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# THE IPTS REPORT

Edited by the Institute for Prospective Technological Studies (IPTS) and issued in cooperation with the European S&T Observatories Network

- **Greenhouse Gas Emissions and the Balance of the Global Carbon Cycle**
- **Euro-Mediterranean Policies and Olive Oil: Competition vs. Job-Sharing**
- **Bridging the Efficiency Gap: The Downside of Downsizing**
- **The Productivity Paradox of Demographic Change**
- **Biomedical Implants: Quality Standards and Promoting Innovation**

**OCTOBER 1996**

**EUROPEAN COMMISSION**
Joint Research Centre

*The IPTS Report, launched in December 1995 on the request and under the auspices of the Commissioner for Science, Research and Development, Edith Cresson, has now completed its pilot phase. What seemed like a daunting challenge in late 1995, appears now in retrospect as a crucial galvaniser of the IPTS energies and skills.*

*The Report has published articles in a number of areas, keeping a rough balance among them and exploiting interdisciplinarity as much as possible. Articles are deemed 'prospectively relevant' if they explore issues which are either not yet on the policymaker's agenda (but due to be there sooner or later), or aspects of issues which although on the agenda their importance has not been fully appreciated.*

*The thorough drafting and redrafting process, based on continuous interactive consultation with our collaborating network of institutes, which will progressively become even more involved in the process, guarantees quality control.*

*The first, and possibly most significant, indicator of success is that the Report is being read. Issue 00 (December 1995) - of which 2000 copies were printed in what seemed to be an optimistic projection at the time - has become a collector's item. Since then circulation has risen to 6000. Requests for subscriptions have come not only from all over Europe but also from the US, Japan, Australia, Latin America, N. Africa, etc.*

*The positive comments our efforts have received have been highly gratifying and the constructive and engaging criticism of our readership has formed part of the ongoing process of improvement. The comments we have received range from the informal, formal communications (in paper or electronic form), and take in as well as a Reader Survey commissioned by IPTS.*

*Readers' direct engagement with the content of the report's articles has led us to include a 'Letters-to-the-Editor' section, which started in the June issue.*

*The rising esteem in which the publication is held is also making it increasingly attractive for authors from outside the Commission. We have already published contributions by authors from such renowned institutions such as the TNO in Holland, the VDI in Germany, the ENEA in Italy, the Council of Strategic and International Studies in the US, etc.*

*The Report is produced simultaneously in four languages (English, French, German and Spanish), by 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's World Wide Web, makes it quite an uncommon undertaking.*

*We will continue to strive to meet the expectations of our very diverse readership, to avoid the traps of oversimplification, encyclopaedic reviews or the inaccessibility of academic journals. The key is to remind both ourselves and our readers, that we cannot be all things to all people, that it is important to carve out our niche and keep on exploring and exploiting it, hoping to illuminate topics under a new, revealing light, for the benefit of the readers, to prepare them to manage the challenges ahead.*

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Herbert J. Allgeier

EDITOR-IN-CHIEF
Dimitris Kyriakou



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## CONTENTS

The first article in this issue of The IPTS Report is the third instalment in a series of articles on climate change and in particular greenhouse gases. In previous articles the need to act in the face of uncertainty, as well as the ways in which to integrate uncertainty into decision making were explored. Here the focus is on global carbon cycle, on the difficulty and importance of associating precise measurements with it. It suggests a dual approach wherein carbon budgets are studied at field and ecosystem levels for extended time periods, while at the same time not neglecting the mechanisms of smaller scale fluxes. Moreover parallel to research on natural $CO_2$ absorption and sequestration patterns, the opportunities to increase carbon storage could be explored.

The second article presents scenarios for the development of olive oil production in the Mediterranean. Due to its healthy image olive oil is projected to raise its market share in wealthy non-European countries. This coupled with opportunities afforded by new environmentally-friendly technologies, may present an opportunity for EU and non-EU Mediterranean producer countries to work together, promoting and exploiting complementarities, fighting unemployment and rural exodus, as well as environmental degradation, not simply focusing on productivity growth within the olive oil industry.

The third article raises questions regarding 'downsizing', often presented as a path towards productivity growth, and efficiency enhancement. The article suggests that the (mis)application of certain principles in downsizing experiments, may actually undermine technology innovation and adoption, as well as the loss of tacit knowledge facilitating technology use. It argues for the importance of exploring alternative approaches based on creating conditions that allow small companies to thrive, promoting closer involvement and even investment by employees in projects, and a philosophy of continuous improvement

The issues of unemployment reduction and improving competitiveness behind the third article are also central to the fourth article. Demographic patterns, leading to problems, which are uncharacteristically predictable, make the reduction of unemployment and the competitiveness of EU firms a crucial condition for the preservation of an affluent lifestyle, especially in the light of a rapidly ageing population, expecting to receive the benefits it has been promised and to which it has been accustomed.

Current demographic patterns make the questions raised by the article on biomedical implants, a rapidly growing market, for which standards will have to be devised and updated following technological developments, increasingly relevant. Regulation would need to be both adequate and effective, performing the dual task of protecting the recipient of the implant, while at the same time still leaving incentive for innovation that will enhance patients' lives.

**The article "Towards the Zero Emission Vehicle: The role of the hybrid car", in issue 02 (March 1996) of The IPTS Report, is based on a number of questionable assumptions. We would like to comment on them on the basis of our experience of market launch projects in the automotive field.**

## The need for higher performance

One premise was the assumption that there is a need and a market for vehicles with ever higher performance. Presumably this refers to acceleration, maximum speed and range as the main performance variables. These variables are indeed important sales arguments for the automobile manufacturers and sales agents. However, the acceleration and the maximum speed of most passenger cars already now exceeds real needs and possibilities. It exceeds the requirements both in urban areas and secondary roads and motorways. The type of vehicle usage (mission profile) determines in particular the driveline characteristics, and through this, the vehicle performance figures. An increase of available acceleration will only have a marginal effect.

The maximum permitted/recommended speed in most European countries is 130 km/hour. Most passenger cars on the market are already overpowered, capable of a maximum speed which exceeds these limits. There is therefore no reason for a further increase in acceleration and maximum speed performance.

An adaptation of the internal combustion engine to actual requirements could produce benefits for energy efficiency and energy consumption, and consequently for the environment. It is of interest that Dutch automobile importers and sales outlets have agreed not to use acceleration and maximum speed in their advertising.

## Electric vehicles

Another assumption was the comparison of electric vehicles (EVS) with "normal" cars, that is: cars with internal combustion engines (ICVs). They should have the same acceleration qualities and the same range. We have never seen such a car. Is it a Panda, a Cadillac, a Volkswagen Beetle, a Chrysler Voyager? Based upon this point EVS are quite often disqualified.

However, many EVS have now very acceptable acceleration figures, as shown by information given by automobile manufacturers. Comparing battery electric vehicles (BEV) with vehicles powered by internal combustion engines, therefore, is questionable. BEVs have their own niche markets: small package transport by parcel services, repair services, utility company fleets and second cars. They perform very satisfactory in towns and urban districts, where the required range is 100 - 150 km per day. With an acceleration that fully meets the need in these areas. There they have their optimum environmental benefits: they are clean and quiet.

**Hybrid vehicles**

The hybrid vehicle (HV) is seen as a future substitute for the ICV. This will only be the case when it is performing satisfactorily for the driver, executing its mission for him/her. Its characteristics would equal that of ICV's then available on the market.

Another of the article's assumptions was the need for off-board battery charging. The layout of the drive line of an HV with its components, should guarantee that for most trips, the batteries do not need any off-board charging. Off-board charging should be an exception. The need for an additional infrastructure for overnight recharging facilities should be considered carefully. It is one of the drawbacks of private owned EVS but is not a problem for fleet owners. In many cases the public electricity supply system is inadequate for this purpose. Maybe it can manage slow charging, but fast charging will, in many cases, give rise to problems.

For realistic comparisons of emissions, a kind of life cycle analysis is required. Emissions are determined by the way electricity is generated in a given country. A ZEV is in a broader sense, not at all a "zero emission vehicle", but an "elsewhere" emission vehicle (EEV). A HV is at its best a low emission vehicle (LEV).

Specific R&D effort is still needed for controllers and battery management systems. The importance of these devices is generally underestimated.

Another of the article's assumptions was that HV can ease and shorten the period of the eventual introduction of pure EVS. In the near (?) future we could expect the introduction of pure EVS.

However, the physical and chemical properties of the materials, used in existing and in experimental batteries, will never make it possible to store an amount of energy comparable to that of a tank of petrol, diesel fuel or LPG. Thus, the car of the future will not be a pure electric vehicle, but it could be a hybrid one.

**Authors:**

**Ben van Spanje, Arie Brouwer (Programme-managers Traffic and Transport Novem BV / Utrecht / The Netherlands),**
**tel, +31 30 239 34 21**
**e-mail: nlnovbvs@ibmmail.com**

# Greenhouse Gas Emissions and the Balance of the Global Carbon Cycle

*Astrid Zwick*

**Issue:** Since the process of industrialisation began, atmospheric $CO_2$ content has increased by over 30 %. However, atmospheric CO is growing 2-3 times slower than total anthropogenic emissions. The reason for this difference is not yet known and makes the need for better quantification of the global carbon cycle clear.

**Relevance:** The parties to the United Nations Framework Convention on Climate (UNFCC) are currently discussing the question of QELRO (Quantified Emission Limits and Reduction Objectives). Future emission reduction scenarios depend entirely on the way in which the carbon balance is calculated. Since the carbon balance still involves many unsolved questions, more empirical data on the global carbon cycle and related biogeochemical processes are required in order to improve the quantification of climate related parameters such as $CO_2$ levels and so increase the reliability of future projections.

## Introduction

In previous IPTS Report articles on the $CO_2$ issue and climatic change research emphasis was put on the question of how to act in the context of uncertainty. The first article discussed the reasons why it is time for action. Increasing energy consumption and the depletion of our fossil energy sources have already raised the policy makers' awareness of the limitations of our energy supply and provided a rationale for action. Considering the long start-up times for new technologies it is advisable to set the course for environmentally sound and economically beneficial technologies now in order for them to be ready in time to be effective. The risk of expensive damage caused by climatic change introduces a further incentive for precautionary measures. The facts mentioned underscore the need to take the issue of $CO_2$ seriously.

In the second article the main facts and uncertainties in climate research were presented, and focus was put on how to integrate uncertainties into decision making. The article suggested that, given the seriousness of the issue, the existence of scientific uncertainties should not preclude taking political measures. On the contrary, new information, which could be obtained by strengthened research, would help policy makers in the decision making process. The decisions taken must, of course, be flexible enough to make it possible to incorporate the information obtained from research and to adapt them to the new state of knowledge. Thus, it was concluded that the prudent course of action when dealing with climatic change is a well prepared gradual regulation policy. This policy could be beneficial in environmental as well as in economic terms and simultaneously encompass measures for mitigation, adaptation and improvement of knowledge.

*Atmospheric $CO_2$ concentrations are influenced by the combustion of fossil fuels, land use and uptake and release by the oceans, vegetation and soils*

ENERGY

*Accurate calculations and measurements of carbon flows are a prerequisite for the definition of reduction targets*

*Unless there are significant changes in the market fossil fuels will continue to dominate energy production well into the 21st century*

The problematic nature of the global carbon balance means that the greenhouse gas $CO_2$ remains a crucial point in the climate debate The present paper in this series highlights the status of research on the carbon cycle and aims to explain why the early clarification of this issue is essential and focuses on the unresolved research questions.

## Why is a detailed knowledge about the carbon balance so important?

Carbon dioxide is the most important of the greenhouse gases that are directly influenced by human activities. The rising atmospheric concentration of carbon dioxide is predicted to exert a global warming influence arising from its infrared absorption. The $CO_2$ concentration in the atmosphere is determined by the emissions from combustion of fossil fuels and land use as well as by $CO_2$ uptake and release by the earth's oceans, vegetation and soils The excess anthropogenic $CO_2$ is usually transported into the ocean and the biosphere by the same processes as natural $CO_2$ and the fact that these exchange processes are non-linear means that uptake of the excess anthropogenic $CO_2$ is not proportional to the natural exchange fluxes.

Estimates of carbon balance parameters vary as a result of differences in location and time of measurements and have resulted in more confusion than clarification. Improvements in measurement techniques have contributed to the detection of additional carbon sinks and sources and caused a revision of previous estimates

A fuller understanding of the carbon balance could affect expectations about the proportion of future carbon emissions that would be accumulated in the atmosphere. Since a reasonable and realistic $CO_2$ emission reduction target needs to be based on a reliable scientific calculation of the carbon flows among the different reservoirs, it seems to be imperative to focus research efforts on this issue in order to define reduction targets. The clarification of the scientific background is a prerequisite for an appropriate quantification of emission limitation and reduction objectives

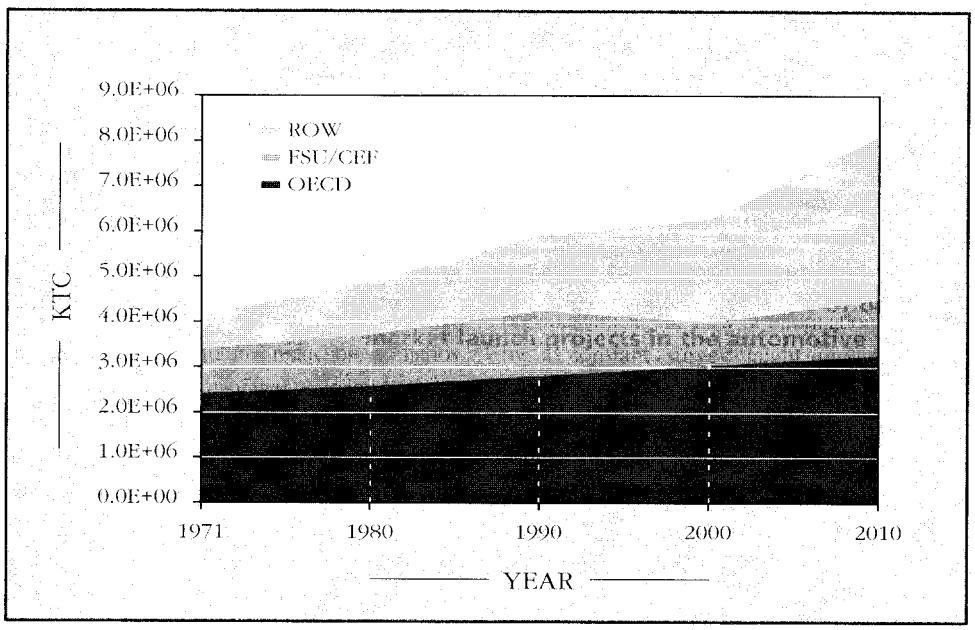
## Why is the balance of the carbon cycle so difficult to estimate?

According to recent estimations, present carbon emissions from fossil fuel burning and land use amount to about 7 Giga tons per year (Gt C/yr) globally. The most relevant contributors to the emissions can be segregated into the transport, electric power generation, deforestation, industry and the residential sector, with the first three being the most important sources of emissions (IEA, 1995).

Since the world population is expected to grow from 5 3 billion in 1990 to 9.5 billion in 2050 and up to 10.5 billion in 2100, energy demand can be expected to experience a dramatic increase (IPCC, 1996) The projections forecast that by 2010 annual global emissions will have increased 50 % relative to 1990, and emissions from developing countries will exceed the OECD (Organisation for Economic Co-operation and Development) level by 2010 (IEA/OECD, 1995) (Fig. 1). The IEA (International Energy Agency) study suggests that unless there are significant changes in energy markets the dominant energy sources will still be based on fossil fuels well into the 21st century. This outlook increases concern about the $CO_2$ emissions.

$CO_2$ provides the biggest share (approximately 60%) of the contribution to the anthropogenically enhanced greenhouse effect If net global anthropogenic emissions are maintained at the present level of about 7 Gt C/yr (including emissions from fossil fuel combustion, cement production and land-use changes), they will reach about 510 parts per million by volume (ppmv) by the end of the 21st century - almost twice the pre-industrial concentration of 280 ppmv - inducing an increase in temperature of about 2 _C, as about 50 % (3.4 Gt C yr) of the total 7 Gt C/yr remain in the atmosphere (IPCC, 1992) This figure corresponds approximately to the annual increase in the atmospheric $CO_2$ concentration of about 1 5 parts per million by volume (ppmv) observed over the period 1980 - 1989.

**Figure 1: World carbon emissions by region, revealing the increasing weight of the developing countries**




*Legend: ROW = Rest of the World, FSU = former Soviet Union, CEE = Central and Eastern Europe. Source: IEA, 1995.*

## Where is the bottleneck in the quantification of the carbon cycle?

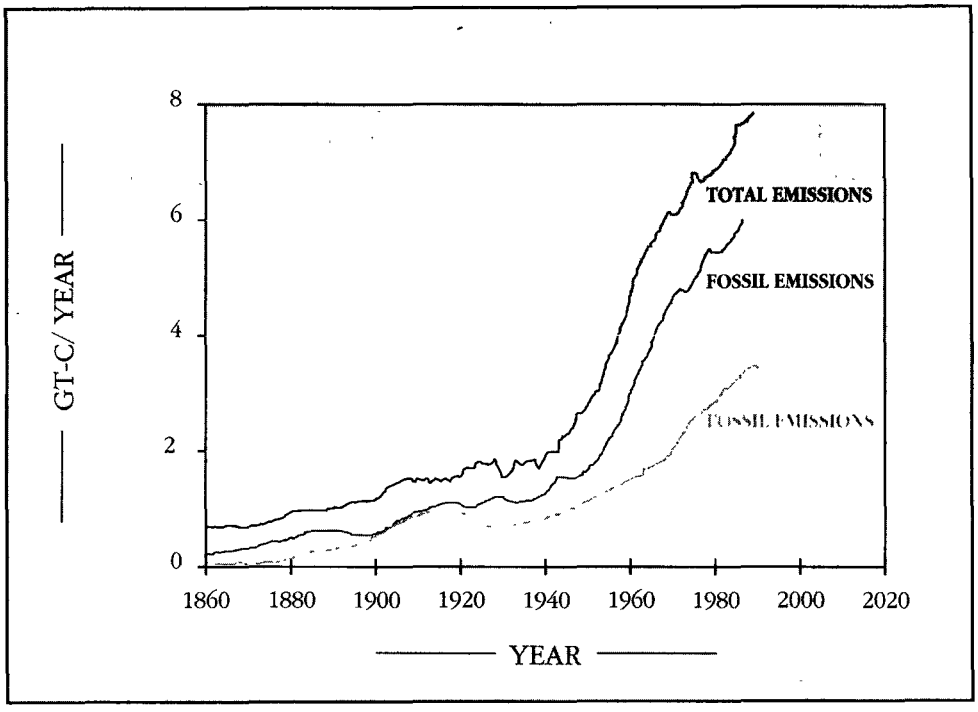
Despite steadily rising atmospheric $CO_2$ levels, the measured atmospheric growth rate does not exactly correspond to anthropogenic emissions (Fig. 2). On the contrary, the growth rate of atmospheric carbon is 2-3 times lower than the rate of the increase of the sum of $CO_2$ emissions (Joos & Sarmiento, 1995). The mixing of the air masses in the troposphere along a latitude occurs within 2-3 weeks, in one hemisphere in about a few months, and between the hemispheres in about one year, while the exchange between troposphere and stratosphere needs about 2-3 years. In the higher stratosphere, mixing can take up to 10 years due to the slower vertical convective exchange of air masses. In general, one would expect that the relatively fast mixing times within the atmosphere would exclude a significantly delayed response time for the atmospheric $CO_2$ concentration levels, so there must be another explanation for differences in the rates of increase.

The non-linear increase in $CO_2$ emissions and atmospheric concentration may also make it necessary to change assumptions about reduction limits. In recent years, an enhanced uptake capacity of carbon sinks has been observed causing an imbalance in the calculation of the carbon budget. The missing carbon is being taken up either by the oceans or by the terrestrial biosphere (plants and soils), or both (Table 1).

The $CO_2$ balance of the ocean has been partially measured and partially modelled. The uptake by the ocean is estimated to be about 2.0 Gt C/yr. Circulation patterns and other physico-chemical conditions govern $CO_2$ solubility, gas transfer rates across the sea surface, and bulk transport of carbon within the oceans. Two basic processes are superimposed on these effects: carbon fixation by photosynthesis, and $CO_2$ release by respiration. These rarely leave the surface ocean in equilibrium with atmospheric $CO_2$ (Chen, 1992).

*Atmospheric carbon is increasing at a rate 2-3 times lower than anthropogenic carbon dioxide emissions, the missing carbon is being taken up by plants and soils, the oceans or both*

**Figure 2: Increase in total anthropogenic $CO_2$ emissions (emissions from fossil fuel combustion and land use) compared with the increase in atmospheric carbon concentration (Gt C/yr)**




*Source Joos & Sarmiento, 1995*

*Higher concentrations in the atmosphere mean higher absorption by the sea However, the rate is inversely proportional to temperature and so may be limited by global warming*

A higher $CO_2$ concentration in the atmosphere steepens the gradient between $CO_2$ in air and (under-saturated) surface sea water This leads to a higher flux of $CO_2$ into the surface water (in areas with an upward displacement of $CO_2$-rich deep water, this water meets an atmosphere with a higher $CO_2$ concentration and therefore the gas release becomes less intense). These processes lead to a greater $CO_2$ uptake by surface water than in pre-industrial times. However these processes are rather slow (equilibration time about approx. 1 year), so that they are likely to get out of pace with seasonal changes, meaning that complete equilibrium is not reached.

The solubility of $CO_2$ in water is temperature dependent, with higher solubility in cold water, thus this process might be influenced by global warming. The chemical process of dissolution of $CO_2$ in surface water only gives atmospheric $CO_2$ access to a small part of the ocean reservoir

The physical process caused by oceanic circulation with an overturning rate of several hundreds to thousand years determine the eventual uptake rate of the ocean. Mixing of surface water with deep water is very slow, but mechanisms like North Atlantic Thermohaline Circulation (THC) provide a possible mechanism for the transport of surface water to the deep ocean. The temperature of surface water is lowered and the salinity is increased by seasonal cooling and the formation of sea ice, which periodically causes the transport of parcels of this dense water to greater depth, thus starting the conveyor belt movement of cross-regional oceanic circulation. Thus, the THC is sensitive to variations in temperature and salinity. Future climatic changes might alter its carbon uptake capacity and therefore constitute an important object for further investigation.

The biological process is governed by the uptake of $CO_2$ by organisms from dissolved inorganic carbon in surface water or in part directly from the

atmosphere, incorporating the carbon into organic tissue and carbonate shells. This transformation process lowers the surface $CO_2$ concentration and increases the flux from the atmosphere. The particulate material is recirculated or sinks to a greater depth, a process, known as the 'biological pump'. It is assumed that an acceleration of production brought about by higher $CO_2$ concentrations, as found in the case of land plants, is unlikely since carbon is not as limited in surface sea water as are nutrients (nitrate, phosphate) and light. Regional changes in oceanic productivity, as a secondary feedback mechanism due to changing temperature and light conditions, could be taken into account and could cause differences in the ocean carbon balance as well (Gaudry et al., 1987). This is a strong possibility in the case of the El Niño/Southern Oscillation events which coincide usually with periods of high atmospheric $CO_2$ growth.

**Table 1: Annual average of the global carbon balance for 1980 to 1989.**

| | Mean Values in Gt C/year | Uncertainty in % |
|---|---|---|
| **$CO_2$-sources** | | |
| (1) Combustion of fossil fuels and cement production | 5.5 ±0.5 | ±9 |
| (2) Changes in tropical land use | 1.6 ±1.0 | ±63 |
| **Total** | 7.1 ±1.1 | ±15 |
| **$CO_2$ -sinks** | | |
| (3) The atmosphere | 3.3 ±0.2 | ±6 |
| (4) The oceans | 2.0 ±0.8 | ±40 |
| (5) Boreal forests | 0.5 ±0.5 | ±100 |
| **Total** | 5.7 ±1.0 | ±18 |
| (6) Additional terrestrial sinks = [(1) + (2)] - [(3) + (4) + (5)] | 1.3 ±1.5 | ±107 |

*Source (IPCC, 1996, Joos, 1995)*

*Land plants consume about 12 times the world's fossil fuel emissions annually, but the biosphere gives off just as much through respiration and decay*

$CO_2$ is also absorbed by boreal forests at a rate of 0.5 Gt C/yr. The rest, about 1.3 Gt C/yr, is assumed to be sequestered by additional processes in the terrestrial biosphere. Land plants, for example, consume about twelve times the world's fossil fuel emissions annually. Unfortunately, the biosphere also gives off about the same amount of $CO_2$ through respiration and plant decay. This makes land plants a critical part of the global carbon cycle.

A number of factors are thought to account for the increase in carbon uptake by the terrestrial biosphere. A fertilisation effect due to the increased atmospheric $CO_2$ level and to nitrogen fertilisation resulting from industrial emissions has been assumed. This fertilisation effect was observed in small scale experiments and probably applies to the temperate forests of the northern hemisphere, which are possibly sequestering a part of the excess $CO_2$. Increases in forest productivity were mainly simulated for the northern forest types, while southern forest types may show small increases or decreases in productivity. The importance of the $CO_2$ uptake capacity by the land biota in the northern temperate regions was repeatedly highlighted by measurements taken over the period 1991-1994 (Keeling et al., 1996). These measurements confirmed the estimates of the $CO_2$ budget recently made by the IPCC. Interestingly, their investigations might suggest that tropical

*Increased atmospheric CO2 and nitrogen from industrial emissions may exert a 'fertilisation effect' on vegetation*

forests are a weaker net source or sink. The regrowth of forest forms a further potential for carbon uptake since it is assumed that young plants sequester more carbon than a mature forest (Marland & Marland, 1992).

External factors like sky conditions, volcanic activity, interaction of ozone levels with $CO_2$ levels, precipitation rates (Ham et al., 1995), length of growing season (Goulden et al., 1996) as well as seasonal changes in the use of fossil fuels are influencing the carbon transfer. Within the biosphere differences in species sensitivity to altered $CO_2$ levels, genetic factors determining the sensitivity of individual plants to stress or their uptake capacity (C3/C4 plants) or local biogenic activity (varying about 3 ppmv in the yearly cycle) (Levin, 1987) create additional problems for the estimation of the carbon balance and have to be taken into account

*Links in the mechanism require studies of the ecosystem over long periods of time whilst simultaneously examining specific fluxes on a smaller scale*

The evaluation of the different factors involved in the terrestrial part of the carbon cycle reveals very well the ambivalence and the temporary nature of its mechanisms For instance, while forest soils have the capacity to act as a net sink for anthropogenic $CO_2$, soil respiration is particularly sensitive to temperature changes and might at least partially offset increased carbon storage in the future (Bird, 1996) In addition, carbon uptake by land plants constitutes, of course, transient storage depending on the duration of carbon uptake and rate of turnover

*Phenomena like North Atlantic Thermohaline Circulation and El Niño could provide useful information about CO2 flux*

Oscillations in the carbon balance are of both temporal and spatial nature Interannual variations in $CO_2$ are partially due to natural climatic changes The daily amplitude, for example, in summer, has been estimated to be around 3 ppmv for biogenic activity of terrestrial plants in the hemispheric average (Przybylak, 1992) This effect is higher on a local scale. In areas close to extended forests in mid-latitudes seasonal variation due to the growing cycles could amount to about 30 ppmv and more (Goulden et al , 1996) Different vegetation zones and, of course, the emissions from different countries are contributing to regional variations in the $CO_2$ budget

*Improved forest management could represent one type of active, but moderate, climate change policy*

## How can the carbon balance problem be dealt with in the future?

Carbon fluxes are governed by complex relationships and feedback responses that link a multitude of mechanisms over time and space These mechanistic links demand a research approach in which carbon budgets are studied at field and ecosystem scale over long periods, while simultaneously examining the specific mechanisms governing fluxes on smaller scales It is crucial to establish the means by which $CO_2$ is being sequestered (e.g. regrowth, fertilisation) and where it is stored (e g tree-trunks, soils, ocean sediment). Special attention should be paid to the different time scales involved in carbon uptake and turnover in terrestrial ecosystems. The issue of carbon emission by deforestation should be clarified since recent satellite data have shown different figures than previous statistical data on tropical land use. It also has to be taken into account that an intensified productivity of land plants can saturate carbon uptake capacity

The ocean's uptake capacity for $CO_2$ is obviously great, but the mechanisms involved have not been fully explained. Thus, it is important to understand the processes governing oceanic uptake or carbon release Among these, the North Atlantic Thermohaline Circulation and El Niño events could help to detect mechanisms that lie behind the $CO_2$ flux between the ocean and the atmosphere and are of particular interest in a changing climate regime.

Parallel to research efforts and in accordance with a moderate climatic change policy, the opportunity to increase carbon storage above the expected baseline might be explored. This is possible and has been investigated by studies showing that $CO_2$ emissions can be effectively offset by sequestering additional carbon at various steps in the life cycle of wood growth, harvest, use and disposal. Typical practices to offset carbon emissions would include tree planting on marginal agricultural land, increasing timber growth in forests now used for timber production, increasing

the use of wood in place of fossil fuels, and improving wood utilisation. These measures are the most promising alternatives for reducing atmospheric $CO_2$ levels. Ideas about the transport of $CO_2$ into the deep ocean have been proven to be more cost and energy intensive than sequestering carbon in land biomass. Ecological damages due to carbon storage in the oceans is highly likely and reduces yet further the attractiveness of its possible application.

The way in which the carbon balance is calculated strongly influences future reduction scenarios. Discussions of new quantified emission limits by the parties to the UNFCC (United Nations Framework Convention on Climate) in order to define global efforts to reduce $CO_2$ emissions have not yet reached the negotiation stage on account of the unsolved questions. More research efforts in terms of monitoring $CO_2$ sources and sinks are required, such as the research which has started with the European Commission's greenhouse gas inventory project. Improved forest management, as mentioned above, could also be one of the appropriate beneficial measures, as frequently proposed as an active but moderate climatic change policy. In conjunction with a flexible decision making framework, as discussed in a previous article, the flow of information obtained by a constant survey might provide better knowledge. The new information could be integrated into policy decisions in accordance with an active response and a flexible adjustment to address climate change.

**Keywords**
global carbon cycle, missing sink, terrestrial biosphere, $CO_2$ fertilisation, forest regrowth.

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**Contacts**

Astrid Zwick, IPTS,

tel. +34 5 4488288, fax. + 34 5 4488339, e-mail: astrid.zwick@jrc.es

Antonio Soria, IPTS,

tel. +34 5 54488294, fax. + 34 5 4488279), e-mail: antonio.soria@jrc.es

**About the author**

*Astrid Zwick holds a diploma and a PhD in geology/palaeontology from the Ludwig-Maximilians Universitat, Munich She is currently working for the IPTS as a post-doctorate grant-holder Her area of responsibility is co-ordinating activities related to global warming issues*

# Euro-Mediterranean Policies and Olive Oil: Competition vs. Job-Sharing

*Matteo Bonazzi*

**Issue:** Nearly all the world's olive oil is produced and consumed in the Mediterranean region, three quarters in the EU. However, thanks to its healthy image demand is growing worldwide, especially in wealthy countries. Driven by changes in world trade and technology, non-EU Mediterranean countries have a new opportunity for growth, reducing both poverty and migration, but they could become competitors of the EU producer countries.

**Relevance:** Olive oil could be made a key-activity for the market-based cohesion objectives outlined in the context of the Euro-Mediterranean space of cooperation. The EU and non-EU Mediterranean countries could work together to optimise world market growth, increase employment and protect the environment, by promoting the complementarity of their different production patterns. Failure to do this could exacerbate the existing gaps. Technology will be a pivotal factor in addressing job-sharing and environmental objectives. The product and market differentiation option needs to be examined without excluding strategies for controlled mobility and training of the labour force throughout the whole Mediterranean region.

## Olive oil, a typically Euro-Mediterranean question

Up until now the Mediterranean region has been the most important producer and consumer of olive oil; it produces 97% of the world's olive oil and consumes 91% of it. Southern EU countries take the lion's share with approximately three quarters of world production and consumption.

In the Mediterranean olive oil generates direct income for about 7 million families and indirectly supports 30-35 million people in less favourable areas. 71% of employment in the industry is located in southern and eastern Mediterranean countries (SEMC) while their share of world production does not exceed 20%. The opposite situation exists in EU producer countries which account for only 27% of employment but 76% of the world production (Fig.1).

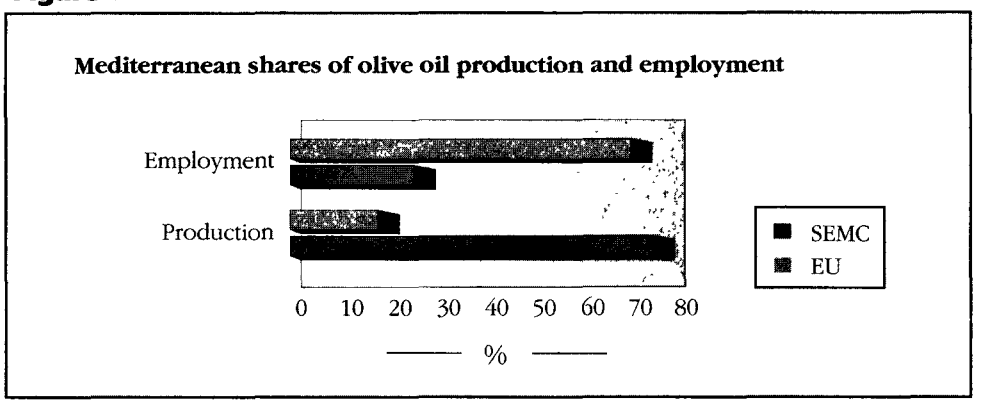
Olive oil's healthy image is causing a remarkable rise in demand worldwide, particularly in wealthy markets. As a consequence some SEMC (Tunisia, Morocco, Syria) are investing heavily in the olive oil sector, but they remain technologically dependent on the EU producer countries, which are also raising their productivity and quality through technological innovations. These innovations are also improving both the environmental and competitive profiles of their production patterns and reducing employment dramatically.

Objectives clearly need to be defined at this stage. Driven by favourable market and technological prospects, the SEMC could increase both olive oil production and quality. On the one hand this would open up new opportunities for winning significant market shares, stabilising rural populations, reducing poverty and thus alleviating

*In the Mediterranean region the olive oil industry supports some 7 million families directly and 30-35 million people indirectly*

*The new EU-Mediterranean policy calls for 'intelligent technology', technology which is 'politically correct' and responds to new ethical priorities*

**Figure 1**




migration dynamics. On the other hand the SEMC could provide competition for EU producer countries.

In the light of the new orientation given to the EU Mediterranean policy (Barcelona Conference, 27-28 November 1995) technology is called upon to respond to new ethical priorities, thus assuming the meaning of 'intelligent technology'. Its use could become 'politically correct', aiming to incorporate job-sharing and environmental objectives throughout the whole Mediterranean region, without exacerbating the existing gaps.

Starting from these assumptions it is possible to outline for the olive sector two basic scenarios, referred to here as the 'trend' scenario and the 'active' scenario.

The trend scenario (horizon 2000) is based on an extrapolation of the current evolution pattern, which is assumed to be more radically affected by the GATT agreements than by the expected Euro-Mediterranean policies. Accordingly, it appears dominated by the related market-based and pressures toward even higher productivity and international competition.

On the other hand, the active scenario (split into two horizons: 2000 and 2010) foresees the radical optimization of the potential offered by the olive oil sector for achieving the 'politically correct' objectives. This means the targeted promotion of world demand coupled with the extension and transfers of 'intelligent' technologies, especially to the SEMC. Finally, this means progressively moving the focus of technology from mere productivity growth towards broader social and environmental targets.

*Olive oil demand responds asymmetrically to price variations. The demand drop caused by a price jump is smaller than the expected demand rise caused by a price cut*

## Rising demand and 'intelligent' technologies: the trend and active scenarios

Olive oil is becoming increasingly present on the food scene as the healthiest alternative among the edible oils, helping reduce the incidence of cardio-vascular disease, breast cancer and cell

**Figure 2**

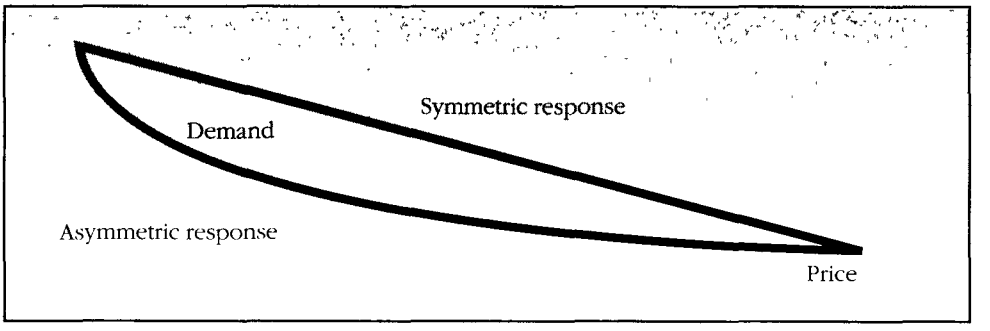
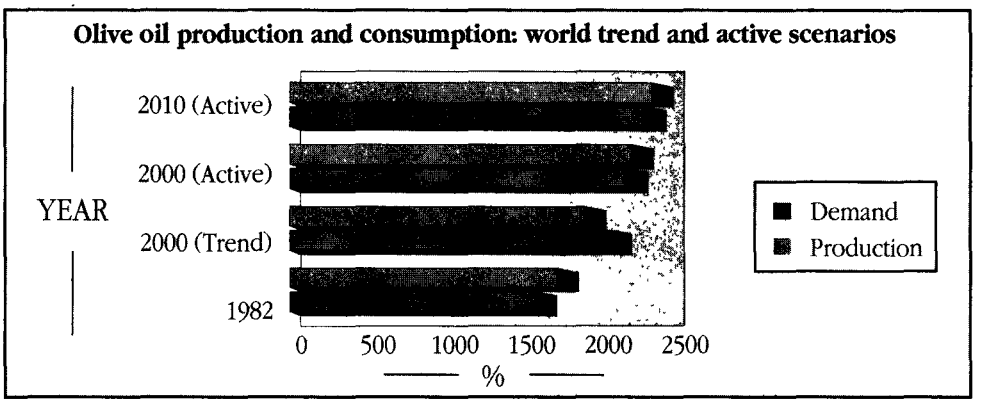


**Figure 3**




ageing. This is causing its production and consumption to increase worldwide. Thus, olive oil demand is growing, gaining worldwide new and wealthy markets (US, Japan, northern EU, Canada, Australia, south America, south-east Asia). Among these the US - which has witnessed a 460% demand rise over the last 15 years - Japan, south-eastern Asia and northern EU seem the most rapidly expanding markets.

Additionally, recent studies carried out in the US and in Spain have rather surprisingly shown that the behaviour of olive oil demand responds asymmetrically to price variations. The demand drop caused by a price jump is smaller than the expected demand rise due to an equivalent decrease in price. This means that consumers who get used to the taste of olive oil do not replace it with another cheaper oil when the price goes back up, as a consequence price increases don't affect olive oil demand significantly, consumer education apparently being a more important factor (Figure 2).

Although starting from this promising starting point the 'trend scenario' (horizon 2000) predicts the global under-exploitation of the growing olive oil world market, due in particular to the absence of a concerted Mediterranean cartel for the product, the disparity between the technological and economic levels of the EU and SEMC rims, and the threat of the vegetable/olive oil blends. Although supply and demand for olive oil are expected to rise slightly, over-production is not expected. Production patterns imposed by the physiological bi-annual alternate bearing of the olive tree, Mediterranean macro-climatic fluctuations (10-12 year periodicity) guarantee an absence of production surpluses for the next 5 years (Figures 3 & 4).

*The 'trend' scenario predicts under-exploitation of global olive-oil market potential and a widening gap between high-tech EU producers and their labour-intensive non-EU competitors*

In the 'active scenario' (horizons set on the years 2000 and 2010) world demand for olive oil increases further through promotional campaigns

*The 'active' scenario envisages promotional campaigns pushing demand above supply and technology transfers and labour mobility benefiting all producers in the Mediterranean region*

**Figure 4. Olive oil world production: horizon trend scenario**

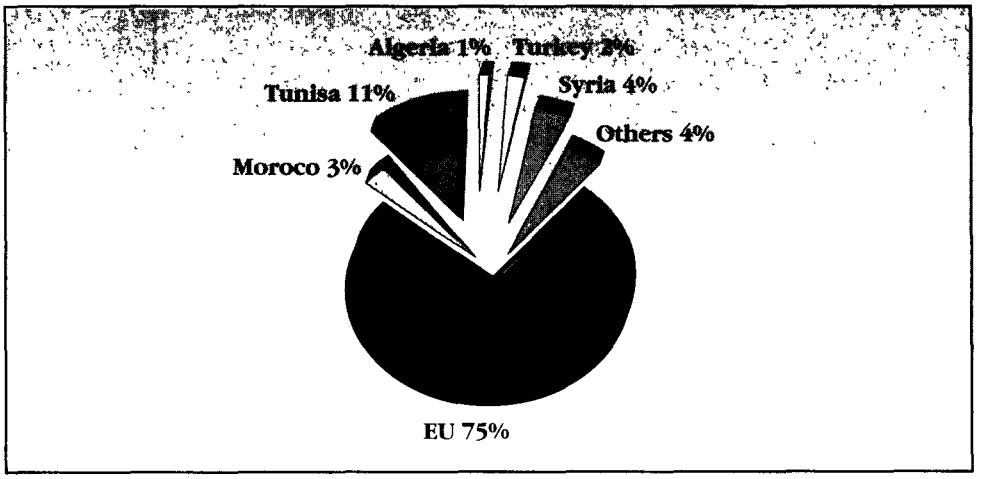
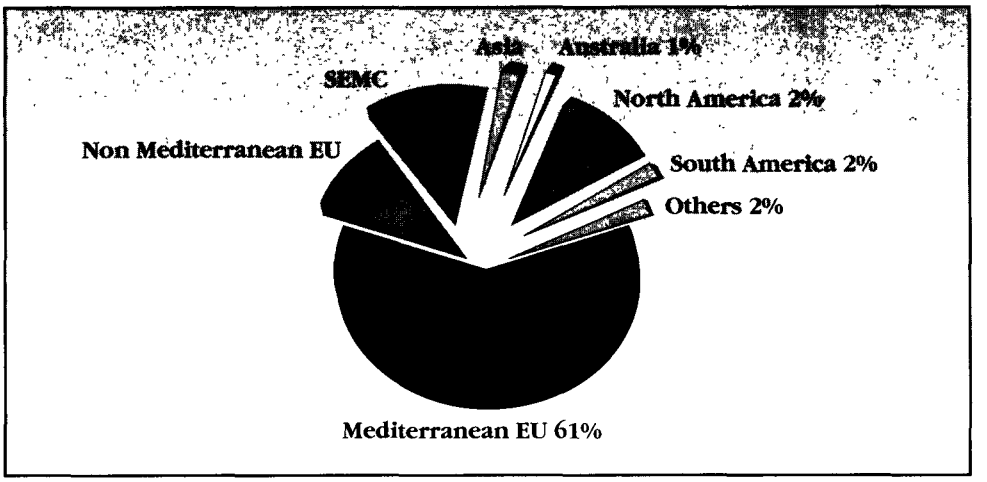


**Figure 5. World consumption of olive oil (Active scenario, horizon 2010)**




in growing markets in wealthy countries. Driven by increasing health concerns this scenario appears to be dominated by demand rising slightly faster than production, opening in SEMC countries promising opportunities for growth (Figures 3 & 5). They could benefit from the climate of Euro-Mediterranean cooperation through technology and financial transfers. On the production side in fact, driven by the market forces mentioned, the olive oil sector is witnessing a very important technological change, mostly concentrated in the EU countries. This could allow significant improvement of the environmental and quality profiles of the olive oil production chain during the next 10-15 years, with important repercussions for job creation and environmental protection.

Finally the 'active scenario' outlines the availability of an integrated 'intelligent' technology transfer package for the next 10-15 years, dedicated to preserving the olive agri-ecosystem as well as the large labour force employed mostly in the SEMC (Figure 6).

On the agricultural side, the combined manual-mechanical harvesting technique can improve olive oil quality cost-effectively without destroying jobs; living plant covers, integrated pest management, salty, deficient and drip irrigation reduce dramatically chemical inputs (55%), soil (99%), water (65%), and biodiversity (70%) losses .

On the extraction side the ecological centrifugation technology, coupled with the differentiation of by-product valorization, make it possible to further reduce water needs and pollutant emissions, as well as improve olive oil quality and thereby generate 15% more revenue.

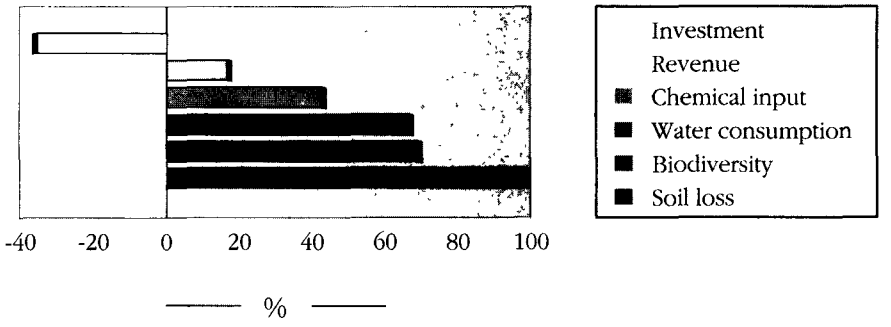
The impact on employment is positive, especially for higher skilled jobs. However a 25-30% higher investment has to be envisaged for training and equipment, for which global amortization is estimated to require a 10-15 years period.

## 'Active' market scenarios for tomorrow: producer and market countries

### The short term horizon (year 2000)

Both market and technological prospects make olive oil particularly attractive for Mediterranean countries Some of the SEMC are embarking on production strategies directed towards 'export' or 'domestic consumption' objectives. The former trend is followed by Tunisia and Syria, while Morocco will follow the latter, mostly to face their significant deficit in the oils and fats sector. Together they will become more important producers, together accounting for 22% of world production and 9% of consumption The EU producer countries although maintaining their current shares, (since the growth in the Moroccan, Syrian and Tunisian shares is not projected to come at the expense of European countries' shares) will push toward marketing strategies (including 'temporary import').

**Figure 6. Gain shares of the 'active' versus 'trend' technological scenario**




### The medium term horizon (2005-2015)

The rising star in south Mediterranean olive oil scene will be Tunisia, while Morocco could take second place, overtaking Turkey. Its recent association agreements with the EU underline the role of Moroccan agriculture as the exchange currency for Spanish fishing and the opening of new spaces for allocating the surpluses of the European industry Significant technological modernization will make it possible to increase its olive production by up to 50%, in order to meet a 2-3 fold growth in demand.

Syria also will witness a further growth of both olive oil production and consumption, becoming a very important producer country in the Middle East.

### The long term horizon (2020-2025)

In the longer term Morocco may also promote a further radical restructuring of its olive oil sector, with the aim of quadrupling olive production, doubling whole olive exports and increasing 6-fold both olive oil production and consumption.

The challenge is to reduce the tremendous deficit in the oils and fats sector (70% comes from imports), curb both rural depopulation and emigration, as well as preserve its environment and the integrity of its cultural patterns.

### Between competition and cooperation: which EU policies?

European olive oil has up until now received heavy subsidies for production, consumption and trade levels through the CAP (Common Agricultural Policy). However, the GATT agreements outline a less protected and more globalized market for olive oil, and the EU is to cut a significant share of its subsidized global exports.

In this light international competition is expected to mount. Countries outside the Mediterranean basin are also making significant investments in the sector (e.g Argentina and Australia, which is increasing its olive patrimony at a yearly rate of 1 million trees).

The new philosophy underlying EU Mediterranean policy is epitomised in the Barcelona Declaration (27-28 November 1995), which follows the Declaration of Tunis and the EU Council Conference of Cannes (26-27 June 1995). Its challenge is to define a multilateral framework dedicated to creating a common 'space of shared prosperity', which is a pre-requisite for a wider political, socio-economic, environmental and cultural dialogue, aimed to promote both sustainable growth and stability right around the Mediterranean region. The development dynamics will be restructured on a wider Euro-Mediterranean scale, moving

*Pressure from GATT to reduce subsidies on agricultural production are attracting new players onto the market Olive oil production is growing in countries outside the Mediterranean region, such as Australia and Argentina*

progressively from the marginalization of the SEMC towards the co-development of all Mediterranean countries.

The setting up of the Euro-Mediterranean Free Trade Area could be the starting point and the basic tool of this process, establishing a space of free movement of people, goods, services, and capital, which would become operative from the year 2010, and which will start with the liberalization of industrial products trade and gradually extend to agricultural produce. This aims to create the Euro-Mediterranean market-based cohesive dynamics able to optimize the complementarity of the different economies and production patterns, and valorize the comparative advantages of the different countries. In this light it is clear that olive oil could be an interesting case study in which to examine the possible contradictions between the two trade philosophies, as the logic of the globalised market could impede the achievement of the socio-economic objectives of the Euro-Mediterranean co-development policy in the region.

*Stronger technology in the EU could result in job-losses and transnational companies may seek to take advantage of lower labour costs in the SEMC*

The fact that the 'trend' scenario of totally open competition sketches little technological cooperation between the EU and the SEMC means an open race between the producer countries to achieve increased productivity and competitiveness, and market share growth through product and market differentiation.

In the EU producer countries this may lead to a drive for stronger technology but could also cause more employment losses. On the other hand SEMC will try to achieve an acceptable quality level using its existing technology This would create a favourable environment for profit-seeking investments by large transnational companies, which could easily benefit from both the relatively low labour costs in the SEMC and the higher technology available in the EU.

Overall, a shift from labour to capital intensive activities is expected, as well as from low to higher skilled jobs. This could have a negative effect on employment throughout the Mediterranean region and worsen rural depopulation.

The 'active' (or 'forum') scenario embodies the willingness of cooperation between the EU and the SEMC. In this scenario olive oil could become a key-activity for the related market-based cohesion objectives This co-development strategy has to draw attention to defining the playing fields of competition and complementarity between the different production patterns of each country, based on a 'deep integration' model ('partenariat').

For this purpose it is necessary to promote a concerted multilateral decision process between EU and the SEMC which could optimise the potentialities for sharing growth and jobs. Otherwise the existing gaps could be exacerbated, embittering both social and economic tensions

Accordingly, the EU and SEMC should work together, as they would share common goals such as maximizing income, jobs, and world demand for their products, so as to alleviate poverty, rural depopulation, migration and pressure on the environmental

In this light 'intelligent' technology is crucial to the expected EU Mediterranean policies: its 'politically correct' role must give priority to the opportunities for job and growth sharing throughout the whole Mediterranean region by valorizing the comparative advantage of each region.

This political choice could allow the integration of the classic option of product and market differentiation with strategies outlining the controlled mobility and training of the labour force throughout the Mediterranean region, ie. so-called 'horizontal' migration in the agricultural sector Accordingly, optimization of employment growth and structure in the olive oil sector could be focused on the whole Mediterranean region, making it possible to direct both world market prospects and technological choices toward social justice and equity objectives.

**Keywords**

Olive oil, Mediterranean, competition, co-development, job-sharing, technology, EU policy

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- Dr M. Rémi Barré, OST, Observatoire des Sciences et des Techniques, Paris, France.
- Prof. Fontanazza, Istituto di Ricerche sulla Olivicoltura, Perugia, Italy.


**Contact**

Matteo Bonazzi, IPTS, tel. +34-5-448-8337, fax. +34-5-448-8326, e-mail: matteo.bonazzi@jrc.es

**About the author**

*Matteo Bonazzi graduated cum laude with honourable mention in Natural Sciences and holds both a European Master in Environmental Engineering, with an Environmental Strategies specialization, and an International Master in Olive Oil. He is currently researching for a Ph.D. in Environmental Strategy and has work and research experience in Europe, the Middle East, South America and Africa. He is currently working at the IPTS as a researcher on agri-food strategies for sustainable development in the Mediterranean region.*

# Bridging the Efficiency Gap: The downside of downsizing

*Eamon Cahill*

**Issue:** The existence of an efficiency gap between European industry and its US and Japanese competitors has been demonstrated in a number of studies. Accurate quantitative measures of efficiency differences have proven elusive, but clear evidence of the gaps can be seen from qualitative studies based on comparison of practices and methods of operation. One of the principal responses by industry to the problem is the adoption of downsizing strategies to bridge the gap. Such strategies however, may be incompatible with promoting technology and the knowledge to use it, both considered to be crucial efficiency drivers.

**Relevance:** Two concerns which rank highly on the European Union's current agenda are employment and the competitiveness of European industry. The problem of the efficiency of industry impacts on both these concerns. If the chosen strategies of industry for improving efficiency in support of competitiveness impact unfavourably on employment conditions the classic 'trade-off' exists. However, if alternative strategies which lessen the unfavourable impacts can be implemented then it is important that such strategies be examined and public policy oriented to providing the climate and environment which support them.

## Introduction

*The concept of industrial efficiency compares the performance of a firm or unit with that of the best firms in the same industry utilizing the best available technology*

The concept of industrial efficiency is a simple one It compares the actual performance of a firm or unit with that of the best firm or firms in the same industry utilizing the best available technology. Measuring accurately the level of efficiency has proved very difficult but differences in efficiency can be seen clearly. Studies based on the adoption of 'best practice' methods have shown that while the best European companies are on a par with the best in Japan and the US, the large cohort of European companies below that level are less efficient than their equivalents in the other blocs (Voss, Blackmon, et al. 1995).

The process of improving economic efficiency is a combination of adopting technological improvements which tend to raise the level for all firms, including the most efficient, and internal restructuring and innovation which closes the gap between the most efficient and the others. In terms of the efficiency equation, restructuring involves reducing the proportion of labour to capital while maintaining output thereby giving improved efficiency. This reduction is the essence of downsizing.

## Downsizing

A distinction should be drawn between the natural destruction of economic activity through large scale innovation and the changes which arise from adaptation. The first type of change shifts demand away from products or industries and consequently causes redundancy and job loss. These companies may be very efficient (cf. Buggy whip manufacturers on the advent of the automobile). These job losses tend to be compensated for by new opportunities in the

industries to which the demand has shifted. The second type of change occurs in response to competition where the fundamental demand in the marketplace remains.

A number of key attributes of downsizing have been identified, namely that: (a) it is an intentional policy; (b) it usually involves a reduction in the company's personnel, (c) it is focused on improving efficiency of the organization and (d) knowingly or unknowingly it affects work processes. Downsizing is a strategy consciously adopted by the company and its widespread use dates back to the late 1980's and can be traced to a revision of the basic assumptions about organizational performance and dynamics which had been widely held until then. In the early 1980's it was thought that: (a) bigger organizations were better organizations, (b) continuous growth was good and desirable, (c) flexibility was linked to loose coupling and slack resources and (d) consistency and compatibility were the traits of effective organizations By the end of the 1980's these had been replaced by the ideas that (a) smaller can mean better; (b) slower growth and cutbacks can be natural phases of the life cycle process; (c) tight coupling and non-redundancy are also associated with adaptability and flexibility and (d) conflict and inconsistency point to organizational vitality and effectiveness. The onset of recession, the introduction of technologies which replaced human effort and the advance of low cost competition combined to force restructuring. US companies turned to downsizing as a solution and were followed by European ones.

## Has Downsizing worked?

Public policy attitude to downsizing as a strategy for improving efficiency rests on the following issue· Has downsizing produced the desired positive outcomes to outweigh the negative effects in terms of employment and loss of human capital? The evidence to date from the US would suggest that it has not. There is, as yet, very little data about the European experience because European industry has adopted the practice much later than the US.

Surveys by the American Management Association (AMA) have revealed that between one third and one half of medium sized companies in the US have downsized every year since 1988 (30-50% annually). The reported results from downsizing are shown in the Table 1 below:

*Downsizing is an intentional strategy adopted by companies. It seeks to improve efficiency and competitiveness by reducing company personnel*

**Table 1. The results of downsizing in the US**

| Performance Measure | Survey Result | Survey By |
|---|---|---|
| **Improved Profits** | 44 % | American Mgt.Assoc. |
| | 32 % | Wyatt Assoc. |
| **Improved Productivity** | 25.5% | American Mgt.Assoc. |
| | 22 % | Wyatt Assoc |
| **Reduced Bureaucracy** | 17 % | Wyatt Assoc |

*Source American Management Association, 1994*

*In the US the benefits of downsizing have not out outweighed its negative effects in terms of employment and loss of human capital*

*Damage to morale and commitment seriously reduces companies' vitality and ability to adapt*

A further study by the National Bureau of Economic Research found that the contribution to overall productivity increases in the 1980's of the improvements shown by the firms which had downsized had been matched by the improvements shown by the companies which had improved output per worker while increasing employment (though it must be noted that such comparisons are tricky since firms that face high demand, employment growth, and investment leading to productivity growth, would not be prime candidates for downsizing in any case).

The picture, therefore, is one of some success and a lot of failure. The failures can be traced to poor management of the downsizing process in some cases and in others to the fact that the technique is not the appropriate solution to the firms' problems. In the first category of failure the resulting damage to morale and commitment among surviving employees has seriously reduced the vitality of the companies and their ability to adapt to their new situation Nynex, a major US telephone company, was ordered by the New York Public Service Commission to return $50m to its customers because its slimmed down workforce was providing poor service. In the second category of failure a range of problems may exist from poor quality and logistics to out of date technology none of which are cured by downsizing. The ultimate manifestation of inappropriate downsizing is when managements fail to realise the importance of some activities until they have been removed and are faced with having to live with the inefficiency caused or to replace the dismissed employees.

*Downward mobility is the rule for those released in downsizing, representing a loss of human capital for companies and national economies*

## Human Capital Effects

When the question of loss of human capital is addressed some other disturbing trends are apparent. Middle managers, who represent a significant reservoir of accumulated knowledge and skill, have lost almost 19% of all the jobs eliminated between 1986 and 1991 even though overall they represent between 5% and 8% of the American workforce The same pattern has been observed in more recent studies for supervisory, technical and professional jobs. When this observation is coupled with survey results which show that downward mobility is the rule rather than the exception for those released in downsizing (replacement work is found at approximately 50%-60% of previous wage levels) the dimension of the problem of shrinking real wages, which is emerging in the US, can be seen.

This loss of tacit knowledge to many firms is reflected in the poor results of the downsizing exercises. The future effects on the firms may be even more serious as they strive to adopt new ideas and technologies. Downward mobility represents a loss of human capital to the national economy and there would appear to be a high opportunity cost in failing to reabsorb the dismissed resource. The argument that middle managers are harder to retrain and adapt reflects a continuation of the inappropriate attitude of many companies to training generally.

The other disturbing trend to be found among downsizing firms is the pattern of regular annual downsizing; as many as 60% of firms which downsize in any one year repeat the process the following year.

*Corporate survival depends more on innovation and continuous improvement than simply removing corporate fat*

## Motivation for Downsizing

Before looking at some alternative strategies to that of downsizing it is appropriate to examine briefly some broader issues underpinning the motivation of industry to adopt this approach With the evidence that the process is successful in only a minority of cases, why is it persisted with so vigorously?

One principal reason that downsizing is so prevalent in the US among public companies is the very positive reaction that Wall Street gives to announced intentions of such restructuring. Given the short-term orientation of stock exchanges top managers will continue to court the favour of the markets however short sighted the behaviour may be.

Reducing bloated hierarchies is essential to ensure corporate survival in competitive markets But improving performance requires much more than

simply removing corporate fat. The only sound basis for corporate survival and development is innovation and continuous improvement and these call for major inputs of human resources. The process of downsizing may well be counter productive in the longer term if valuable knowledge and skill is lost for short term bottom line gains.

## Alternative Strategies to Downsizing

Perhaps the most disappointing finding in the surveys on downsizing is the one which indicates that for the majority of companies downsizing was the first resort not the last. On the assumption that the implementation of the strategy was a genuine response to what were perceived as the economic imperatives many of these restructuring attempts showed signs of being ill-planned almost panic reactions which had little chance of succeeding. In many instances real problems were completely missed because they were not addressed by cutbacks in personnel.

By contrast there are many companies which have succeeded in growing rapidly and creating large numbers of jobs through a range of innovative strategies. A few key concepts are at the heart of these strategies: (a) the creation of conditions that allow small companies to thrive; (b) the adoption of a wide range of innovations and (c) a philosophy of continuous improvement.

It is generally recognised that small companies have the best record for consistent job creation. As these companies grow some have been able to consciously retain the characteristics of small companies within the larger whole. This is frequently ensured by continuously 'spinning out' the successful core activities into separate units. This is different to the conventional 'spinning off' of under-performing sections of the business.

This strategy is available to older, larger businesses which can create the same conditions if they are prepared to cede control to the smaller units and permit employees to invest personally directly in the successful projects The ideas behind this approach are not new but basically correspond to the development of intrapreneurship, a concept which was first put forward in the 1980's. One successful example of this approach is to be found in the German media conglomerate Bertlesmann.

The second concept covers the innovation element of the strategy. In one sense downsizing does contribute to the fostering of innovation in that the removal of excessive layers of management does create the setting in which innovation thrives. But streamlining the organisation is not enough on its own. Innovation requires that companies tolerate diversity and nurture mavericks These conditions may not exist in the aftermath of downsizing. One company which has pursued a policy of delayering but which has redeployed its middle managers and professionals has been Ford in its 'Ford 2000' development programme Innovation also requires that some slack resources be available to respond to opportunities for development and these may be lost in downsizing exercises. The range and types of innovation cover all activities in the company and include not only product and process innovation but the establishment of creative partnerships with customers, suppliers and even sometime competitors, aimed at reducing risk and enhancing capabilities.

The final concept embraces the philosophy of continuous improvement which implies the continuous reorganization of activities and people with growth and development in mind. A key characteristic of all of the above concepts is the central position that human resources take The companies which have followed these strategies have been at least as successful if not more than those which have downsized. The fact that most of them have taken deliberate decisions to retain and create jobs would suggest that lack of that commitment and not the inevitable effects of economic change leads to excessive downsizing.

These strategies merit public policy support in those areas where they encourage and promote innovation, for example by providing appropriate taxation regimes to support employee investment in the projects in which they are involved and to

*A philosophy of consistent improvement and innovation are the keys to the success of very small companies*

*Innovation requires that companies tolerate diversity and that slack resources be available to respond to opportunities*

*Public support should be given to companies involving employees in projects and to providing frameworks that foster creative partnerships*

provide regulatory frameworks that foster the creative partnerships and alliances that are essential components of these strategies.

## Conclusion

It would appear that the pursuit of efficiency through downsizing has not yielded the positive effects on a sufficient scale to outweigh the negative effects. Other options exist but they require that managements plan better, innovate more and change their attitudes to human resources. Public policy support for these latter strategies would be appropriate, and particular attention needs to be paid to measures for preserving the human capital stock through support for retraining and redeployment.

**About the author**

*Eamon Cahill holds a primary degree in mechanical engineering and an MBA from University College Dublin and a Ph D. in industrial engineering from University College Galway His industrial management career was spent in multi-national companies, GEC, Pilkington and Rockwell International Most recently he has spent 20 years in management consultancy including seven years as Chief Executive of the Irish Productivity Centre He is currently a Visiting Scientist at IPTS working in the areas of technology, industrial efficiency and competitiveness*

**Keywords**

downsizing, restructuring, human capital, efficiency, strategy, innovation

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## Contacts

Eamon Cahill, IPTS, tel. +34-5-4488355 fax. +34-5-4488359, e-mail: eamon.cahill@jrc.es
James Gavigan, IPTS, tel. +34-5-4488319 fax. +34-5-4488326, e-mail: james.gavigan@jrc.es

# The productivity paradox of demographic change

*James Gavigan*

**Issue:** The slow-down in growth of the EU's population is characterised by a continuous increase in the proportion accounted for by the over 60s and its declining demographic importance on a world scale. By 2025 the relative proportions of the under 20s and over 60s will have reversed. This may have a number of consequences for European society, but at the most aggregate level, it threatens the stability and sustainability of the affluent lifestyle and generous welfare system to which the EU's citizens have become accustomed.

**Relevance:** The European Commission's report on current demographic situation and trends in the European Union in 1995 highlights the consequences for employment and the productivity increases required to maintain the welfare status quo over the next 30 years, resulting from the ageing of the population. Public policies need to be sufficiently foresighted to ensure that these issues be addressed together with all stake-holders, particularly the productive sector (industry and services) and trade unions, in an atmosphere of shared responsibility. Advanced technologies and a highly skilled work-force are sine qua nons for the productive sector to measure up and bear the brunt of the strains. However, in spite of the predictability of the problem, demography often remains absent from the main-stream economic policy discussions, particularly in relation to technology and competitiveness.

## Introduction

It is very much 'business as usual' among politicians, policy makers, economists, and all categories of commentators, as they move from one pressing issue to another, debating how best to foster economic growth and oversee equitable wealth distribution. In the EU and elsewhere, competitiveness and unemployment have been at the top of the agenda for a number of years. A prominent subset of issues associated with these primary concerns include, the role of S&T and innovation, the IT society, the productivity paradox, organisational and managerial change, technology's impact on employment, foresight and prospective analysis, the fading of the manufacturing - services dichotomy, etc. Such issues broadly typify the economic policy debate from a technology / industry angle.

However, in spite of the level of sophistication which the discussions have reached, demographics - the characteristics of the human population on which society is built and evolves - has been surprisingly left out of the picture to a substantial degree. Most of the present discourse, be it centred on future technological trends and markets, sectoral strategies and priorities, or the improvement of working conditions, etc., implicitly, if not explicitly, factor the dynamic element of demography out. However, rather than being a constant of the problem, demographers have for some time been drawing attention to a number of imminent dramatic demographic changes in the EU which will have important consequences for virtually all aspects of society and the economy at large. The trends include (i) a fall in population, (ii) a decline in the number of children and young people, (iii) a

*Surprisingly, demographics, the characteristics of the human population on which society is built and evolves, has largely been left out of policy debate*

*The 'demographic time-bomb' has been a foreseeable problem for sometime*

*Employers are resisting attempts by governments to shift social welfare liability onto them and individuals are increasingly turning to private retirement provision*

*'Output per capita' is a useful indicator for monitoring changes in society's average welfare*

significant drop in the number of people of working age, and (iv) an explosion in the number of people approaching retirement and old age. This so-called 'demographic time-bomb' has been a foreseeable problem for some time, something rare in the affairs of nations. Its dimension and urgency, however, warrant action beyond mere recognition and acknowledgement, at the political level, among the social partners, and at any other level right down to the level of individual families and citizens, in order to diffuse, or at least dampen, its mounting impact.

This article aims to draw some implications of the demographic changes afoot, in relation to the present discussions around Technology-Employment-Competitiveness. It raises a number of questions which, even if they have been addressed in some quarters, deserve to feature more in the mainstream discussions.

## The time-bomb - an ageing population

The demographic time-bomb is essentially the name given to the economic problems associated with continuing to provide a self-supporting and improving welfare system that all segments of the EU population have become accustomed to this century. According to projections to the year 2025 (COM(96)66 The Demographic Situation in the EU), the under 20s group will fall by 9 5 million or 11 %, the 'adults of working age' group will lose 13 million or 6.5 %, while 'retired adults' will increase by 50 % to over 37 million, or 30 % of the total population (1). The compensatory effects of the opposing trends for the young and old groups (whereby the relative proportions of each will totally reverse), means that the overall dependency ratio (i e the number of dependants per working member of the population) is set to increase only slightly. However, the needs and social welfare expectations of the retired and elderly are very different from the needs of the young, and the burden of each group affects different aspects of the economy, as discussed further below

The centre of gravity lies clearly in the pensioner-dependency side of the problem in terms of how to guarantee funding and organisation of social protection - i e pension systems, health-care, etc. - that the present generations of contributors/ future pensioners, rightly feel entitled to. (The current ratio in most developed countries is four to five of working age for each person over 65, and is set to drop to around two-and-a-half to one in Europe by 2025 - The Economist, 27 Jan 96). Already, governments, employers and private individuals are beginning to take some action on this. In particular, employer groups are beginning to counter government efforts to shift social welfare liability onto them There is also an increasing trend, driven partly by fear of what the future might hold, for individuals to take out personal savings and complementary pension schemes. Such trends and readjustments as well as other very different, indirect policy measures (e.g. incentives for increased fertility in women, re-thinking immigration policy, extending the retirement age, etc.) are necessary and will help to dampen the shock, but at the end of the day, the overall macro-economic figures have to balance.

## Another productivity paradox?

A relevant indicator to monitor regarding changes in average welfare of society is 'output per capita' of the economy. Model calculations for the EU, reported in COM(96)66, predict that the portion of annual per capita productivity growth needed to cancel the purely demographic effect on pensions will have to climb from the present level of 0.1 - 0.3 % up to 0.5 % by 2005, and by over 1 % by 2025 and beyond. However, the conditions under which this should be achieved do not look very favourable: (i) coming out of the recent recession, the present state of growth is rather sluggish, (ii) the amount of growth increase required translates into an even higher productivity increase demand placed on each worker, given the shrinking proportion of the 'adults of working age' group, and further accentuated by high unemployment, (iii) the

demand for aggregate output increase placed on the EU economy, collides with the likelihood of a shrinking domestic market (population-wise) and a relative decline of the EU proportion of the world's population

It is instructive to take the implications of these points a bit further

## Reducing unemployment

Firstly, in order to increase the aggregate output of the economy, getting more, if not all, of the unemployed of working age back into productive activities takes on an even more urgent dimension (if this is possible!). This would have the compound effect of helping to lighten the unemployment contributions part of the social welfare bill, adding to wealth generation and providing governments with the higher taxable revenues they need. - (Note that OECD governments already spend on average 9 % of GDP on pensions. This is set to rise to between 15 -20 % by the 2020s but with further increases in net public spending arising out of even faster increasing associated health-care costs.) The Commission's 1995 report on the demographic situation in the EU demonstrates that while the pure demographic effect on unemployment levels is clearly positive, it falls far short of eliminating the problem for the lower and medium age groups of the working population.

## Higher productivity - higher skills & technology

Secondly, if the workforce is to stand a chance of attaining the extra productivity increases mentioned above, the only way is through an increased technological intensity of the productive sector (in both product and process) coupled with a general and continuous up-skilling of the work-force - both through the formal education system and professional training. This is based on the assertion that so-called high-tech activities, be they in traditional or new emerging industries and services, provide the most fruitful sources of growth potential and employment creation (see for example Technology, Productivity and Job Creation OECD 1996).

## Increased output for whose consumption?

Thirdly, the question arises of whether or not all, or most, of the required output increases envisaged above, will be consumed domestically in the EU, especially in a situation of a static or declining overall population. Clearly per capita production and consumption can rise in a closed economy, if technology pushes the production possibility frontier, and if the price mechanism negotiates between producer's abilities and consumers' tastes. More realistically however, for open economies, export markets can be crucial. As most exported goods are subject to the rigours of free competition, the maintenance of a market share requires (among other things) a level of performance and efficiency best afforded by technological proficiency and a well trained work-force, and as such concurs with the previous point. This would reinforce the argument for the EU to urgently acquire more prominence in the high-tech, high growth sectors than it presently has (see The IPTS Report No. 02, March 1996)

*Only through increased technological intensity will it be possible for the workforce to meet the necessary productivity increases*

## Will producers stay in Europe or go elsewhere?

However, the development of internationally competitive high-tech industries in Europe requires first and foremost that the EU constitute an attractive location for the investment of private capital. In the medium to long term, demographic change again does not look particularly favourable, given that the relative importance of the EU's population with respect to the rest of the world is set to decline by a couple of percent over the next 30 years to 4.7 %. If declining population also means declining market, firms may wish to relocate elsewhere, near the growth markets they wish to exploit. In spite of the nominal EU nationality of such mobile firms, the welfare impact loss of relocation abroad will probably not be offset by repatriation of profits and dividends to shareholders, etc

*Compensatory incentives may need to be offered to discourage companies from relocating closer to younger populations*

*An ageing population could create new types of demand in the fields of education, housing, health, transport and leisure*

Industry can have many reasons to wish to locate right next to the markets it serves. The question raised here is whether or not demography is going to be an increasingly important one of these. If so, compensatory incentives may need to be enhanced, and structural conditions improved, to offset the perceived disadvantage of locating in the EU. The above analysis depends on general 'transport' costs (including non-tariff barriers to trade) and, of course, on the net effect of population and disposable income trends.

## What to produce - the changing profile of society's needs

As the median age of the population moves upwards (35 at present, set to reach 45 by 2025), the age-weighted profile of needs will change substantially with major consequences for some parts of the productive sector and the provision of public services.

On the downside, the decline in the number of young people will have a major impact on the educational system, and on any sector targeting the youth market (toys, entertainment, etc.), some of which are presently leading particular technological developments - e.g. Nintendo in multimedia software design.

On the 'up' side, the ageing population will give rise to whole new types of demand, principally in the fields education, housing, health, transport and leisure, with many new sorts of goods and services required. The productive sector as well as the S&T system will have to anticipate, innovate and develop the new technologies to enable these new markets to develop and expand in proportion to the emerging level of demand. In this way, disciplines such as gerontology and gerontechnology will increasingly come to the fore (see, for example, the COST-A5 action on Ageing and Technology) in underpinning the developments which define the new markets It is also probable that such advances in leading to a healthier ageing population (i.e. so-called rectangularisation - see "Economics of Population") will not only reduce health and social care costs, but also facilitate the postponement of the retirement age for those who can or wish to continue their productive working.

## Ageing - a new global growth market?

These new goods and services represent clear opportunities for business development and expansion. The associated market place is of global dimension, given that the same ageing trends in the EU are mirrored right across the OECD. Even in the developing world (with the exception of Africa), the ageing phenomenon is manifest, with the over 60s set to reach 14% in Latin America and most of Asia, and 20% in China by 2030 (The Economist 27 Jan 96).

This immediately begs the question as to whether, at the aggregate level of the EU, the OECD or the world economy, this and other growth markets will overcompensate for declines elsewhere, with a resultant net positive growth rate Clearly, with all the developed world coming to terms with the same problem of attaining the growth levels needed to finance the heavier social welfare burden, there is incentive to exploit to the full the win-win effects of free trade, etc. However, because of the nature of the ageing market, in targeting a by and large inactive portion of the population, its overall effect may turn out to be simply neutral.

One way out of this apparently catch-22 situation would be if free trade and reasonable growth were to take hold of the developing world in a serious way (as it very well could given the right conditions - The Economist 25 May 96). As such, the ageing problem constitutes a further stimulus for increased public and private efforts in this regard, of potential mutual benefit to the developing and developed world.

## Conclusion

The purpose of this article has been to speculate in a schematic way on a number of implications of the demographic changes afoot for the economic activity and welfare of society at large. In short

these changes raise a number of questions:

- How increasing rates of output growth can be achieved in the medium to long term by a shrinking workforce
- The consumer markets for industrial output.
- The changing profile of output.

These, and other related questions deserve a more sophisticated analysis in the on-going policy debates so taken up with unemployment, innovation, etc., both of necessity and in the hope that some new and useful insights emerge from the underlying synergies and contradictions.

**Keywords**
ageing population, competitiveness, productivity paradox, employment

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**Notes**

The same reference contains individual country-by-country data which show a variety of different situations with the result that the implications for some Member States would appear to be much less dramatic than others, in spite of the overall dominating trend.

**Contact**

James P. Gavigan, IPTS, tel. +34 5 44 88 319 fax. +34 5 44 88 326 e-mail: james.gavigan@jrc.es

**About the author**

*James Gavigan holds a Ph D from the University of Dublin in Pure and Applied Physics. He is employed by DG XII as a Scientific Officer in the Industrial Technologies and Materials Unit and is currently working at the IPTS in the TEC Unit. His research interests include the organisation of agile enterprises and clusters of economic activities (webs)*

# Biomedical Implants: Quality Standards and Promoting Innovation

*Tonino Amorelli*

**Issue:** In a context in which the use of biomedical implants is on the increase it remains an open question whether they should be controlled by the same kind of strict regime as exists for pharmaceuticals and what impact such standards might have on innovation in the industry.

**Relevance:** The combination of an ageing population and today's active lifestyles make it seem likely that the importance of the medical implant industry will continue to grow in the next century. This is an area where quality standards, testing, in-use warranties, etc. are of the utmost importance. The need to protect the health and welfare of those who require implants is clearly vital, thus regulation needs to be sufficiently strong and effective to work in the interests of both patients and the industry.

## The Ageing Society

*Changes in longevity and increasingly extreme forms of exercise make the chances of multiple implants greater*

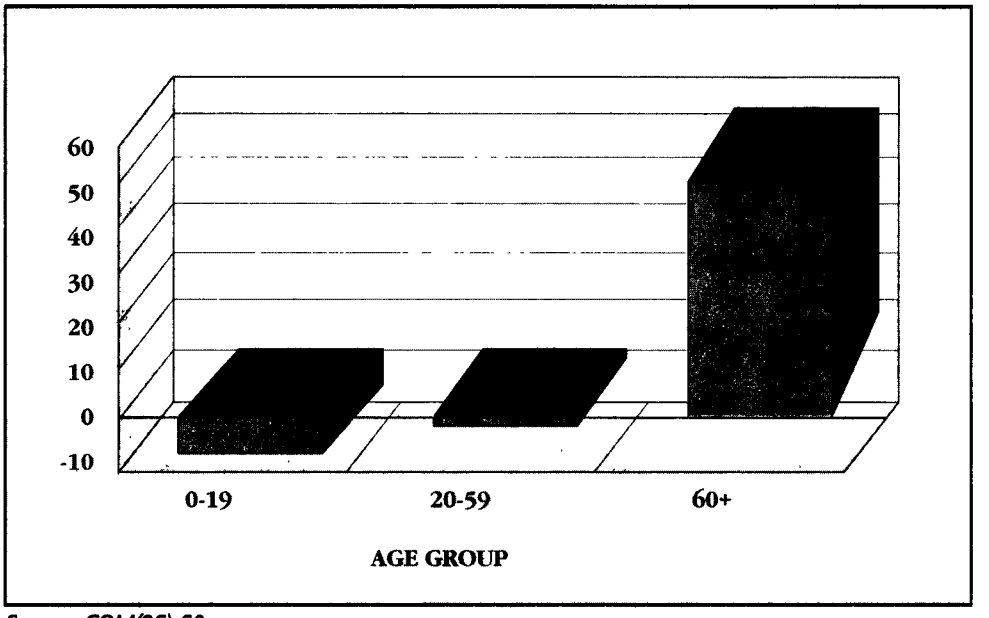
A large number of studies are now confirming that the there will be a marked increase in the 'greying population' during the early part of the next century. In the graph below (Figure 1) we can see that recent scenario estimates, for population growth between 1995 and 2025, give an EU average rise of 52% for those over 60, while there an average net decrease is expected in other age groups.

The implications of this for the medical industry as a whole are positive, as health-care will become increasingly important. Growth in the medical implant industry is expected to be particularly significant. At present, in the UK alone, there are estimated to be 40,000 hip replacements and 16,000 knee replacements per year. Such implants currently have a lifetime of 10-15 years. Changes in the make-up of society resulting from better health-care and increased longevity makes the possibility of a second, or even third, implant much greater.

The possible need for multiple implants must be stressed even more as we assess other changes in lifestyle such as increased physical activity. This encompasses not only general physical exercise such as walking or running, but also more 'extreme' forms such as aerobics, mountain bike riding, etc. This boom in the 'keep fit' mentality has yet to reveal its true impact on, not only the older generation, but also the young to middle aged. It is here, in this 'younger generation' where there has also been an increased need for implants to replace bones worn out from over- or mis-use.

Of course, this has further repercussions with regards to the cost of health-care, coming not only from demographic factors and increasing consumption, but also from advances in technology. Improvements in the treatment of certain disabilities is expensive and costs increase in proportion to the sophistication of the methods and materials used.

**Figure 1. Average EU Population Growth (%) between 1995 and 2025**




*Source: COM(96) 60*

## Matching Standards to Advancing Technology

A consequence of the use of new techniques and materials for biomedical implants is that they must comply with certain mechanical and chemical testing standards. The problem for the regulator lies in the need to provide a quality assurance framework which maintains pace with technological developments while at the same time allowing the most up-to-date and efficient techniques to pass through the system and so benefit patients

Imposing too many regulatory standards and procedures leads to increased costs for implant manufacturers which must be passed on to the health-care system or to patients. This has a dual effect On the positive side this increases quality assurance, but on the negative side manufacturers may be less willing to innovate in design and use of materials, tending instead to depend on less up-to-date but thoroughly tested models With large markets at stake, this could have a major effect on the competitiveness of European implant manufacturers. However, this is not to say that standards should be minimised, only that they should be sufficiently flexible to be applicable to both the testing and implementation of rapidly developing technologies.

In the USA the Food and Drug Administration (FDA), the main regulatory authority, is preparing itself for changes in the rules The USA is similar to the EU in that each state has its own regulations concerning human implants and these are run in parallel with the FDA's own standards, set up under the control of the American Society for Testing and Materials (ASTM) In Europe, the European Committee for the Co-ordination of Standards (CEN) is the body which aims to harmonise regulation in this field However, there may be a need to make this structure more effective by stimulating intercourse between national bodies, industry and research institutes This could ensure that all interested parties were aiming for a common goal - the welfare of the patient

This is significant when considering exports to other nations, where regulations can differ In particular, the USA has slightly different regulatory procedures, characterised by longer times for the development and subsequent market penetration of the implant (which is not to say that their regulations are more stringent) This slowness of the US system is demonstrated clearly by a recent ground-breaking operation to implant an artificial titanium heart FDA regulations prevented the

*Standards need to keep pace with technological developments but should not represent an obstacle to innovation*

*Regulatory procedures vary from one country to another and this may give rise to problems for global harmonisation and market openness*

*Apart from a need for better insight into the biocompatibility of each material used, there is an equally important need to evaluate the effects of wear on the implant itself*

*Understanding how different human cells behave in the interface between tissue and the implant is fundamental to the definition of biocompatability for the material*

*In vivo testing offers the best general screening method, but is slow, costly and can involve large numbers of animals*

Americans, who were leading research in this field, to test their devices in vivo and so they were beaten to the first by a British team.

This short-cut to the market can, however, have its disadvantages in the international marketplace. Currently, in the area of drug research and development, the FDA is participating in harmonisation discussions with the EU, but has its reservations about accepting a mutual recognition agreement until it is satisfied with EU procedures and that regulatory equivalence exists. There is also some controversy in the USA over the inspection of imported medical devices. At present the US taxpayer pays the FDA to carry out inspections, but some officials now believe that the cost should be met by either the exporters or their governments.

## Improving testing procedures improves standards

At present, many aspects of the functionality and passive impact in the human body of prosthetic implants are not well understood. Apart from a need for a better insight into the biocompatibility of each material used, there is an equally important need to evaluate the effects of fatigue and wear on the implant itself. These latter qualities differentiate implants from drugs, since the patient has a prolonged exposure to the implant (a number of years), whereas most drugs are prescribed over a much shorter period.

When prosthetic elements are implanted in living organisms, they are in contact with the surrounding biological environment. The biomedical material needs to be both biocompatible and biofunctional, in order to ensure that it performs effectively without harming the host patient. An understanding how different types of human cells behave in the interface between tissue and the implant is crucial for the definition of the biocompatibility of the material. There are two different ways of studying this behaviour: *in vivo* and *in vitro* techniques.

At present, *in vivo* testing is the most widely-used. This type of test undoubtedly allows better screening of general device biocompatibility and biofunctionality, but the techniques are very costly and require lengthy tests involving large numbers of animals, if not human patients, to yield satisfactory evidence. On the other hand, *in vitro* testing of laboratory prepared cell cultures can be very sensitive, reproducible and rapidly yield quantitative results that are both and statistically coherent. Advances in tissue culture techniques and genetic markers allow the rapid screening of specific interactions between tissues and implanted materials and devices. It is from such tests that biologists have been able to gain some understanding of the genetic toxicity and biocompatibility of materials without endangering a human host.

The main problem is that the complex reaction of a living organism to an implanted material or device is the sum of the interactions of these specific cellular responses. It therefore takes a lot of time and effort to correlate the results of *in vitro* tests with in vivo behaviour. Nevertheless, by separately evaluating different cell cultures, prior to *in vivo* testing, it is easier to understand any biocompatibility problems which may be present in one application that may not arise in another Such specific biocompatibility tests need to form part of preliminary testing procedures before longer and more expensive *in vivo* tests are embarked upon.

A good example of where such specificity can be found is in the use of hydroxyapatite, which is a material that mimics bone There has been some success with its use as a coating for hip prostheses where it helps to promote the acceptance of the implant through integration with natural bone cells. However, when it has been used for dental implants, the acidic environment of the mouth dissolves the hydroxyapatite and allows bacterial infection.

There are *in vitro* tests which do satisfy some of these criteria and offer general biocompatibility standards. However, these standards do not give information on, among other things, the cell-specific biocompatibility of a material, needed to guarantee the physiological integrity of its functions or the potential of cells to

mature normally whilst in contact with a material, which is necessary to guarantee successful long term implantation. It is interesting to examine these two points with respect to the court cases concerning breast implants. Almost thirty years ago the manufacturers, Dow Corning, observed contracture (tissue hardening around the implant). Despite concerns from the medical profession over possible leaks and the safety of gel, it was still used. It has now been proven that leaks are possible and that the gel migrates around the body, although it has not yet been shown conclusively whether or not this then reacts inside the body.

## Conclusion

Standardisation and regulatory controls are important aspects of all scientific development, and they are even more important when the technologies in question are to be used inside the human body. Although standards do exist at a national, and, in some cases, international level, they may not be sufficient to guarantee effectively that the use of implants is completely safe. Testing technologies are now being developed which can evaluate their precise impact on a human host on a cell-by-cell basis, and this would seem to be an ideal opportunity to develop genuinely specific standards.

A co-ordinating body, or network of interested parties, based at the EU level, dedicated to developing testing methodologies and with tight regulatory powers is one possible way forward. Establishing a pan-European base for the development of standards of this kind also offer a better outlook for the industries involved in the international market, as well as protecting the increasing number of citizens who will take advantage of these technologies over the coming decades.

*In vitro testing can be very sensitive, rapid and reproducible and makes biocompatability testing with specific cell types possible*

*In vitro testing is not able to assess long-term survival of cells in contact with the material*

**About the author**

*T Amorelli holds a BSc and Ph D in Chemistry from the University of Wales, College of Cardiff, UK Before coming to the IPTS, where he is currently working as co-ordinator of the Advanced Materials project, he spent 2 years researching catalysis for automotive applications His current research interests include automotive materials, composites, biomedical materials and general aspects of technology transfer*

**Keywords**

biocompatible materials, standards, ageing population, implants, innovation, competitiveness

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G. Clarotti, DGXII
C. Zanantoni, Institute for Advanced Materials, DGJRC

**Contacts**

T. S. Amorelli, IPTS, tel. +34 5 4488295; fax +34 5 4488339; e-mail: tonino.amorelli@jrc.es
J. R. Naegele, IPTS, tel. +34 5 4488265; fax +34 5 4488339; e-mail: jochen.naegele@jrc.es
F. Brossa - tel. +39 332 789069; fax +39 332 789171; e-mail: francesco.brossa@jrc.it

## Information Exchange in Promoting Innovative Activity

*Maria Maroushkina*

It is generally acknowledged that the 'information pool', i.e. the critical mass of the information used in information exchange between participants in the innovation process (capital donors and recipients, authors of innovations applied in the project, and venture firms promoting technologies), is a stimulating factor for innovative activity. It was the realisation of this fact that spurred the creation of 'technoparks' and 'technopolis' areas aimed mainly at stimulating contacts between researchers in various fields of knowledge and firms engaged in promoting R&D projects on investment markets.

The range of interests and tasks performed by the participants in the innovative activity is extremely wide: and includes selecting investment media, searching for spare capital, choosing the best forms of investment cooperation, searching for investment partners, upgrading the cost-effectiveness of the innovation project, searching for the most competitive projects, and managing the innovation project effectively. Each participant in the innovation process within the given innovation project is indispensable, as the innovation process is essentially a corporate process bringing together participants with different interests, claims of ownership, legal status, etc. It is the extent to which these different interests can be reconciled that determines the project realisation efficiency, minimizing the risk of project failure.

Information exchange, from selecting innovations for the investment project to the project accomplishment, is what unites and reconciles all the different interests at all stages of the innovation's life cycle. At the first stage of an investment project a circle of participants is formed, and technology for the project realisation is determined. At this stage combination of production factors emerges which most effective from the viewpoint of the capital donors as well as those proposing technical, organizational, legal and economic solutions. Therefore, it is of crucial importance that there be free access to the information on the range of technological solutions, on experience in implementing investment projects, on the effective forms of innovation cooperation, and on the potential participants in the project, are of crucial importance. The STN world information network is an example of a network which stores information on effective technological solutions and on the promotion of technological solutions on the world investment market.

Nevertheless, information concerning innovative initiatives by individuals and firms is not readily available, nor is information on certified project-managers, nor, in general, on individuals' innovative activity. Such information is no less important than that on the scientific and technological potential, as far as stimulation of the innovation process is concerned.

Both the versatility of the innovative business and the importance of personal factors in the innovative sphere make it necessary to form specific information environments capable of securing the development of effective cooperative interaction.

There exists an effective information-based solution to stimulating innovations, namely the organisation of an electronic innovation 'fair' based on computer networks. Technically, this

would imply the creation of an information data bank that would contain information on all kinds of innovative initiatives originating from both corporations and individuals.

One could suggest the following specialised data bases:

- projects for capital recipient businesses;
- proposals by capital donor financial institutions;
- projects by the creators of new technologies;
- proposals by project managers capable of undertaking to implement relevant innovation projects (those holding international certificates);
- proposals by venture firms;
- proposals by regional authorities on preferential treatment for innovation projects;
- regional information on the investment climate;
- information on the investment legislation;
- lists of firms ready to lend intellectual support to an innovation project;
- systematized know-how of successful innovations worldwide.

The annual international innovation fairs are hard-pressed to fully satisfy the demand for multi- aspect information on innovations. They often last for too short a time for all those interested to be able to familiarize themselves with the exhibits Secondly, retrospective information is also useful. On the whole fairs and exhibitions, though valuable, are basically limited in their capability to organise information exchange

The Green Paper on innovation pinpoints the creation of innovation databases as an important problem. Databanks with sophisticated computer retrieval systems could help by locating complementary innovative initiatives not only in a limited database, but also on-line, through computer networks in multilingual media.

In such a databank any originator of an innovative initiative should be entitled to display information on the initiative at the "electronic innovation fair". Moreover, the "electronic innovation fair" itself should be freely accessible. Running such an information bank is a separate task, which could be performed within the framework of a joint venture centre.

Creating such a data base is a necessary but not a sufficient condition for securing the right choice of competitive projects: analytical work on projects is needed, based on a data base reflecting the dynamics of the world commodity and capital markets, as well as on information technology capable of securing the selection of the most interesting innovation projects.

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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 rsearch to imporve 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 across 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-sectorial 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.

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