in all of this is the recipient egg, without which no such experimentation, lifesaving tissue, and the economic windfall gains to producers of such tissues, would be obtainable.

Let us take this a step further: only women can produce the recipient eggs. In an environment in which there is 'prohibition' against such activities (trafficking in eggs and in the resulting human tissues), prices for the eggs and the resulting tissues will skyrocket (think of cocaine trafficking, or even alcohol during the prohibition period in the US). Women (having a natural monopoly in both senses of the word in the production of eggs) would gain in income in this scenario.

If alternatively, there is no 'prohibition', prices will be driven down, as the procedures become increasingly simpler and affordable and given the very large number of possible legal sellers of eggs, unless airtight collusion among sellers drives supply down and prices up again (think of the case of the OPEC cartel and oil prices in the seventies).

This scenario is a tongue-in-cheek effort to show how unexpected repercussions may arise in the social sphere due to specific S/T choices/developments. It may not teach much about cloning, it may however demonstrate the possibility of bringing together different strands of analysis in projecting future impacts of S/T developments.

Urban Wastewater Treatment in Europe: What about the Sludge?

Laurent Bontoux, Miguel Vega and Demosthenes Papameletiou, *IPTS*

Issue: The implementation of the European Urban Wastewater Treatment Directive (91/271/EEC) is leading to a rapid multiplication of waste water treatment plants across Europe, producing increasing quantities of sludge. At the same time, disposal at sea is being banned, the landfill directive project restricts the possibility of landfilling organic material, and environmental and health concerns lead the farming profession to become more and more reluctant to spread sludge on land. To date, these were the main disposal routes for sludge. A way forward needs to be found.

Relevance: The simultaneous implementation of various areas of European environmental policy combined with environmental and public health fears could create a large problem for the management of sludge from wastewater treatment. The issue carrys important public health and environmental risks, striking sensitive chords now that the fear of pervasive and insidious chemical pollution is rising. Therefore, a combination of appropriate policy and technical responses at European level are rapidly needed.

Introduction

The most common municipal wastewater treatment technology applied in Europe is the *activated sludge process*, a biological process consuming large amounts of energy and generating large amounts of organic sludge. This sludge, separated from the treated water in the last stage of the process, contains more than 90% water and is highly biodegradable. Dewatering processes are usually applied to facilitate sludge handling and disposal. Until now, the main disposal routes were landfilling, spreading on land, disposal at sea (mostly in the UK), and incineration.

However, times are changing and limitations are appearing on all the sludge disposal routes. Restrictive waste disposal legislation linked with concerns on the potential health and environmental risks of spreading sludge in crop-fields are rendering the sludge disposal problem more acute. Simultaneously, activated sludge wastewater treatment plants keep being built in compliance with the wastewater directive and will foreseeably continue to function as "sludge factories" in the long-term with an unstoppable output. It is therefore essential to find safe, affordable and sustainable outlets for sewage sludge.

As of the beginning of 1999, disposal of wastewater treatment sludge at sea will be banned. The current restrictions being proposed for landfilling aim at excluding any organic waste from this disposal route. Incineration is expensive because of the amount of water to be eliminated from the sludge. Potentially, the most attractive option could be spreading on agricultural land

The disposal of sludge, generated by the activated sludge process, currently the most common form of wastewater treatment, is becoming critical in view of restrictions being introduced to restrict its disposal routes

because it may recycle nutrients and have a useful agronomic value. However, because of the physical-chemical processes involved in activated sludge wastewater treatment, the sludge tends to concentrate heavy metals and poorly biodegradable trace organic compounds (e.g. pesticides, household chemicals, etc.) present in the wastewater. This raises both public health and environmental issues. Another issue is the availability of enough agricultural land near sludge production centers to avoid transportation costs.

Given this lack of total safety, there is an increasing trend among farmers to be reluctant to spread sludges on their land. More and more "niche markets" (e.g. health food, baby food, vegetable canning) expressly require their suppliers to forbid the use of sewage sludges.

What is often overlooked is the cost of handling the huge quantities of sludge produced by the large treatment plants necessary to treat the enormous volumes of wastewater, and how the sludge can be managed in a safe, practicable and sustainable manner. In some cases, sludge treatment and disposal account for up to half of the overall wastewater treatment costs.

Of the four main disposal routes, disposal at sea will shortly be inoperable, landfill will be severely restricted, incineration is costly and spreading on agricultural land raises health and environmental concerns

We need to take a fresh and serious look at the issue. Quality standards need to be achieved by the sludge to be spread on land and alternative treatment and disposal technologies need to be considered for other types of sludge. This highlights once more the need for good coordination of the various areas of European environmental policy.

The activated sludge process and product

The concept of "secondary treatment" of wastewater is based on the activated sludge process. In this process, organic matter from sewage is oxidized and transformed into microbial biomass by a wide range of organisms. This is generally performed in a large aerated tank where sewage and microorganisms remain in contact for a few hours. This mixture then overflows into a settling tank where the microbial flocs (aggregates) fall to the bottom and the treated wastewater flows over the weir. The flocs accumulated at the bottom of the tank are then extracted as sludge. Part of it is recycled to the aeration tank to maintain the process, while the excess sludge, produced by microbial growth, must be eliminated.

In most cases, this process is preceded by a primary settling operation which also generates organic sludge, albeit of a slightly different nature. This primary sludge must be eliminated with the excess secondary sludge. Another important element to mention is the fact that sludge quality is not constant. It varies according to the design characteristics of each plant, the type of wastewater treated, the industries connected, the season, the weather, the location of the plant, etc. It is the elimination of this excess sludge which constitutes the topic of this article.

The EU *Council Directive concerning urban wastewater treatment* (91/271/EEC) requires, by the end of 2005 at the latest, every agglomeration of more than 2,000 population-equivalent discharging to surface fresh water and estuaries, and of more than 10,000 equivalent inhabitants discharging to coastal waters, to apply at least secondary treatment to its wastewater before discharge.

To comply with this directive, most municipalities choose the well-known activated sludge technology for three main reasons: compactness, reliability and efficiency (if it is properly operated and maintained). However,

this technology produces large amounts of sludge. The current estimate for the EU is 6.5 million tonnes per year, expected to reach 15 to 20 million tonnes by 2005. The corresponding increases in each EU Member State range from 40% to 300%!

The waste sludge must be treated to facilitate handling and to avoid potential problems from odour and pathogens. These treatments modify the sludge properties making them more suitable for reuse or disposal. Among these processes are: thickening, disinfection, stabilization, conditioning, dewatering, thermal drying, composting and others. After treating the sewage sludge the following products are obtained: liquid sludge (stabilized or raw), solid sludge (stabilized or raw), dried sludge and compost. The sludge treatment and disposal costs accounts for up to half of the total costs of sewage treatment and they are likely to increase due to the tightening of European legislation.

Because of the physico-chemical characteristics of the activated sludge process, the sludge tends to accumulate a number of metals and organic compounds. This property is an advantage when one looks at the quality of the treated wastewater but it makes sludge quality dependent on essentially 4 main groups of contaminants:

Metals

Mainly zinc (Zn), copper (Cu), nickel (Ni), cadmium (Cd), lead (Pb), mercury (Hg) and chromium (Cr). Their potential accumulation in human tissues and biomagnification through the food-chain create both human health and environmental concerns. Metals are always present at low concentrations in domestic wastewaters but concentrations of concern come mostly from industrial wastewaters.

Major plant nutrients

They are nitrogen and phosphorus. They are a concern because of their eutrophication potential for ground and surface waters. However, they can be viewed as a valuable fertilizer while their main agronomic value remains in their high organic matter content. In the identified sensitive areas, the wastewater directive requires tertiary wastewater treatment (nutrient removal). These treatments also produce sludge, always high in nutrient content and of a varying nature according to the processes used.

Organic contaminants

Pesticides, industrial solvents, dyes, plasticizers, surfactants and many other complex organic molecules, generally with low water solubility and high adsorption capacity, tend to accumulate in sludge. Even polynuclear aromatic hydrocarbons (PAH) from the combustion of fossil fuels are present in sewage sludge. These cause concern about their potential impacts on the environment and particularly on human health. A specific character of this category of contaminants, compared to the previous two, is their (varied) potential for biodegradation. Many of these molecules have a slow but measurable biodegradation potential. Therefore, biological wastewater treatment systems with longer residence times will have an increased power to biodegrade these undesirable compounds. Biodegradation can also occur after land spreading or during composting.

The WHO Working Group on the Risk to Health of Chemicals in Sewage Sludge Applied to Land concluded that "the total human intake of identified organic pollutants from sludge application to land is minor and is unlikely to cause adverse health effects". However, in spite of a recent increasing level of investigation,

Although the activated sludge process is the most commonly used wastewater process, it generates a large amount of waste sludge which then has to be treated for reuse or disposal: a cost representing half of total sewage treatment expenditure

The four main groups of contaminants in sludge are metals, major plant nutrients, organic contaminants and pathogenic agents

The WHO concludes that the total human intake of identified organic pollutants from sludge application to land is minor and is unlikely to cause adverse health effects

the ecotoxicological role of organic contaminants in the soil-plant-water system and in the food chain is still not clear.

Pathogenic agents

Bacteria (such as Salmonella), viruses (notably enteroviruses), protozoa, trematodes, cestodes and nematodes are the most significant water-borne pathogens found in sludge. As a result, any safe disposal of sludge requires the elimination, or at least the sufficient inactivation of these pathogens. A range of treatments can be applied to the sludge to this end, such as pasteurization, aerobic or anaerobic digestion, composting, lime stabilization, liquid storage and dewatering and dry storage.

Sludge disposal routes

The traditional disposal routes for sewage sludge are:

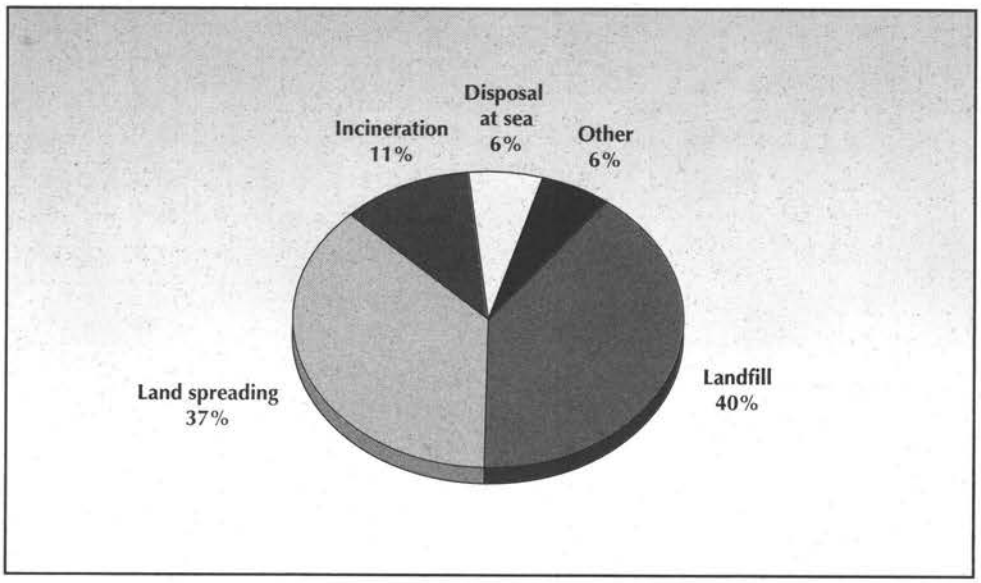
Landfill

Over the last decades, landfill has been (and still is, see Figure 1) a widely used disposal route for sludge. However the new proposal for a Council Directive on the Landfill of Waste is changing this perspective. This proposal aims at reducing gradually until the year 2010 the total amount of biodegradable wastes to landfill to less than 25% of the total amount (by weight) of biodegradable municipal waste produced in 1995. Such a strong reduction will probably not be accepted in the end (a figure of 35% has been proposed), but the general trend is set. This new situation will push forward the development of alternative sludge disposal routes.

Land spreading (agriculture)

The application of sewage sludge to farmland is possibly often the cheapest sludge disposal option. It can be compared to what is traditionally done with a wide range of organic wastes spread on land such as manure or livestock wastes. It provides an opportunity to recycle beneficial plant nutrients and organic matter for crop production. Moreover, it seems that the application of sludge to soil may in many cases improve the physical properties of soil, leading to increased crop productivity.

Figure 1. Disposal of sewage sludge in the EU in 1994



Source: *S.R. Smith; Agricultural Recycling of Sewage Sludge and the Environment*, CAB International, UK, 1996

However, care must be taken that chemical or pathogenic contaminants present in sludge do not cause adverse effects. For example, heavy metals concentrations in sludge are mostly larger than those in the soil and these elements may be retained indefinitely in the cultivated soil layers. Therefore repeated applications of sludge will gradually increase the trace element content of soil. According to the application rate of the sludge and the metals concentrations, a time can be calculated (usually 70 to 80 years) after which the maximum permissible concentrations for each of the regulated elements in the soil are reached. After that period, sludge can no longer be applied safely. Zn, Cu and Hg are the principal elements limiting sludge recycling to agricultural land while Cd raises specific questions due to its toxicity and variable mobility.

The Cation Exchange Capacity (CEC) is the main soil property controlling the retention and toxicity of metals in sludge-treated soil. Consequently, regulations for spreading sludge on agricultural land must take into account the establishment of different sludge application limits for toxic metals. The CEC depends on pH, organic matter content and soil texture. However, the absorption capacity of plants depends on soil properties and farming practices. Spinach, celery lettuce and carrots are likely to be the crops most at risk from accumulation.

Incineration

Although it is the most expensive outlet, is frequently used simply because it reduces sludge volume by more than 90% while producing a

The four traditional sludge disposal technologies in Europe are landfill, spreading on agricultural land, incineration and disposal at sea

Table 1. Disposal of sludge within the EU in 1992

Country	Quantity (x1000 dry tonnes per year)	Agriculture (%)	Landfill (%)	Incineration (%)	Sea (%)	Other (e.g. forestry) (%)
Austria	170	18	35	34	0	13
Belgium	59	29	55	15	0	1
Denmark	170	54	20	24	0	2
Finland	150	25	75	0	0	0
France	865	58	27	15	0	0
Germany	2680	27	54	14	0	5
Greece	48	10	90	0	0	0
Ireland	37	12	45	0	35	8
Italy	816	33	55	2	0	10
Luxembourg	8	12	88	0	0	0
Netherlands	335	26	51	3	0	20
Norway	95	57	43	0	0	0
Portugal	25	11	29	0	2	58*
Spain	350	50	35	5	10	0
Sweden	200	40	60	0	0	0
Switzerland	270	35	30	25	0	0
UK	1107	44	8	7	30	11

* Disposal to surface waters

Source: Adapted from P. Matthews and K.-H. Lindner, "European Union" in *"A Global Atlas of Wastewater Sludge and Biosolids Use and Disposal"*, P. Matthews (ed.), Scientific and Technical Report nº 4, IAWQ, UK, 1996

mostly mineral ash (< 5% organic matter) that can be landfilled. In spite of specific environmental concerns, incineration is widely expected to increase due to the restriction on the organic content of landfilled material.

Disposal at sea

The disposal of sludge at sea has been one of the most popular routes in both the UK and Spain, but will be banned at the beginning of 1999. The risk of repetition of problems such as the Minamata affair, in which hundreds of people were affected by excessive concentrations of methyl mercury in the marine food chain, have pushed to ban this outlet. The issue concerned was the biomagnification potential of certain elements present in sludge.

All European countries have been relying on these various disposal routes in different respects. Table 1 gives the respective statistics for 1992.

Alternative disposal routes already exist or are being developed. They fall into four categories:

The four major alternative sludge disposal routes are land application, energy recovery, mineral recovery and composting

Land application

Low organic matter content (either natural or through losses) is a major problem in ensuring the maintenance of good water retention properties in soil. Sludge solids may be used to maintain, restore or create soil fertility, as well as appropriate soil-structure in degraded land. As mentioned above, heavy metals can have detrimental effects on crops and human health if allowed to accumulate beyond established safe limits. The potential risks are reduced in the soils from arid areas because they are mostly alkaline and minimize crop uptake of many elements such as heavy metals. A major sludge reuse study, funded in the frame of the Mediterranean Environmental Technical Assistance Program (METAP) by the European Investment Bank, and promoted by the Cairo Wastewater Organization, began in 1995.

Forestry has a huge potential to absorb sludge in the future. Its main advantage is the possibility to require less stringent standards than agricultural applications. Nevertheless this disposal route highly depends on regulatory support.

Energy recovery

The construction of the first commercial scale oil-from-sludge plant began in Australia in 1997. The process mimics nature by thermochemically converting sludge to oil, tar, gas and water. The oil produced is similar in nature to a middle distillate fuel and can be used to fuel both internal and external engines. The tar and gas produced are burned to dry the sludge prior to processing in the conversion reactor.

Anaerobic digestion of sludge is already widely used thanks to its ability to produce methane gas (for power production) and a more stable, easily dewatered sludge. Important trends in the anaerobic digestion towards the reactivation of the digestion process are: ultrasound treatment and special thickening centrifuge prior to digestion.

Mineral recovery

In Japan, recent legislation restricts the landfilling of ash that contains heavy metals (such as ash from incinerators). This lead to the development of the "sludge melting" technology. This process vitrifies the sludge in a combustion chamber at 1400º C. This offers a means of stabilizing and minimizing the volume occupied by sludge, as well as offering the potential for reuse as a construction material (cement, glass ceramics, crystallized slag, etc).

In Europe, examples already exist of the use of wastewater treatment sludge in cement kilns. However, a new application is appearing: the fabrication of bricks for construction using sludge. A first full scale industrial project has started in Spain consuming about 18 tonnes of sludge solids per 200 tonnes of bricks produced.

Composting

The composting of sludge for inclusion into soil mixes for urban landscaping purposes is an important avenue for the disposal of sludge solids. However, these products are not allowed for home landscaping and cannot to be sold in bags to the general public. Another technology, vermicomposting is also promising. Development work at a number of plants in Poland has demonstrated the effectiveness of earth worms in degrading treated sludge to a non-odorous, humus-like material with high agricultural nutrient value.

Producing less sludge with alternative wastewater treatment processes

There are other biological processes than activated sludge that provide secondary wastewater treatment: trickling filters, rotating biological contactors, oxidation ditches, ponds, etc. They all produce sludge, albeit in smaller amounts than the classical activated sludge process. Each has its specific performance characteristics and none can fully replace the activated sludge process. However, more attention could be paid to them at the hour of choosing a new wastewater treatment facility in cases where sludge disposal is problematic. In the case of the activated sludge process, a low organic load will result in a smaller sludge production than a high organic load.

Other solutions have also been presented. In Japan, for example, a full-scale prototype activated sludge plant has been operating successfully for nine months without producing surplus sludge. This has been achieved by ozonating a portion of the returned activated sludge in the wastewater treatment plant, increasing its biodegradability and promoting biological oxidation within the aeration tank.

Sludge quality standards

Of course, each set of sludge quality standards must correspond to each disposal route. However, so far, the disposal of sludge on agricultural land is the only option which has seen any standard setting activity at the European level. These standards are stipulated in the European Directive 86/278/EEC concerning the protection of the environment, and in particular of the soil, when sewage sludge is used in agriculture.

This directive limits the total amount of several heavy metals depending on the pH of the soil. Nevertheless, it contains only minimum requirements permitting stricter national measures. An overall assessment of the land spreading outlet may bring together all aspects such as human health, crop yields, animal health, groundwater quality, surface water quality, air quality, soil fertility and natural ecosystems.

Therefore, an extension of this directive could be desirable especially to other pollutants such as chromium, selenium, arsenic, fluoride, molybdenum, cobalt, dioxin, PCBs, AOX, PAH, chlorinated solvents and other organic chemicals. It may also be complemented by a Code of Practice for Agricultural Use of Sewage Sludge, a measure already taken by the UK government and called for by the European nitrates directive (91/676/EEC).

Directive 86/278/EEC limits the concentration values of heavy metals in both sewage sludge and soil (see Table 2).

The generation of lesser amounts of sludge can be achieved through the use of alternative wastewater treatment processes, such as trickling filters, rotating biological contactors, oxidation ditches and ponds, although none can fully replace the activated sludge process

As alternative disposal technologies are considered, a need for new sludge quality controls or the expansion of existing ones will arise

Table 2. Limit values for potentially toxic elements given by Directive 86/278/EEC

Parameter	Limit values in soils (mg/kg dry soil)	Limit values in sewage sludge (mg/kg dry solids)
Caldium	1 - 3	20 - 40
Copper	50 - 140	1000 - 1750
Nickel	30 - 75	300 - 400
Lead	50 - 300	750 - 1200
Zinc	150 - 300	2500 - 4000
Mercury	1 - 1.5	16 - 25

Current scientific evidence indicates that detrimental effects on human health from the agricultural use of sludge are unlikely. The high accumulation of sludge cadmium in crops could be potentially harmful

The WHO believes that when land application operations are managed properly, accumulation of pollutants in soil can be managed so that they will not reach levels harmful to human health

In spite of certain limits for organics set in Germany and Denmark (e.g. dioxins, PCB, AOX), there are no limit values set for trace organic contaminants in sludge or soils within the current European legislation concerning sewage sludge (in December 1997, France proposed a new legislation which includes provisions for some organics contaminants). Nevertheless, the US Environmental Protection Agency has already selected 18 organic pollutants - in the standards for the use or disposal of sewage sludge - for further evaluation by risk analysis of environmental exposures. The selection criteria considered were frequency of occurrence, aquatic toxicity, phytotoxicology, human health effects, domestic and wildlife effects, and plant uptake.

The scientific information available supports the conclusion that detrimental effects on human health arising from the agricultural use of sludge are unlikely. The main heavy metals of concern are Cd, Pb and Hg. Pb and Hg are not absorbed to any extent by crops and consequently do not pose a risk through the dietary intake of foods grown in sludge-amended soil. On the other hand, Cd is not subject to the soil-plant-barrier and can accumulate in crops to concentrations which may be potentially harmful.

Sludge application to land aims to take the maximum advantage of the soil's capacity to assimilate, attenuate and detoxify pollutants. The World Health Organization (WHO) believes that when land application operations are managed properly, accumulation of pollutants in soil can be managed so that they will not reach levels harmful to human health.

Contamination of groundwater by leaching of nitrate from sludge-treated soil, is probably the most important impact arising from the agricultural utilization of sludge in the context of current environmental legislation. Nevertheless, assuming that the total amount of nitrate (from sludge and other sources) remains in accordance with the nitrogen requirement of the crops being grown, nitrate pollution of groundwater should stay minimal. The WHO concluded that no numerical limit should be set for the nitrogen content of sewage sludge.

An important concern currently arising is the presence of persistent organic contaminants in the sludge and their behavior in the soil-plant system. So far, the risk to human health from crops grown on sludge-treated soils appears to be small because there seems to be little or no plant intake of organic contaminants and no bioaccumulation in livestock.

Conclusion

In view of the increasing production of sludge in Europe and the simultaneous tightening of waste disposal practices, the likely preferred choices for sludge disposal in Europe for the medium-term will be chosen between land spreading (agricultural or other) and incineration. The practical choice will be made locally according to many cultural, economic and scientific parameters.

So far, there is general agreement that agricultural use can be a safe and viable option. It is certainly one of the more likely ways forward, although in some countries such as France, Germany, Sweden, and the Netherlands, fears about the effects on soils and crops are disabling this outlet. These countries, especially Germany, are developing new technologies for incineration of sludge. In other countries such as the UK, sludge use for land spreading is encouraged. In Sweden, life-cycle assessment studies of some wastewater treatment facilities identify sludge reclamation in agriculture as the best option in some cases.

In several Member States such as UK there has been a tremendous focus on developing robust control policies and practices to protect the security of the land spreading option. However, at the EU level there is a lack of a more coordinated approach to regulating sludge application to agricultural land. To date, it is up to each Member State to implement a secure and cost-effective disposal strategy for sludge.

This state of affairs highlights the need to ensure the safety of sludge spreading on agricultural land and to reassure those who already practice it or are susceptible to do so in the future. To this end, the quality of sludge is important, starting at the discharge of wastewater to the sewers, and an efficient control of this quality must be enforced. It may be useful, therefore, to encourage the treatment of certain industrial effluents separately from domestic wastewater in cases where this is not already done, or to pre-treat them before release to the sewers in order to remove excess concentrations of undesirable elements such as heavy metals.

Further research in the implication of the agricultural and incineration outlets for the environment is needed, as well as a sound scientific coordination to drive the current investigations.

It is vital that adequate information on sludge production, treatment, outlets, products and markets be available. Therefore the time for defining reasonable standards for sludge uses, as well as for wastewater re-use, has come. The classification of sludges into well defined quality classes, adequate for each disposal or re-use option must guarantee a safe use and disposal. Sound environmental criteria should be devised for each option. A possible basis for such standards need to include risk assessment.

The simultaneous increase in sludge production and tightening of sludge disposal technologies will lead to the probable development of the two alternative systems of land spreading and incineration, according to country

Now is the time to define concrete standards pertaining to sludge disposal, including its safety aspects, uses and possible environmental and human effects

Keywords
municipal wastewater treatment, sludge management, environmental legislation, european perspectives

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Exploring Environmental Standards Co-ordination within the EU

Michalis Vassilopoulos, *IPTS*

Issue: As a result of European unification and market integration, harmonization of environmental regulation may be attempted across EU Member States in order to allegedly guarantee the proverbial "level playing field". The questions that arise, however, concern the potential and practicability of environmental policy co-ordination and how these policies and/or strategies should be implemented to maximal overall benefit.

Relevance: A combination and/or mix of appropriate European-wide environmental policies may be needed to address the multi-stage - multi-player strategic interactions involved. Unfortunately, there exist significant technological, financial and environmental asymmetries among the fifteen Member States which need to be smoothed in order to reach consensus and guarantee enforceable agreements.

Introduction

Since the times of Adam Smith and David Ricardo , economists have always regarded international free trade as a source of wealth and welfare gains. The existence of trade and the exchange of products and commodities promotes patterns of specialization among countries that specialize in producing according to comparative advantage. Thus, all countries end up producing more efficiently and the benefits accrue to all (Krugman 1987). Europeans adhered to these fundamentals when they created the European Union (EU) and envisaged a Common Market.

Nevertheless, these tenets have been repeatedly challenged by other economic theorists advocating optimal tariff clauses and infant industry arguments. Lately, free trade has also been attacked by environmentalists in conjunction with advocates for industry. The former assume the destructive force of trade for the global environment stemming from over-consumption, global trade of waste, increase in transportation and relocation of mobile factors to "pollution-havens". The latter advocate protectionist measures to compensate for loss of competitiveness to developing countries (Snape 1992).

Stevens (OECD 1993), summarizes these theories. She presents the interaction between "push" and "pull" factors in the relationship between environmental policies and industrial relocation. The **push-theory** or **industrial flight** hypothesis focuses on the migration of polluting

Although product standards are in place, process standards are not as well developed and if their future use is not monitored by international arbitrators ,they may be used as protectionist barriers

industries from countries with strict environmental regulation to **pulling countries** which purposefully set low standards; the **pollution haven** hypothesis.

Available evidence does not allow a definitive judgement. Although there are **product standards** in place (applied in situations where the consumption of the imported good or its utilization as a factor of production causes environmental damage in the importing country), which address a wide range of goods, process standards (enforced in so far as the way a good is produced employs environmentally unsustainable or harmful practices) are very limited. Product standards can be used strategically to shift foreign profits towards domestic industry (probably hurting domestic consumers in the process), while **process standards** may provide means for disguised trade distortions. But, only the Montreal Protocol, signed in 1987, contains the possibility to punish agents that not only produce ozone depleting manufactures, but also use such substances in the production of other goods.

It is worth mentioning is that if the use of product and process standards are not sufficiently monitored by an international arbitrator, their future use might signal a new era of protectionism. That is particularly the case when members or signatories of GATT, EU or NAFTA are induced to abolish or reduce all other protectionist measures in place (tariff and non-tariff barriers). The NAFTA Treaty already provides for some harmonization of environmental standards. Tendency to harmonize process standards is also currently viewed at EU level (i.e. through the IPPC Directive), albeit not yet formalized.

Empirical studies as to whether the introduction of measures protecting the environment generate higher production costs, lower productivity and lower profits are rendered obsolete due to lack of reliable data

The Empirical Evidence

Conventional wisdom dictates that measures imposed on firms to reduce pollution or otherwise protect the environment may increase the costs of production, reduce productivity and/or lower profits. A country adopting strict environmental regulation may end up importing products in which it formerly enjoyed a competitive advantage, while exporting related jobs, pollution, and profits to other countries that enact more lax environmental standards (Baumol and Oates 1988). Nevertheless, the authors also note that conventional wisdom could also be false when demand is highly inelastic and regulation improves the country's terms of trade. That is when high value added differentiated products come into question.

In the developed world, however, potentially high compliance costs may have been offset by exemptions, rebates, credits or grants, subsidies, time deferrals, all of which have eroded the effectiveness of environmental policies on production costs. Hence, the impact of these significant investments undertaken may be undetectable and/or ameliorated, especially if marginal costs can be accounted for downstream or distributed over the entire economy. Therefore, empirical studies are rendered obsolete due to lack of reliable data. As long as the parameters are unknown, economic theory provides a pool of policy recommendations from which one can choose what he/she likes.

The reader may, nevertheless, resort to literature reviews like those of OECD (1993), Patrick Low (1995), and Jaffe et al. (1995), among others, which demonstrate a wide range of studies and different methodologies of assessment. To sum up, the majority of the studies mentioned analyse aggregate effects on productivity, trade, and investment. The effects on competitiveness are found negligible. They do not usually represent more than 1-2% of Gross Domestic Product (GDP) in countries with strong environmental policies. The most affected sectors, however, score high on the list, reaching even 8%

of production costs (environmental investments may also represent 25% of the cost of a new coke plant in the iron & steel industry). Nevertheless, most trade of intermediate goods (70%) still takes place within OECD countries in a intra-industry setting. The numbers are not totally insignificant when the aforementioned intermediate bulk and capital intensive products, such as basic chemicals, minerals and metals are considered.

Some environmental- close up intensive industries (metals or basic chemicals), may have partially relocated, but this is more due to the existence of factor endowments and/or market growth in other developing countries or product phase-out in developed ones (i.e. asbestos, benzidine dyes). However, this can be easily explained by the rapid market growth which took place in the developing world. As economies industrialize, "dirty industries" tend to represent a larger share of their economic activity. These industries usually represent great parts of a country's manufacturing base and this growth phenomenon should be considered natural. One may also argue that the same countries were net importers of these products in the past, but as their markets expanded Foreign Direct Investment (FDI) was necessary to better serve local needs. Another important criterion, following the same line of thought, is factor endowments where- a country rich in a resource attracts relevant industry. One cannot advocate that Europe lost its competitiveness in petroleum extraction or even petrochemicals if the same products are manufactured in Saudi Arabia. Neither can the US- assume a deteriorating copper industry if FDI is directed towards Chile (holds 20% of all known copper reserves).

Most other sectors do not seem to be affected by increasing environmental costs. Once products are differentiated or high value-added, then environment is no longer a reason for concern. In fact, if environmental costs are successfully absorbed downstream, a country may even improve its terms of trade and overall comparative advantage. Environmental costs would, in that case, be considered as value added in products whose demand is not so sensitive to price differences.

The "Porter Hypothesis"

To this end, Porter and Van der Linde (1995) conduct a series of case studies and find that forerunners of environmental technologies implementation have encountered significant benefits from waste minimisation, increases in efficiency, optimisation and quality. Moreover, the same companies or countries that adopt stringent standards are assumed to gain first-mover advantages in the fast growing market for environmental technologies.

Porter's assumptions of inefficiencies in companies may have some merit for oligopolistic incumbent firms. A better performance can be achieved by any exogenous shock (an abrupt increase in the price of a resource by fully internalizing the environmental costs associated with its extraction and/or use), but is environmental policy, necessarily, the best tool to achieve better performance? It is not unclear whether a government knows better how to make a firm more profitable. Such firms may arguably need investment in R&D to upgrade their products.

In essence, Porter's meritorious idea provides sound political arguments to reduce the influence of industry lobbyists towards sound environmental standards. Moreover, the use of market-based instruments (MBI) may work better when innovation is endogenous and rent-seeking behaviour by industry needs to be diminished. A recent application of Porter's philosophy can be found in the implementation of the Clean Air Act

In studies on the subject, aggregate effects on productivity, trade and investment and effects on competitiveness are found negligible

Few sectors appear to be affected by increasing environmental costs. Once products are differentiated or high-value added, then environment is no longer a reason for concern

Although the need to improve environmental effects on an EU global level is unquestionable, this is rendered difficult given the diversity in nature of EU countries and the interests of those most benefiting from them

As EU enlargement proceeds, the need for co-ordination of environmental policies will be the buzz word of the next century in Europe

Fears of industrial relocation and strategic disadvantage should tend to decrease in a Single Market. It is unthinkable to consider the EU facing major competitors without strategic consensus

(OECD 1993) in the US, whereas territories were identified at different stringency levels and a market for permits was set up. The results, though slow to emerge, are expected to be fruitful both for polluters and pollutees.

The use of taxing schemes and MBI to create incentives for increased R&D may be one solution. Unfortunately, MBI is not applicable to all pollutants. Implementation may be successful for air emissions, but what about soil? Most importantly, the current integrated approaches and overall environmental remediation, under the framework of the IPPC Directive, are far too complicated for the use of MBI. Further research is, therefore, needed to assess the potential of market-based instruments over command and control when policies address more than one media and/or the environment as a whole.

The EU Context: A Multi-Stage - Multi-Player Interaction

The European Community is far less homogeneous than the US: it consists of countries with relatively diverse industrial structures, financial abilities, and sizes. The environmental problems do not always coincide. Some countries' environmental absorption capacity is larger than others, though one should assume - if not identical - at least similar attitudes towards environmental quality among citizens. Similarly, environmental effects can be subdivided into the categories of global (i.e. CFCs, CO_2), trans-boundary (i.e. SO_2, NO_x), and local (i.e. water pollution). Attempts to harmonize environmental standards are naturally constrained by governments', producers', and occasionally individuals' interests as to where the rent shifting benefits will occur and what the welfare benefit will be in financial and ecological terms. It is admitted, nevertheless, that the need for harmonization to ameliorate global and/or trans-frontier problems is unquestionable.

However, as enlargement proceeds, the need for co-ordination of environmental policies (also at the local level) will be the buzz word of the next century in Europe. The effectiveness and efficiency of economic instruments vs. command and control in a Europe of multiple speeds and environment capacities will have to be explored.

Strategic Concerns

Some would argue that it is extremely important to maintain a "manufacturing base". Over-dependence on imported intermediate products renders a country's industry susceptible to boycotts and crises. One needs only remember the effects that the 70's oil crises had on European industry and economy as a whole. In other words, it may be essential, according to this argument, for an industrial country to exert some control over its markets of intermediate strategic products. For purely political reasons, one may admit that lump-sum subsidies, protectionism and/or cartelization, to a certain extent, are justifiable. However, the Maastricht Treaty principles prevent such behaviour on a legal basis. Such behaviour may squeeze available funds from other profitable investment opportunities, impede EMU convergence criteria and decrease general welfare and consumer choice.

The question that arises with the conception of the Single Market is whether such measures are any longer necessary, at least within EU boundaries. Fears of industrial relocation and strategic disadvantage should tend to decrease in a Single Market, especially when only a few industrial sectors are impacted. Member States are supposed, according to the fundamentals mentioned in the introduction, to make use of their comparative advantages. It is unthinkable to consider the EU in the process of a globalizing trading system facing major competitors (i.e. US-, Japan), without strategic consensus, but myopic state-confined interests.

As integration proceeds, the incentive for self-sufficiency weakens. It is clear that some regions in the Union may gain some industries at the expense of others. But, if changing industrial employment has an impact on wages and other production costs (i.e. environmental), then there is a point beyond which the losers inside the Union are able to re-attract the lost industries. If countries are forced to adopt unnecessary or premature standards, funds and investments may be diverted away from more productive investments. Especially at medium stages of development, stringent environmental standards may shift imports away from other consumer or capital-intensive goods. Moreover, less developed regions in the EU, in order to retain industry, may be forced to relax other standards (labour safety, worker wages and/or benefits, etc.) to remain competitive in the global market. Such practices would rather create defensive attitudes among Member States endangering the process of unification.

There is a danger that the adoption of and investment in premature environmental standards may lead to the relaxation of other standards (labour safety, worker wages and benefits) in order to retain competitive advantage

Undoubtedly, a commonly agreed minimum of standard setting should take place to ensure certain ambient levels across the EU, but as it indicated below, no reasonable State would ever downplay its environment for a few more "dirty investments."

The Rationale behind "pollution-avoidance"

To date, dirty investments have not demonstrated worrying signs across the EU: enterprises have not relocated to the periphery.. As expressed well by Rauscher (1997) book, even if capital is assumed to be mobile, individual countries shall compete for it to the point that marginal environmental costs equal marginal economic benefits. Indeed, a country (i.e. middle-income) will not knowingly offer "implicit" subsidies (the right to pollute) when the rents from this pollution are later expatriated. Especially when pollution is local, and free-riding on trans-boundary environmental problems is negligible, welfare maximizing countries would reconsider their strategic behaviour towards attracting additional polluting units. Even if we consider some less industrially-developed Southern EU Member States or countries with large environmental absorption capacity (i.e. Austria in the Alps), we realise that these countries actually capitalize on their superior environmental levels through tourist activities rather than dirty industries. One need only consider that tourism represents 10% of Spain's or Austria's GDP and/or 30% of all exports. Keeping a consistent environmental level and record is therefore vital for these economies.

Highly indebted countries may resort to attracting "dirty" investments temporarily, in order to overcome large financial problems. But no country in the EU-15 faces such problems and financial mechanisms in place exert some control over such incidents.

The issue of attracting 'dirty industries' does not represent a problem for the 15 Member States

Current Conflict Resolution Mechanisms

The European Commission and Member States have foreseen these potential effects and employed successful measures to level the playing field and compensate for rapid changes in the regulatory environment, following the burden-sharing rule. The structural and most importantly the cohesion funds are tools to mitigate effects of regulatory discrepancies by improving transportation networks, environment, and infrastructure, thus enhancing peripheral or least developed regions' investment attractiveness.

Moreover Article 130r and Article 130s of the Maastricht Treaty both foresee the possibility of derogation or financial support during periods of transition and adoption of stringent regulation, as

Compensation for regulatory discrepancies among Member States has been foreseen by the EC based on the burden-sharing rule

The possibility of formalizing assistance measures during transitional periods arises, as foreseen under the Maastricht Treaty, with the aim of strengthening EU cohesion and international competitiveness

well as the necessity of a cost/benefit analysis when differences occur between environmental conditions in various regions. These measures could be broadened to include some needy polluters, which due to their small size or lack of financial potential, are not able to provide for some of the large investments foreseen in the adoption of BAT's for example. The possibility for variable grace periods and the formalization of financial assistance - at EU-level so as to achieve greater transparency - may form- the basis of environmental capacity building in the European industry as a whole without compromising its international competitiveness or undermining the route to social cohesion among Member States. Moreover, such formalization would help liquidity-constrained firms shoulder the regulation-imposed burden of adjustment instead of folding their operations, leaving the marketplace and the underlying consumer in the hands of a few price-setting oligopolies.

Finally, improved transportation and state-of-the-art infrastructure, coupled with financial and fiscal incentives or a skilled labour force at reasonable price, offer capital-poor countries a comparative advantage. One needs only to refer to the case of Ireland. During its initial steps towards industrialization, Ireland sought "dirty investments" which never really materialized. On the other hand, by specializing in hi-tech sectors, offering skilled personnel, and using EU and other funds successfully to their advantage, Ireland enjoys the fastest-growing economy in the EU.

Conclusions

The efforts undertaken at Commission level should be further enhanced with additional funds for the restructuring of industry towards the use of more environmental-friendly technologies. A concerted effort and adequate financial assistance will benefit the environment, improve the competitiveness of European enterprises, prevent higher concentration in certain industries and enhance innovation once a market for clean technologies has been formed.

Finally, the underlying message is that successful co-operation, and adoption of more stringent environmental standards when industrial maturity is reached provide the European Commission with self-enforcing agreements around the negotiations table. Common understanding is reached when viable solutions are acknowledged. These solutions may depend on financial and current environmental quality considerations.

Keywords

competitiveness, economics, environment, investment, trade

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Electronic Cash: The two Sides of the Coin revisited

Dimitris Kyriakou, *IPTS*

Issue: Recent innovative approaches and business ventures are highlighting the potential for electronic cash use - as well as the associated risks. The issues identified by IPTS analyses more than two years ago remain unaddressed.

Relevance: Whereas it is true that the advent of electronic cash is an inevitable and necessary part of the increasingly commercialised Internet, and may foster entrepreneurship, it may also portend quite drastic and not necessarily welcome consequences for taxation, banking and even monetary policies.

Analysis

The rapidly increasing numbers of Internet users has highlighted the need for an electronic cash payment system

The number of Internet users is rapidly approaching 100 million and tens of thousands of firms (and the numbers are growing at a dizzying pace). In order for the Internet to consolidate its commercial/market position - and avoid suffering the fortune of once popular non-commercial fora such as the CBs of the seventies - transactions should be facilitated through the use of electronic cash. The Internet in this sense is, in an uncommon twist of events, a market looking for a product!

Existing Internet payment transaction systems are often cumbersome

Sellers on the Internet have had to cope with many visitors and few buyers, largely due to the difficulty in concluding transactions on-line, without forcing the buyer to resort to calling or faxing credit card numbers, or to mail checks. Since intercepting messages is easy for determined Internet eavesdroppers, sending personal financial information on-line is not recommended. Moreover, using encryption techniques would stumble on the lack of an Internet-wide adopted encoding protocol, as well as on the ongoing debate regarding the state's right (and questionable ability) to break such codes when deemed necessary. Several firms have tried to bypass these problems. In some schemes a third party (e.g. a bank) brokers transactions, in effect mimicking the role of banks in credit card transactions. The buyer and the seller would have to maintain accounts with the bank; special software installed in the customer's computer would notify the bank of the customer's intent to buy from a particular merchant, resulting in a transfer of the corresponding amount. Other firms propose variations of this scheme, wherein the bank asks the customer to confirm each transaction before transferring the amount. The latter approach can protect the customer, but may require too much trust on the part of the seller.

More generally there are several different types of electronic cash:

- on line vs. off line;
- labelled (trackable) versus anonymous (untrackable);

- pre-paid versus post paid;
- directly redeemable vs. conversion required;
- issued by banks or non-banks;
- dependent on bank account vs. independent of bank account; and
- linked with established payment system or with a new or novel system.

The desirable properties of digital money tokens are as follows:

- *Authenticity.* Users must be assured that the tokens they accept are valid. This assurance might involve contacting some third-party authority that can certify the tokens, or it might involve some hardware device, such as a smart card.
- *Fungibility.* To be accepted as real money, tokens must be convertible into cash, or at least into bank balances that can be turned into cash.
- *Non-refutability.* Users must be able to verify, through some proof-of-payment mechanism, that a transaction has actually taken place. This might be done by adding information to the token itself (like endorsements on the back of a paper check) or by a separate receipt document (which itself must be accessible, authentic, private, etc.).
- *Privacy.* The system must keep confidential any records of transactions. In some systems, privacy and non-refutability are incompatible; but at least one proposal offers both features.
- *Protectibility.* Users must be assured that they cannot be swindled or falsely accused of attempting to swindle. Note that protection may require some loss of privacy, such as when settling a claim of fraud, or tracking down a counterfeiter.
- *Reliability.* The infrastructure that handles tokens must be available all the time; it must work even with heavy system loads or component failures (Electronic Commerce, ESTO-IPTS, p.9-10).

The more interesting versions of Electronic cash (e-cash) involve the use of a method akin to the one used by telephone companies in providing 'smart' telephone cards to users. The customer purchases a certain amount of e-cash by paying in real cash, through some collaborating bank. The e-cash is a form of money-token which consists of strings of ones and zeros, which include special 'anti-forgery', 'anti-duplication' substrings. The absence of the latter activate in the 'issuer's' program an alerting mechanism, when a 'duplicate' is encountered. What is crucially different about this scheme is the anonymity it offers. The identity of the user of these tokens is untraceable - except when indeed a 'duplicate' is encountered in which case the original user can be identified.

Digital money tokens would ideally fulfil the criteria of authenticity, fungibility, non-refutability, privacy, protectibility and reliability

Such developments have clear positive repercussions. They facilitate the growth of business on the Internet, and, potentially more importantly, they may provide a strong boost to overall entrepreneurship. Through e-cash and a good bookkeeping program anyone can start a business on the Internet, with substantially fewer regulatory obstacles than in the real (as opposed to the virtual) marketplace. Furthermore if accepted as a medium of exchange it can reduce transactions costs substantially for commerce, by expediting instant settlement of often complex financial obligations.

E-money is still very much at the experimental stage, since it is designed exclusively for use in net transactions. For instance, approximately 100 Internet sites currently accept the "cyber bucks" issued by DigiCash, one of the best-known approaches to online e-cash. Trials have taken place in the US (Mark Twain Bank, St. Louis), in Finland (with EuNet and Merita Bank), and in Germany (with

The advantages of e-money include facilitation of Internet transactions, promotion of entrepreneurship and a reduction in overall costs

Perhaps the best-known operational version of e-money to date is the one issued by DigiCash which is accepted on approximately 100 Internet sites

Deutsche Bank) and Sweden (the Post Bank). Further trials in Norway and Austria have been announced. A rival firm is CyberCash, which is closely linked to Verifone Inc. This consortium is developing a rival system to DigiCash. There are joint projects with the Wells Fargo Bank and the First National Bank of Omaha. A cooperative venture was announced with SLIGOS, a French company specialized in bank payment systems. An indicator of the significance of this kind of activities is the purchase of Verifone by Hewlett-Packard for US$1.2 billion. (op.cit., p.12-13).

Taxation issues

Policy-makers need to be alerted not only to the positive effects, but also of the potential headaches e-cash may generate. Since traffic of strings on the Internet can be very fast, token money can move readily from computer to computer, from jurisdiction to jurisdiction, making it very hard for tax authorities to assess true taxable income. Tax is imposed on a person or entity on the basis of its identifiable physical and permanent location, such as in a specific country. Electronic commerce, however, is conducted in 'cyberspace,' and is not subject to locational constraints, and its activities need not be 'permanently' situated in any one locality. Classification problems regarding income and its sources are also exacerbated by e-cash.

One of the problems envisaged with money tokens is its fiscal implications. Tax authorities are considering the possible modifications that will be necessary to account for and audit 'cyberspace' commerce

In the light of wide usage of e-money and the extent to which it results in an extensive payment outside the established banking channels, tax authorities are considering how current techniques to combat tax evasion using e-money can be adapted; whether new audit techniques will be necessary and if information reporting can and should be imposed on issuers of e-money, without jeopardizing the rules on confidentiality and disclosure of returns (US Department of Treasury, 1996; Shin, 1996). Note that it is 'unaccountable' e-cash, where no record is kept of the transaction (i.e. it is like real cash in this sense), that generates more concern (it is also however the one that holds more potential, exactly because of its low transaction costs, and of its facilitating business start-ups).

Despite such concerns regarding the impact of technological developments, it is expected "that current tax regulations and principles will be adequately flexible to deal with technological developments" (Electronic Commerce, ESTO-IPTS project, p29).

The banking sector

Banking supervisory authorities are faced with three main issues with respect to the introduction of e-money. The first issue involves the types of issuers of e-money. The importance of an issuer lies in its right to make e-money available to the customer; and money received by an issuer is regarded as a bank deposit and only regulated credit institutions are authorized to accept deposits. Second, liabilities are created with the issuance of e-money and these are generally payable to those entities accepting e-money as payment. Third, such liabilities entail liquidity risks for issuers. Hence, current regulations for deposit-taking are aimed at creating and maintaining the stability of the system and the liquidity regime (Shin, 1996).

Furthermore, cross border issuance of e-money, by domestic institutions to pay foreign-based merchants or by issuers in one country to consumers in another country in the consumer's home currency, creates jurisdictional ambiguities. Furthermore,

multiple jurisdictions may provide incentives for money laundering, especially as the ability of e-money systems to allow for anonymity imply that cross border transactions also have the potential to diminish the effectiveness of national data protection laws (Electronic Commerce, ESTO-IPTS project, p.24).

Several banking supervisory authorities, including those in the US, are cautious about imposing regulatory costs that may turn out to be counter-productive or unnecessary (Goldfinger, 1996). Their overall focus, however, is on strengthening institutions' risk management capabilities and internal controls. There are a range of approaches for implementing internal controls. For example, Germany, France, Italy, Sweden apply deposit insurance schemes to e-money. The Netherlands and Belgium, on the other hand, are reviewing this applicability. With respect to licensing, Belgium and Sweden have no restriction on issuance of electronic money. In France, the Netherlands and Italy, all issuers must be credit institutions. In Canada and the US, there is no restriction on non-financial institutions to issue e-money, but authorization is required for banks to invest in e-money activity or to establish a subsidiary to conduct such activitiy (Group of Ten, 1997, pp. 22; 32; 34).

There are hence justifiable concern for banks as well. Undoubtedly, e-cash will be dealt with much suspicion by many people, as were banknotes, checks and credit-cards when they first were introduced. With e-cash this long process of money abstraction (from banknotes to checks to credit-cards) reaches its purely abstract form. In any case the facilitating effect of e-cash on commerce may undermine the banks' role - and profits - in such transactions.

The solution the banking sector seems to favour is based on giving the banks the non-trivial privilege of being the sole permitted issuers of e-cash (Electronic Commerce, ESTO-IPTS, p.22). Though this solution would suit banks perfectly (and would add to their sources of income), it would reduce the attractiveness of e-cash to that of a very fast credit card (reducing its transactions costs effect and its entrepreneurship-promoting role).

Central banks and monetary policy

If e-cash builds up a good reputation it may start being used as a store of value and not only as a medium of exchange. To achieve this it should be convertible to real cash, through the issuer's guaranteeing one-to-one correspondence between the amount of e-cash outstanding and real cash kept in the issuer's vaults. In this scheme e-cash balances can earn no interest, because any interest they earn would have to be 'paid' towards the interest foregone by the 'frozen' real cash, that backs the outstanding e-cash. Since there can be no interest there can be no lending, and hence e-cash is not a particularly attractive source of income for the banks. The commissions they can charge on the issuance or conversion of e-cash will have to be very low in a competitive environment. Having said that, it is true however, that due to the difficulty in converting across foreign currencies e-cash may face limitations in international commerce (or conversely, it may prove an excellent means of conducting black-market operations in foreign exchange).

Taking the analysis a step further, just like the one-to-one correspondence with gold, originally backing the then novel banknotes, eventually was interpreted loosely and lending in cash flourished, similarly lending in e-cash

In banking terms, questions are raised regarding e-money issuers and cross border issuance

The solution the banking sector seems to favour is based on giving the banks the privilege of being the sole permitted issuers of e-cash

The possibility that e-cash may start being a store of value and convertible to real cash does exist but the hypothesis raises a number of questions

may be undertaken. Although this could be good news for the banks, it may be quite problematic for monetary authorities and monetary policy designers. If e-cash effectively becomes simply another form of money, then the fact that it is privately issued, may make the Central Bank quite uneasy, as it would have to track a largely unpinnable new component of money supply. To make matters more complicated it may be the case for certain countries, that private issuers may have higher credibility than the government. If, indeed its role expands beyond and across national frontiers it may provide a competitor to national currencies, that would either anticipate monetary union in an embryonic form (if its credibility leads to its adoption by an increasing number of consumers), or would bring unification around a real currency sooner, due to the competition the virtual e-cash would provide.

If e-cash did become another form of money with trans-border operations, it could anticipate an embryonic form of monetary union

More specifically, the introduction of e-money could potentially affect the formulation of monetary policy by affecting the demand for bank reserves or by affecting the ability of the central bank to supply these reserves. Demand could be affected if e-money substitutes reservable deposits or if there is a substantial reduction in banks' demand for settlement balances since interbank settlements typically occur on the books of central banks (BIS, 1996). Large substitution by e-money could implicitly complicate the procedures of central banks to set money market interest rates.

The introduction of e-money could potentially affect the formulation of monetary policy by affecting the demand for bank reserves or by affecting the ability of the central bank to supply these reserves

The capacity of central bank to supply reserves could be affected by the extent of the substitution of e-money for cash. Since cash generally constitutes the largest component of central bank liabilities in many countries, for instance, in Canada, 87 per cent, in Japan, 85 per cent, in the US, 84 per cent, in the UK, 70 per cent, and in Spain, 49 per cent, widespread use of e-money could shrink central bank balance sheets significantly (BIS, 1996, p. 5, 7). This, in turn, could affect the capability of central bank to undertake 'reserve absorbing' operations (BIS, 1996, p. 7).

As noted above, banknotes in circulation represent the largest component of non-interest bearing central bank liabilities. Thus, a substitution of e-money for cash, in large degree, could affect the central bank seigniorage revenues (the revenue accruing to those who hold the privilege of printing money). Some analysts suggest that central banks could consider adapting the monetary aggregates, such as M1 (such as adopted by the German Bundesbank), to include e-money issued by domestic and foreign institutions, and to allow for the possibility that e-money could affect shifts in velocity (the frequency with which money changes hands in economic transactions). This, in turn, could question the viability of monetary aggregates as either targets or indicators for monetary policy (Shin, 1996; BIS, 1996). Furthermore, with extensive substitution and wide usage, a monetary system could evolve in which convertibility into legal tender ceases to be a condition for e-money (Crede, 1996).

In sum, EU central banks feel that at this early stage of the use of e-money systems, they should remain flexible and not introduce any significant new measure.

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There is also a degree of confidence that the conduct of monetary policy by central banks will not be radically affected if they are the only authorized issuers of e-money (which is similar to the wish of commercial banks as noted above !!). Such judgements, however, may

need to be revisited if the use of e-money is widespread and it displaces currency substantially. Importantly, in the context of the Single Market and with the introduction of the Euro, the future European Systems of Central Banks will need to consider the overall impact of e-money denominated in Euros. (op. cit., p. 19-21).

Conclusion

More than two years after the IPTS Report placed the issue on the table in its first issue in December 1995, followed by several studies in 1996 and 1997 by the Bank of International Settlements, US Treasury, etc., the fundamental problems set forth in that article remain largely unaddressed.

The attitude of relevant actors in the areas of taxation, banking and monetary policy can be summarized as follows: present arrangements/regulations are flexible enough to adequately deal with the impact of the various forms of electronic cash (including the most real cash-like, which also happen to be among the most popular ones). The only clear solution (quasi-panacea) recommended by both banks and central banks is that they are given the exclusive right to issue electronic money. It is surprising that even in the area of taxation, which cannot claim the issuing of electronic money, there is no more than a wait-and-see attitude apparent. The surprising acquiescence in all three areas is encouragingly tempered by a realisation that continuous monitoring is needed so that no authority is caught off-guard by developments.

About the author

Dimitris Kyriakou holds a BSc in Electrical Engineering and Computer Science and a Ph.D. in International Economics from Princeton University. Before coming to the IPTS, where he is a scientific officer and is responsible for advising on economics issues and the editing of the IPTS Report, he worked as an economist at the World Bank. His main research interests include information technologies, employment, regional development and sustainability.

Keywords

electronic cash, encoding protocol, transactions, Internet, taxation, banking , monetary policies

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Patent law in Europe: Can the Hoped for Benefits be Achieved?

Anette Schmitt, *VDI-TZ*

Issue: Europe's system for awarding patents to innovators is too expensive and too atomized. Four years into the single European market, there is still no common system for allocating patents which are valid throughout the Union. In June 1997, EU Commission DG XV (Internal Market) highlighted the problem in a paper calling on industry and national governments to submit ideas on how to overhaul the cumbersome existing system.

Relevance: There is a need for a patent unification in a single market system with a single currency, as well as for a new procedure for both granting and challenging patents, which was one of the main stumbling blocks for the original Community patent. The Commission proposals will make patents cheaper, more accessible and more widely understood. The Commission would like to see both granting and legal challenge procedures centralised, using the European Patent Office and the European Court of Justice.

Definition

A patent is a legal title granting its holder the exclusive right to make use of an invention for a limited area and time by stopping others from, amongst other things, making, using or selling it without authorisation. Since all patent applications and granted patents are published, they provide a useful indicator for monitoring market trends, as well as being a source of information about innovative developments in all areas of technology, and as such are an effective means of avoiding parallel developments and duplicated research.

Analysis

The patent system plays a major part in the **transfer of technology**, which acts as a stimulus to technical innovation. The exclusive right to exploit an invention commercially makes it easier for companies to finance research and development. As exclusive rights, patents strengthen a company's market position. The number of patents indicate the level of innovative activity and the strategic planning of companies in a particular market. They generate new investment and are a motivating force behind technical progress.

The patent registrations, drawing on six different databases, was examined to determine the overall trends. As expected, a steady growth, particularly in the 1990s, was evident in most of the databases. This is most clear in the data taken from the US patent database.

It should be noted however that the increases are only truly apparent in the US patent set.

Changes to current EU patent system are becoming increasingly necessary to harmonize procedures, disseminate understanding and reduce costs in the single European Market

Patents are an essential key in technology transfer, stimulating R&D and its financing sources and acting as a tool for monitoring market trends

The fact that few patents are actually used points to their limited utility as a monitoring source for technological activity in general, although database information pertaining to them represents a source of long-term statistics

One major economic role for patents lies the strategic possibility of "reserving" processes rather than products, particularly in industries such as biotechnology, to serve as an asset for raising finance for future research

Patent statistics as indicators for technological activity

Patents are important tools to protect expensive R&D results, but they are also a good source for technical information. Around 80 per cent of all published technical details is given in patent documentation - often nowhere else.

Patent statistics have long been used as indicators of technological activities by academics as well as policy-makers. As with other technology indicators, such as R&D expenditure, they have their own relative advantages and disadvantages and these have been reviewed in detail elsewhere[1, 2, 3]. Does counting the number of patents in industrial sectors and companies provide a useful indicator of competitive success? As Sharp et al have shown, there is no consistent relationship between R&D expenditure, number of patents and number of products in the Top 50 pharmaceutical companies[4]. Thus the pharmaceutical firm Roche, which is first in the set in terms of the percentage of sales devoted to R&D, and is amongst the top group in patenting activity and new drug development, has only one of the top selling drugs. On the other hand, Glaxo's patenting activity and the number of new drugs under development were relatively low in comparison with companies with much less R&D expenditure.

The main advantage of patent statistics as indicators of technological activity is that such datasets are available over long periods of time and can be grouped into technical fields and by organisation. **However, since only about 7% of patents will ever actually be used (and the remainder not being commercially exploited), there is considerable empirical evidence for the limitations of patents as economic indicators.**

The Strategic Role of Patents

In process-engineering-intensive production fields such as biotechnology, patents are a highly significant economic factor. Very often, a patent does not only protect a single product but a whole production processes, hence, providing for further benefits through licences. For SMEs this means that they can take part in large-scale production through patenting processes rather than products which could guarantee future market shares. For example, application possibilities of inventions in the 'young' biotechnology sector, e.g. new fermentation processes or certain inhibitors for enzyme classes are not yet foreseeable. For practically oriented research however it seems to be strategically important to `reserve´ special processes for the future.

In some cases where products cannot be patented because of existing prior art or lack of novelty or inventiveness, a process patent can be used instead. For instance, for biotechnology companies, particularly those in the US, patents have become a very important asset with regard to the raising of funds from venture capitalists and shareholders. Several studies have shown that small companies preferentially patent over large companies in terms of the numbers of biotechnology patents per company[5].

Hence, the combination of research with market strategies plays an important role. Patents alone, without strategic steps and marketing know-how, for instance seeking licensees or partners in big industry, are without economic significance.

Most patents are predominantly registered in countries with a high level of industrial application, and not in the inventor´s country itself. The patents are registered to gain strategic benefits. This explains the high registration of research results in the USA. For instance, there is

no Danish patent registration in Spain or Italy, but many in Germany and Britain (following the USA) - a phenomenon which can be explained by the overall economic and technological situation. Both countries have a high R&D expenditure and a high level of activity.

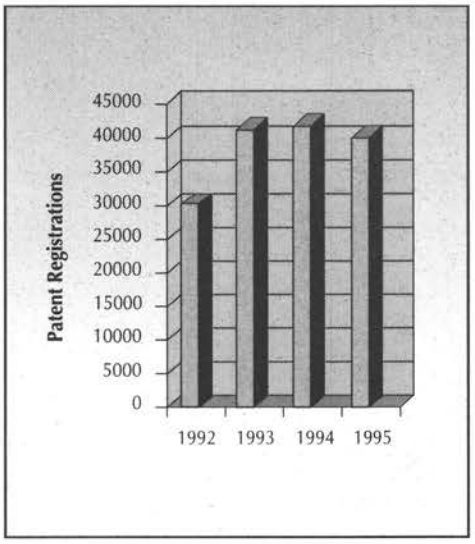
The European Situation

Since there is no single European patent, with separate patents needed for each Member State, there is a potential for fragmentation of the internal market. The cost of securing patent protection in every Member State discourages companies from exploiting their innovative potential, while the lack of legal mechanisms and judicial infrastructure at European level means that interpretations and applications of patent legislation are different. The article contrasts this with the situation in the USA and Japan, which both have a single patent mechanism and legal framework allowing protection in the whole territory - both comparable markets to the EU.

The existing structure in Europe consists of the European Patent Convention (EPC), which includes non-EU Member States, and the Agreement relating to Community patents, which has not yet entered into force. These two instruments represent a complex legal framework for those seeking patent protection, and are subject to different legal jurisdictions.

Alongside national patents, which continue to exist, there is a European patent, though only an embryonic one: once granted by the European Patent Office in Munich, the European patent operates to all intents and purposes like a national patent. There is no provision for a court of law with jurisdiction at European level to decide disputes in patent cases, such as actions for infringement or revocation of a patent, so that there is always the danger that the courts that hear such actions in the Member States may deliver conflicting judgements. The present system consequently places serious difficulties in the way of the openness and smooth operation of the single market.

Figure 1. The evolution of patent registration in Europe



Source: (European Patent Office)

The fact that in 1996 less patents have been registered by the EPO as in 1994 and in 1995 might indicate that patenting becomes more and more a strategic competition instrument which is highly influenced by the national patent system.

The highest number of patent applications per one million of population were from Sweden (195), Germany (169) and Finland (166). The European average is approximately 90 applications per one million population.

In addition, the number of patents applied for in Europe show that the USA and Japan have strong positions in the European market. This is particularly the case for Japan in the electronics industry. The corresponding figures show that EU companies have fewer patent applications in the US market than US companies have in Europe.

The existing internal European patent system, unlike in the US and Japan, is fragmented, leading to differences and difficulties in respect of legal interpretations and applications

The figures for patent registration with the EPO are falling: a suggestion that patenting may be becoming transformed into a strategic competition instrument revolving around national systems

The main reasons for the low use made of patents are high costs, lack of standardization between national and European systems, translations required into the different languages, slow administration and relative inaccessibility to existing patents registered

It seems that the high costs and a lack of awareness mean that European companies are failing to make best use of the patent system. The relatively cheap US patent registration system serves as strategic competition tool, which helps controlling market(s) / shares. The present system of patents in the EU is complex and expensive, and does not provide a unitary patent for all the Member States.

The European Federation of Pharmaceutical Industries' Associations (EFPIA) recently revealed that only 11 patents had been awarded for health products involving genetic engineering in 1995 while, during the same period, 122 were filed in the US. According to recent studies undertaken by the European Patent Office (EPO), only 59,000 companies in Europe have made any use of the patent system in the last five years; a further 111,000 innovative companies are estimated to be in a position to benefit from the patent system but fail to do so. In fact, it is estimated that billions of ECUs are wasted every year in Europe on re-inventing and re-developing existing ideas because of lack of information.

Since the benefits of patents are clear, why do so few European firms, especially SMEs, use the existing patent system? The main problems are excessive costs, overlap between national and European procedures, the need to file patents in foreign languages, slow administration and poor access to published patents. The present system of patents in the Union is complex and expensive, and does not provide a unitary patent for all the Member States. Innovations should enjoy the same protection throughout the single market, in order to develop the role played by innovation in competitiveness and job creation.

There is a need for a "truly operational Community system" dealing fairly with non-Member States which, among other things, would eliminate one of the major obstacles to utility: cost

Probably the most apparent problem with the current system is cost. Patent costs are not always easy to compare, because they are made up of several different components payable at different stages during the lifetime of the patent. Nevertheless, there is no doubt that European patents are far more expensive than those from America or Japan. **A typical European patent giving protection in eight Member States costs around ECU 20,000 and this does not include mandatory translation costs. A US patent, by comparison, costs around ECU 1,500.** Japanese patents cost only ECU 1,100 each, though this figure is somewhat misleading because Japanese patents tend to be smaller in scope than their western counterparts. The total cost includes the fees charged by the EPO and national patent offices, patent attorneys' charges and translation costs. The EPO is currently in the process of cutting its fees by around 20 per cent, but many users think this is still too expensive. These and other problems all stem from today's 'dual system' arrangements. While inventors can apply for a European patent through either the EPO or a national patent office, in reality patent applications are split equally between these two routes. In fact, more than 90% of European patent applications filed by EU nationals are based on a previous national application.

The given situation clearly calls for the adoption of a "truly operational Community patent system", which would be comparable to that of its two main competitors, Japan and the USA. This system should also provide adequate and non-discriminatory treatment for non-EU Member States. Under this system, the costs for patent protection within Europe would be reduced to a level comparable to the USA and Japan (although the costs of translation have to be considered in setting the fees). In the USA, SMEs benefit from a 50% reduction in the costs of patenting, whereas, in Europe, no such reduction exists under the EPC.

The New Green Paper

Consultations on a novel European Patent System have begun; a political agenda will be taking shape in the first few months of 1998. A

main point is that the Community patent must be created, and that it must be less expensive and more efficient than the current system[6].

Costs can be reduced in two ways. To begin with, the amount requiring translation must be reduced. At least two possibilities are being proposed - the production of high quality abstracts, which will be the only text requiring translation; and the 'compacted document' solution, where the patent is reduced to around 20 pages with the help of the patent examiner. A second aspect to reducing costs relates to the problem of enforcement. Yet another approach would be exploiting machine translation, which the Commission has been exploring (see *The IPTS Report*, issue 14, May 1997).

Today's patents may provide protection to small, innovative companies in theory, but if they do not have the financial resources to go to the courts then in practical terms the protection is worthless. One possibility floated is the establishment of a sort of insurance fund which will help finance SMEs' legal battles in enforcing their rights. Finally, there is a need to address the harmonisation of the EU's national systems, tackling issues such as employees' rights to their inventions and the protection of software, which cannot currently be patented as such.

At the moment, it takes around three years for a patent to be researched and become valid nationally, although a 12- month 'fast-track' procedure can simply check the originality of an invention and then leave it up to the certified firm to decide whether to take the procedure further.

Conclusions

Innovations should enjoy the same protection throughout the single market, in order to develop the role played by innovation in competitiveness and job creation. Probably the most apparent problem with the current system is cost. Patent costs are not always easy to compare, because they are made up of several different components payable at different stages during the lifetime of the patent. Nevertheless, there is no doubt that European patents are far more expensive than those from America or Japan.

A unitary Community patent would have the advantage that its effects would be the same throughout the Union; it could be granted, transferred, revoked or allowed to lapse only in respect of the whole of the Union.

It seems that the high costs and a lack of awareness mean that European companies are failing to make best use of the patent system. The relatively cheap US patent registration system serves as strategic competition tool.

Translating this consensus into action will be worth the effort. Patents throughout Europe will be simpler and cheaper to administer and free from today's legal uncertainties. Patent documentation may be more easily available, further stimulating innovation. In short, the Commission is planning a European patent system that is truly competitive with those of the USA and Japan.

Drafts of a new European Patent System due to take shape early in 1998, are working on the dual axis of cost-cutting and harmonization of the EU's national systems

A unitary Community patent would have the advantage that its effects would be the same throughout the Union; it could be granted, transferred, revoked or allowed to lapse with respect to the whole of the Union

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Keywords

patents, innovation, competitiveness, legal and translation costs

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Innovation and Common Agricultural Policy: The European Sweeteners Market

Anette Schmitt, *VDI-TZ*

Issue: Health recommendations promoting less sugar intake on the one hand and the increasing availability of intense sweeteners on the other, are accelerating the problems of potential chronic sugar surpluses and increases in the cost of implementing EU sugar policies.

Relevance: Under present common agricultural support measures for sugar production, farmers are not receiving the price signals that reflect consumer demand, which is also affected by efforts to reduce sugar consumption.

Analysis

Sugar

The effects of high sugar intake on the **health** status of the population is the subject of great debate. The justification for dietary recommendations to remove sugar from the diet requires clear evidence that sugar intake is harmful to health. It should also be proven that the replacement of sugar by another substance, such as intense sweeteners, is not equally or more harmful. However, the specific role of sugar and sweeteners in the etiology of various diseases has been the subject of intense consideration by many national food policy organisations. They have been unanimous in concluding that while sugar contributes to excessive energy intake in the obese, along with dietary fat, it is not a specific or independent cause of any disease, other than perhaps dental caries.

Nevertheless, numerous bodies have made recommendations in relation to sugar consumption and health. The majority advocate a reduction in sugar consumption to 10 per cent or less of total caloric intake and although many propose quantitative guidelines, few offer constructive proposals for their implementation[1]. In terms of the present European sugar market performance, the recommended reduction would represent around 30 per cent of human sugar consumption (3.5 million tonnes white sugar).

While **sugar demand** fell only slightly, intense sweeteners consumption increased greatly, mainly as indirect consumption. This implies that additional low-sugar or sugar-free products have been consumed but not at the expense of usual sugar intake.

The structure of sugar consumption moved considerably towards indirect consumption (e.g. as food ingredient) and currently represents about two thirds of total consumption. This increasing indirect sugar consumption can be explained as an increasing demand for sweetened food and beverages, rather than for sugar as a "table-top"

It is generally agreed by food policy bodies that a reduction in sugar consumption is recommendable but there are no proposals as to how to implement concrete measures

sweetener. Sugar sales to the food industry were 6.7% lower in the first quarter of the 1993/94 campaign compared with the previous year. At the same time, market shares of intense sweeteners increased substantially.

The sugar consumption trend indicates increasing demand for intense sweeteners, or indirect consumption, based on greater demand for sweetened foods and beverages

Intense Sweeteners

Intense sweeteners have been a familiar product for about 100 years. They have been identified as **non-caloric sugar replacers** with a sweetening power (or sweetening intensity) which is far greater than that of sugar. By definition the term 'intense' implies that they provide a sweetness 10 - 2000 times in excess of that of sugar, hence their consumption is limited to very small quantities. Intense sweeteners are by definition 'food additives' - as opposed to 'food' and are classified as such under the industrial code.

Purchasers were have very often been scared by news items suggesting that intense sweeteners are **carcinogenic**[2]. This apprehension was generated as a result of tests in which rats suffered bladder cancer after ingestion of excessive doses of intense sweeteners, although large-scale human studies have not confirmed this finding[3].

The **EU Sweeteners Directive** permits the European-wide utilization of the sweeteners acesulfame, aspartame, cyclamate, saccharin, thaumatin, neohesperidine and the polyols, sorbitol, mannitol, isomalt, maltitol, lactitol, xylitol[4].

Table 1. Intense Sweeteners permitted throughout the EU

Name	EU Food Additive Number	Caloric value
Acesulfame K	E950	0
Aspartame	E951	4*
Saccharin	E954	0
Cyclamate	E952	0
Thaumatin	E957	4*
Neohesperidine DC	E959	0

Otherwise known as non-caloric sugar replacers, intense sweeteners are food additives with a sweetening power in excess of 10-2000 times that of sugar

Maximum daily intake limits of sweeteners have been stipulated by the EU Sweeteners Directive which provides a clear example of how tolerable health risk levels to society can be decided by a political process

In 1987 The EU, Scientific Committee for Foods (SCF)[5] defined an upper daily intake limit for saccharin of 2,5 mg/kg/body weight[6], for cyclamate of 11 mg/kg/body weight[7], for aspartame of 4 mg/kg/body weight, for acesulfame of K 9 mg/kg/body weight, and forNHDC of 5 mg/kg/body weight[8].

The Sweeteners Directive is also a food safety definition and it may be one of the best examples of how the amount of risk tolerated by society is decided by a political process. Only sweeteners listed in the appendix of the proposed Directive may be used and then only at pre-determined levels in specified foodstuffs. It forbids, except under special circumstances, the use of sweeteners in foods intended for particular nutritional use by infants and young children. It also stipulates specific labelling requirements for sweeteners both in foodstuffs and for direct use by consumers.

Sweeteners Replaceability

The food industry uses sugar not only for its sweetening function: it also serves technological purposes. For instance, it helps to preserve food, it

increases boiling point and reduces freezing point, it acts as a bulking agent, it serves as flavour- enhancer, properties which are of considerable importance to many types of food products.

Sugar replacement is therefore to a large extent determined by the **technical suitability** of a sweetener. Intense sweeteners are particularly used in the production of soft drinks where the simple addition of more water compensates for the lost volume of sugar.

The technical substitutability of sugar in food and drink products are estimated to be:

- 100 per cent for soft drinks, ice cream, yoghurt, frozen confectionery, gelatine desserts, canned fruit, pickles, baked beans, sauces, and meat products;
- 50 per cent for canned products;
- 10 per cent for sugar confectionery,
- and 5 per cent for biscuits, chocolate, pie fillings and jams[9].

Based on this assessment, a sugar replacement of around 3 million tonnes white sugar equivalent (about 25 per cent of the 1992/93 total sugar consumption) was technically feasible.

The food industry enjoys great **commercial advantages** when replacing sugar by intense sweeteners in food production. In the beverage industry, for instance, the replacement of sugar by intense sweeteners can result in savings of up to 75 per cent of input costs.

One of the most important commercial advantages of using intense sweeteners in food production relates to the fact that their combination (blending) often provides a total sweetness which is greater than the sum of the sweetness provided by each type individually. This synergistic effect allows for lower dosage levels of sweeteners and, according to the food industry, a fall in the cost of sweeteners in soft drink manufacturing of up to 40 per cent (Tuley, 1991).Furthermore, blending may help to overcome sweetness instability problems and lead to taste improvements. Blending is also claimed, mainly by those promoting the practice, to offer health benefits to consumers by reducing their exposure to a single sweetener.

Substitution scenario under the CAP arrangements

EU sugar production levels remain consistently above consumption. This is partly attributable to EU sugar policies that guarantee producers secure markets and protect them from foreign competition by import tariffs.

The Common Agricultural Policy (CAP) on Sugar (Sugar Regime) includes various production guarantees through minimum prices, production quotas, restitution systems for imports and exports, and market access, measures which have generally kept European sugar prices above world market price.

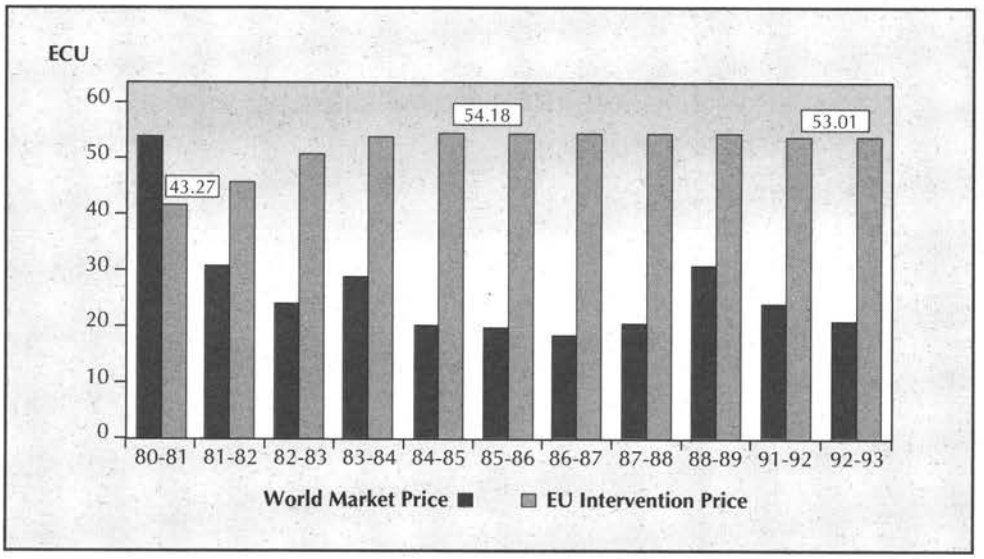
The sugar production sector manufactures only 2.2 per cent of the total European agricultural output. Budgetary appropriations for surplus sugar, however, account for about 6 per cent of the EU Guarantee Funds. The burden of increasing sugar surpluses (costing on average around 400 ECU per tonne) has to be borne by European consumers who finance the surplus sugar through increased retail prices and their contribution to the EU budget.

The implementation of nutritional recommendations on sugar intake would reduce the EU wide consumption by 30 %. Given the various price and quantity regulations under the Sugar Regime, the budgetary charge for this

The replacement of sugar by sweeteners can represent great savings in certain industries, rendering considerable possible reductions in total white sugar consumption technically feasible

European sugar prices remain higher than world prices due to EU production guarantee policies and the cost of financing production surpluses

Figure 1. EU Intervention Price and World Market Price



Source: (Paris Stock Exchange: 100 kg White Sugar[10])

development could total 2.7 billion ECU, plus an export charge for the **additional sugar surplus** of about 2.1 billion ECU (Schmitt, 1992).

This scenario would represent a fall in annual turnover for sugar producers from the current 12.4 billion ECU to around 7.4 billion ECU, distributed in the ratio 60:40 among farmers (4.4 billion ECU) and manufacturers (3 billion ECU). Based on this income situation, farmers would be 13-16 per cent **below their break even point,** hence returns would not cover the fixed and variable costs of sugar beet production[11]. With this loss of 33 per cent in farmers' present income, sugar beet production compared to an alternative land use (in this case, cereal production) would no longer be competitive, **and further EU subsidies** would be necessary to keep farmers on their land.

Reactions to this market development could be heated in Southern Europe (Greece, Italy, Spain, Portugal), southern France, Bavaria (Germany) and Ireland, in comparison with reactions in Northern Europe (Germany, northern France, Belgium, Denmark, the Netherlands, the United Kingdom)[12].

Assuming a linear production and consumption trend, the surplus production could be about 70 per cent by the year 2000, hence a worse situation than under the scenario discussed.

Under the ceteris paribus assumption and that of a linear trend, intense sweeteners[13] consumption could settle in the year 2000 at around 1.8 million tonnes white sugar equivalent, i.e. about 19 per cent of total sweeteners for human consumption within the EU. Other investigations confirm this finding[14]. Note that this value ignores the technically possible replacement (around 30 per cent on average)!

Based on recent consumption trends in the the EU, a more comprehensive perspective on agricultural change should be developed, since it is questionable whether the sugar market can be expected to persist in the long-term under such conflicting factors.

Conclusions

Dietary change, whether consumer-led or as a result of government intervention inevitably entails redistributing effects in terms resources allocation within society. Producers of sugarless foodstuffs have taken dietary guidelines on board with great enthusiasm, whilst sugar producers have tried to defend their ground, occasionally questioning official advice.

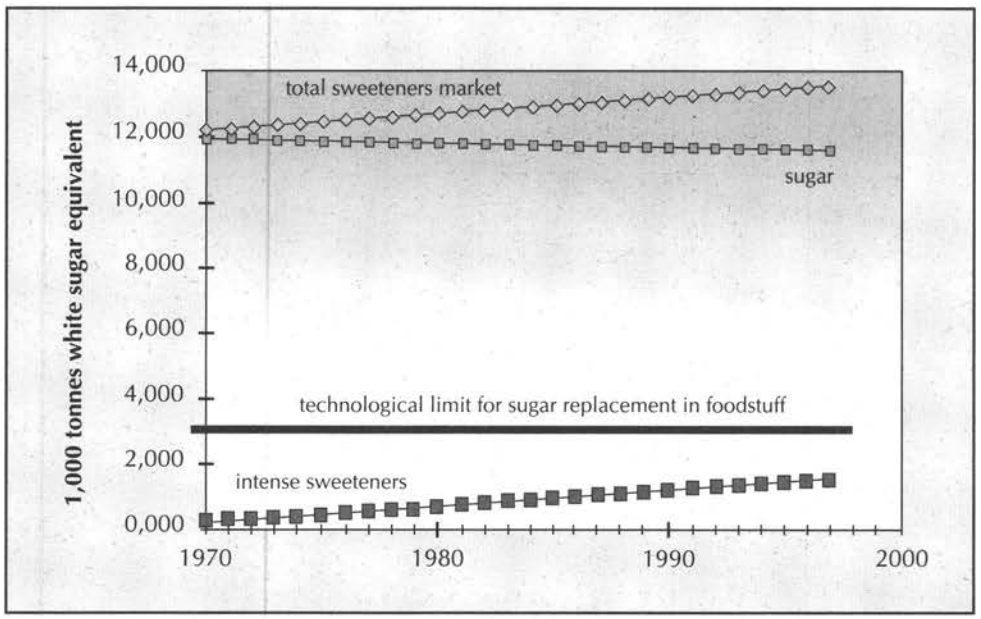
The food industry is able to replace up to 3 million tonnes of white sugar equivalent in foodstuffs by intense sweeteners, which would represent a 30 per cent market share. Already in 1992/93, intense sweetener quantities of about 1.3 million tonnes white sugar equivalent found their outlets in European food markets.

The sweeteners consumption trend indicates stagnation in sugar demand and strong growth in the intense sweeteners sector in all European countries. Although the retail prices of sugar-free products are generally higher than the sugar-containing counterpart, intense sweeteners increased their market-share.

However, far from being a direct sugar substitute, , it seems that intense sweeteners still constitute a separate demand category.

Changes in agricultural policy are also recommendable on the basis of the surplus production that would result from continuation of the sweetener production and consumption trends

Figure 2. EU Consumption Trends for Sweeteners



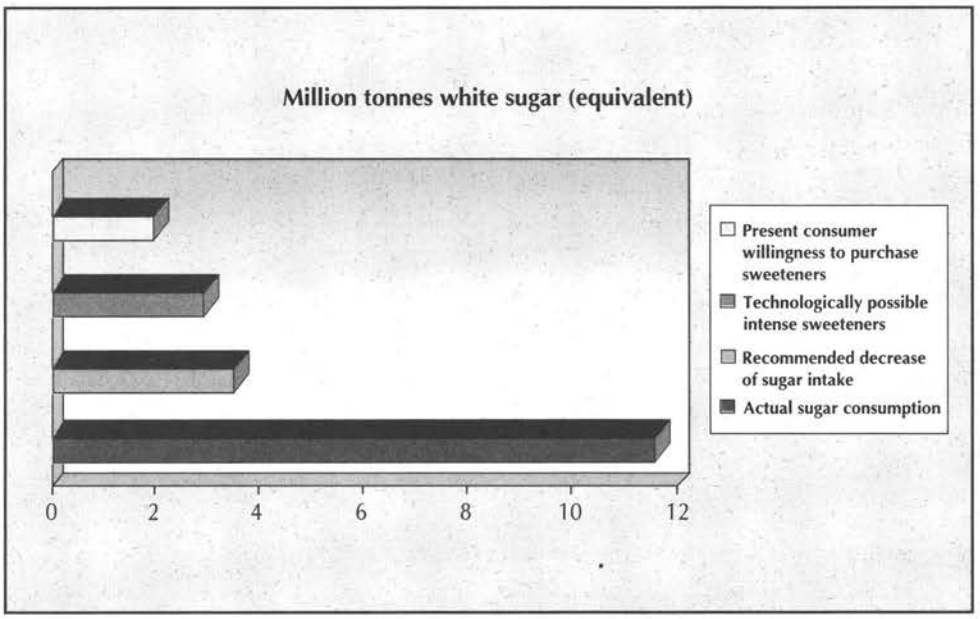
The Sugar Regime is sending signals to domestic producers which do not reflect changes in world markets. In the 1992/93 marketing year, production was 34 per cent above domestic consumption.

The implementation of dietary advice on sugar intake would imply a monetary transfer from consumer to producer through the redistribution effect at the expense of taxpayers burdened with financing the budget expenditures. The marketing experience of the sweeteners sector may lead the way for the development of other food substitutes[15].

The fact that the current low-fat foods market in the EU has increased rapidly could provide an indication as to the lessons to be learnt from the experience of the sweeteners sector.

The Sugar Regime is sending signals to domestic producers which do not reflect changes in world markets

Figure 3. Pressure on the EU Sugar Market



The food industry is developing new product lines in order to satisfy requirements for fat substitutes, natural ingredients, water binding agents, low calorie ingredients, bulking agents and bio-products.

Whatever the true nature of a nutritionally optimum diet, a nutrition policy must explicitly take account of what is attainable in terms of the population's eating habits and the economic environment of the markets. For instance, if there is clear evidence that the consumption of a particular food is likely to be harmful for health, European policy-makers have a duty to place nutritional issues high on the list of the objectives for food, nutrition and agriculture policy. Moreover, particular attention should be paid to the role of interests groups in ensuring an adequate food supply. It is frequently suggested that the interests of the food supply chain (farmers, food manufacturers, food retailers), dominate consumer and health interests.

Nutrition policy must explicitly take account of what is attainable in terms of the population's eating habits and the economic environment of the markets

A closer communication of dietary advisors with food producers, food and agriculture policy-makers and consumers, as well as a better understanding of inter-sectoral linkages in the food chain could improve the quality and liability of dietary advice.

Keywords

European Sweeteners Directive, sweeteners, health policy, nutritional perspectives, European sugar Regime

Notes and References

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2 - Oser, et al., 1968, and Price, et al. 1970.

3 - Lorke, 1991, 1989; Inhorn/Meisner, 1970; Armstrong/Doll, 1975; Burbank/Fraumeni, 1970.

4 - (CEC: OJ, 1991b).

* Aspartame and Thaumatine are composed of two naturally occurring amino acids which contribute 4 kcal/g to the diet. However, because of their very high sweetening intensity and the very small quantity of the sweetener required, the relative caloric amount of aspartamee and thaumatine approaches zero.

5 - The SCF body was set up in 1974 to aid the Commission in questions relating to health in the food sector. Evaluations on intake limits for safe consumption of sweeteners prepared by the SCF are largely based on summary reports carried out on a national level.

6 - The current maximum saccharin intake limit is 5 mg/day/kg/body weight (acid form).

7 - For a person with 70 kg body weight this corresponds, for instance, to 21 tablets of the saccharin/cyclamate combination.

8 - SCF 1989, Council of the EU, 1993; CEU: OJ, 1994.

9 - Heasman, 1989.

10 - Source: World Bank, 1990; EEC: CAP, 1994.

11 - Supposed a break-even point between 5.08 and 5.28 billion ECU.

12 - CEC: Groupe Mac, 1992; Europe in Figures, 1992.

13 - Including saccharin, cyclamate, aspartamee, acesulfame.

14 - Young, 1989.

15 - For example: "N"Oil, Instant "N"Oil, Maltrin M040, Paselli SA2, Polydextrose, Sta-Slim, Snowflake 01906, NutriFat C, NutriFat PC, Simplesse, Creme de Tapioca, Yogalait, Avicel, Trailblazer, Instant NutriFat PC, NutriFat PC Supreme, Olestra, Sucrose polyesters, Finesse Ultrafiltered protein, Polysiloxanes, Oatrim, Tatca, EPG, Prolestra, Olestrin, Colestra, and many others.

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ABOUT THE IPTS

The **IPTS** is one of the seven institutes of the Joint Research Centre of the EU Commission. Its remit is the observation and follow-up of technological change in its broadest sense, in order to understand better its links with economic and social change. The Institute carries out and co-ordinates research to improve our understanding of the impact of new technologies, and their relationship to their socio-economic context.

The purpose of this work is to support the decision-maker in the management of change pivotally anchored on S/T developments. In this endeavour IPTS enjoys a dual advantage: being a part of the Commission IPTS shares EU goals and priorities; on the other hand it cherishes its research institute neutrality and distance from the intricacies of actual policy-making. This combination allows the IPTS to build bridges betwen EU undertakings, contributing to and co-ordinating the creation of common knowledge bases at the disposal of all stake-holders. Though the work of the IPTS is mainly addressed to the Commission, it also works with decision-makers in the European Parliament, and agencies and institutions in the Member States.

The Institute's main activities, defined in close cooperation with the decision-maker are:

1. Technology Watch. This activity aims to alert European decision-makers to the social, economic and political consequences of major technological issues and trends. This is achieved through the European Science and Technology Observatory (ESTO), a European-wide network of nationally based organisations. The IPTS is the central node of ESTO, co-ordinating technology watch 'joint ventures' with the aim of better understanding technological change.

2. Technology, employment & competitiveness. Given the significance of these issues for Europe and the EU institutions, the technology-employment-competitiveness relationship is the driving force behind all IPTS activities, focusing analysis on the potential of promising technologies for job creation, economic growth and social welfare. Such analyses may be linked to specific technologies, technological sectors, or cross-sectoral issues and themes.

3. Support for policy-making. The IPTS also undertakes work to supports both Commission services and other EU institutions in response to specific requests, usually as a direct contribution to decision-making and/or policy implementation. These tasks are fully integrated with, and take full advantage of on-going Technology Watch activities.

As well as collaborating directly with policy-makers in order to obtain first-hand understanding of their concerns, the IPTS draws upon sector actors' knowledge and promotes dialogue between them, whilst working in close co-operation with the scientific community so as to ensure technical accuracy. In addition to its flagship IPTS Report, the work of the IPTS is also presented in occasional prospective notes, a series of dossiers, synthesis reports and working papers.

The IPTS Report is published in the first week of every month, except for the months of January and August. It is edited in English and is currently available at a price of 50 ECU per year in four languages: English, French, German and Spanish.

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