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ABOUT THE IPTS REPORT

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

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

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

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

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

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

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

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Preface

The increase in energy consumption is a global problem directly related to the security of the energy supply and its effects on the environment. It is expected that Europe's energy consumption will grow by 20% between now and 2020, but the demand from developing countries will increase even faster.

The way in which to obtain secured energy sources has been a great concern for the developed countries since the oil crisis of the 1970s. In the last two years, oil markets have experienced serious instability, and the oil price has reached a minimum closer in real terms to the values previous to the first oil crisis. Even if this situation persists temporarily, oil production in the long term will increasingly concentrate around OPEC countries who at present hold a share of three-quarters of the world oil reserves. As a consequence, oil shocks will mostly depend on geopolitical reasons. Therefore, energy diversification policies and the collaboration between oil-related sectors in the producer and consumer countries are advisable to prevent any future crisis.

The European Union energy policy, concerned by the above, has been developed taking into consideration the two major objectives: securing Europe's energy supply (external dependence amounts 50%) and protecting the environment (both in Europe and world-wide). The Kyoto summit has marked the start of a new phase in achieving a global compromise to drastically reduce the impact on the environment of fossil fuel and other greenhouse gas related sectors.

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In the short term diversification and the use of environmentally friendly sources of energy are likely to induce expansion of the use of gas. In the medium term, high efficiency fossil-fuelled technologies, including fuel cells, will have an important role to play. In the long term, renewable energy appears to be the backstop technology to circumvent the problem of scarcity of fossil resources and the environmental negative effects associated to them. In order to support this, the 5th Framework Programme of R&D has earmarked 479 millions Euros for its key action "Cleaner Energy Systems Including Renewables".

The solution to energy dependency and environmental damage inevitably entails important investments in R&D, and a revision of the overall structure of the energy sector including the technology portfolio, the supply and demand aspects and the regulatory framework.

Eriksson

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EDITORIAL

Dimitris Kyriakou

We offered in the previous issue a definition of competitiveness based on the notion of attractive societies. It suggested that competitiveness marks societies which generate and nurture economic entities (from individual to large firms) which can flourish and perform successfully in world markets, and to which human (and other forms of) capital is attracted. Competitiveness implies attractive societies in which to live, work and invest.

More traditional definitions have been suggested of course; a standard one from the OECD goes as follows: Competitiveness refers to the ability of companies, industries and regions, nations or supranational regions to generate, while being and remaining exposed to international competition, relatively high factor income and factor employment levels on a sustainable basis.

The emphasis is on rising living standards, and on international market competition. Since productivity growth is the key to rising living standards the critique has been cogently put forward that competitiveness is really a roundabout way to denote productivity. Productivity – and related statistics – indeed tell a large part of the story (and this is why we will devote a section later on to such indicators). Productivity does not however complete the picture in our forward-looking and broader definition of competitiveness, which is still to come, nor in the more traditional ones.

Although openness leads to overall gains, the distribution of these gains is uneven. Depending on patterns of accumulation of capital (human and all other forms of capital), which is influenced by trade, countries may enter higher or lower growth paths.

A standard fundamental assumption made in economics is that there is no altruism or envy, i.e. you only care about your welfare and not about other people's. Another assumption made only implicitly is that extra-economic considerations, such as conflict (political or even military) are assumed beyond the scope of the analysis. This way a crucial policy-relevant link is missed: economic gains have an impact on a country's power (political, military, etc.) and its ability to use it to compel or deter others. Once conflicts enter the scene, the distribution of gains becomes a very reasonable concern.

To summarise: there are at least three reasons why the international dimension makes competitiveness reflect real concerns, making it more than a mere alias for productivity growth. First, how successfully and profitably you compete is linked to shaping a reinforcing comparative advantage, to the accumulation of capital (human and otherwise) and the likelihood of entering higher or lower growth paths. Second, if conflict is a possibility, how competitive you are, and the distribution of gains in a positive sum interaction matter. Third, if

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altruism and envy are not assumed away, the distribution of gains again matters. (Note that relaxing the no-altruism, no-envy assumption leads to models in which all goods are public goods, making government intervention likely and justified in more cases, and the analysis of Coase-type negotiations even more important – for more on this see IPTS Report editorial October 1998, issue 28).

Lest it be forgotten, let us underline here the point made by, among many scholars, the Commission's own Jacquemin and Pench in the 1997 Competitiveness Advisory Group Report: even for those who have the political-economic or growth-path concerns outlined above, they (and everyone else) would be worse off if the positive-sum interactions promoted by economic openness were to be undermined.

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Climate Change Protection: The Tolerable Windows Approach

Thomas Bruckner and H.J. Schellnhuber, ***Postdam Institute for Climate Impact Research***

Issue: Comparing the quantifiable costs and benefits of climate protection strategies is an extremely valuable exercise. The considerable scientific uncertainties and unavoidability of normative judgements, however, make it difficult to find a globally optimal climate policy path. A complementary approach, the tolerable windows approach, is therefore proposed, which aims to identify the scope for action compatible with pre-defined climate and socio-economic constraints.

Relevance: Separating facts from value judgements is generally regarded as a prerequisite for reliable science-based policy advice. However, this requirement is often misinterpreted as meaning that value judgements should be excluded from the policy advice process altogether. As this is impossible, decision-support methods should allow an explicit consideration of value judgements in a manner that enables opinions and scientific analysis to be distinguished clearly.

One result of the series of international conferences called to discus concerns about the potential risks of anthropogenic climate change is the Framework Convention on Climate Change (FCCC)

Introduction

Increasing concerns about the potential risks of anthropogenic climate change over the past ten years have led to a series of international conferences intended to combat climate change and its adverse effects. However, the Kyoto Conference of the Parties to the Framework Convention on Climate Change (FCCC) and, more so, the conference in Buenos Aires revealed the tremendous complexity of the climate change issue, which makes consensus about necessary mitigation measures almost impossible. Not surprisingly, scientific advice is highly sought after by the policy makers involved, who are interested in the long-term implications of the short-term decisions they are responsible for.

Different scientific approaches were proposed in order to help climate change decision makers confront the difficult choices involved in implementing FCCC. The policy evaluation approach, for example, projects the physical, ecological, economic, and social consequences of pre-defined climate change scenarios. An additional approach, the method of cost-benefit analysis (CBA), attempts to balance the over-all costs and benefits of climate policies by determining an optimal path for all relevant policy variables, such as carbon taxes.

Unfortunately, both approaches often result in contradictory climate policy recommendations. The policy evaluation approach tends to recommend strong reductions in greenhouse gases in order to avoid severe future impacts even

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on a regional level. In contrast, CBA focuses on the globally averaged discounted welfare of current and future generations. In this case, impacts are levelled out by regional and temporal aggregation (accompanied by discounting future utilities) thus justifying only slight emission reductions.

Here we will discuss in detail the implications of -these, no doubt unavoidable,- value judgements together with different attitudes concerning the still large uncertainties surrounding global climate change. Together both aspects are mainly responsible for the discrepancy discussed above - a discrepancy which has caused much confusion and which threatens the credibility of scientific climate policy advice.

Obviously, science-based climate policy **recommendations**, for instance answers to questions like "By how much, when, and where **should** emissions be reduced?" cannot be formulated without referring to value judgements (cf. Findeisen and Quade, 1985). Science's own view of itself, and the need for democratic legitimacy, means scientists are not allowed, however, to formulate the necessary normative inputs to the decision process alone (Rat von Sachverständigen für Umweltfragen, 1996). Therefore, an innovative decision-support tool, the **tolerable windows approach** (also known as the **guard-rail approach**) has been proposed, in order to allow straightforward consideration of normative settings formulated by policy-makers.

The Scientific-Analytical Complexity of the Climate Change Issue

From a scientific point of view, global climate change is characterized by extremely high regional, sectoral, and temporal complexity (cf. IPCC, 1996). Far-sighted climate change decision makers therefore ask for scientific advice in order to assess the outcomes of the climate protection strategies they are willing to defend, for instance, in FCCC negotiations.

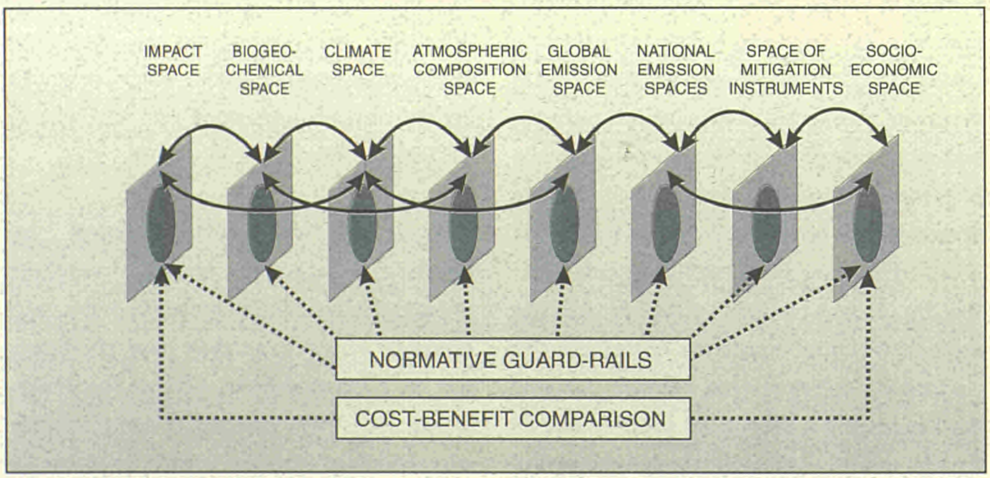
A possible way to proceed in this situation is to specify some test policies and to evaluate the respective physical, ecological, economic, and social consequences by using integrated assessment models. The disadvantage of this

The two main approaches to implementing FCCC are policy evaluation –which projects the consequences of present scenarios into the future- and cost-benefit analysis (CBA)

The difficulty of keeping value judgements out of the debate means conclusions and recommendations may at times diverge

An alternative to trial and error is to define goals beforehand and determine pertinent policies by applying optimization models

Figure 1. Example interconnections (solid arrows) between the relevant spaces (shaded rectangles) in investigating global climate change



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Although the completeness goal of CBA is in principle an advantage, it can impose a problematic requirement to know all possible interconnections when a so-called welfare-optimal path is sought

Although they are built on solid scientific foundations, climate models are plagued by non-linearities and uncertainties which make long-term predictions highly speculative

Investigating the future development of the socio-economic system is the most challenging part of a comprehensive CBA of the climate change issue and simplified models of human behaviour tend to be resorted to

'policy evaluation approach' (IPCC, 1996) is that the respective iterative 'trial and error' process will be very time-consuming.

A promising alternative therefore is to define the goals beforehand and to determine the pertinent policies by applying appropriate optimization models. The basic analytical framework here is cost-benefit (welfare maximizing) analysis (CBA), which firstly seeks to identify all costs and benefits of conceivable climate protection measures, secondly compares the costs and benefits, and finally selects the path that maximizes global welfare.

The definition of guard-rails (see Sec. 4) results in restricted areas for manoeuvre that are depicted in the various spaces by grey 'windows'. Imposing restrictions on the effects of climate change will restrict the causes of climate change, too. The related forward and backward influences are indicated by the doubled arrows. Note that cost-benefit analysis requires a comparison of outcomes occurring at the extremely uncertain poles of the depicted cause-effect chain.

The corresponding pursuit of completeness doubtless is an advantage of CBA, since a complete identification of conceivable costs and benefits of various climate protection strategies, in so far as this is possible, is obviously extremely valuable (IPCC, 1996). As soon as CBA is used to determine a so-called welfare-optimal path, the pursuit of completeness, however, becomes a problematic completeness requirement. In order to determine an optimal path reliably, it would be necessary to know all relevant interconnections (see Fig. 1) between socio-economic activities and related climate impacts in a quantitative way - at least in a statistical sense. Currently, however this requirement is beyond the scientific state of the art. Especially with respect to some impacts of climate change, whole parts of the puzzle that may be the crucial ones have still to be investigated and therefore are not known in either a deterministic or statistical sense.

Climate models are built on the laws of physics, which are well known and have been extensively empirically tested. At first sight, climate models should therefore be able to project climate change reliably as long as the underlying emissions are specified with sufficient accuracy. Problems arise, however, as a result of the limited regional resolution of the models, and the non-linearities and uncertain boundary values. It is therefore extremely difficult to decide whether global climate will evolve in the future in a regular way or whether greenhouse gas emissions will trigger some kind of singularity effect, such as a destabilization of atmospheric chemistry; a shut-down of the so-called thermohaline Northeast Atlantic heating "conveyor belt"; the break-up of the West Antarctic ice sheet; or a potential run-away greenhouse effect caused by permafrost melting.

Cost-benefit analyses carried out to date have relied heavily on the results of the often extremely simplified climate models used to describe the ordinary behaviour of climate. 'Optimal' climate protection paths determined in this way run the risk of transgressing the thresholds that correspond to the above mentioned singularity effects, which are critical but not currently understood with any certainty (cf. Schellnhuber, 1997).

Compared with climate system and biophysical climate impact modelling, investigating the future development of the socio-economic system is an even more challenging part of a comprehensive CBA of the climate change issue. Here generally accepted scientific laws describing long-term human behaviour are

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still lacking. This means socio-economic modelling relies heavily on the extremely idealizing assumption of rationally acting individuals or on extrapolating observed behaviour econometrically far beyond the range of experience.

The Political-Normative Complexity of the Climate Change Issue

With respect to the political dimension of climate change, the corresponding requirement inherent to CBA is as two edged as that relating to the completeness of our present knowledge of the science of climate change. Here, the goal of CBA is to replace all normative judgements by one fundamental judgement, namely that the finally selected climate protection strategy should maximize the global welfare of all current and future generations. A detailed analysis of this goal (Helm *et al.* 1998; Bruckner *et al.*, 1998), however, reveals that in concrete applications various fundamental assumptions of CBA are questionable. For example, already at the stage of defining a global welfare function several normative judgements are involved which affect the intra-personal comparison of different categories of climate impacts, the question of compensating losses by monetary transfers and the relationship between cost-benefit considerations and ethical standards. From a temporal and regional point of view, the normative question is how climate impacts or mitigation costs that affect different generations and different regions should be aggregated. Since the related normative judgements correspond to the definition of often extremely technical aspects of CBA (like appropriately specifying various weight factors used for temporal and regional aggregation), most of these value judgements are not visible to the decision makers who are the ones who should provide the necessary normative inputs.

The Tolerable Windows Approach

The huge analytical and political complexity of the climate change issue means the tolerable windows approach (a.k.a. guard-rail approach) does not seek to identify an absolute and generally accepted scientific answer to the climate change decision problem. Instead, the pragmatic and policy-oriented approach provides a suitable platform making it possible to combine the unavoidable normative settings formulated by the decision-makers themselves with our present scientific knowledge without filling still existing scientific gaps by crude and often arbitrary assumptions. We would mention in this context that according to our point of view, the normative settings reflect the will of policy-makers to actively define the climate protection strategy they are prepared to defend in negotiations, instead of simply adopting what should be done according to mainstream economics.

A typical application of the tolerable windows approach starts with an explicitly normative definition of guard-rails that exclude intolerable impacts of climate change on the one hand and unacceptable socio-economic consequences of mitigation measures on the other. A subsequent scientific analysis of the systems involved (see Fig. 1) is then carried out in order to obtain the set of all climate protection strategies that are compatible with the pre-defined constraints. Finally, a single policy path may be selected either by taking into account additional criteria such as cost-effectiveness, by referring to qualitative arguments (like the precautionary principle) or finally during a negotiation process.

The approach deliberately refrains from specifying how the guard-rails should be defined. Therefore, different value judgements can be taken into account in a flexible way. One important advantage of the approach is that the unavoidable normative judgements can be

In the political dimension of climate change the goal of CBA is to reduce judgmental aspects down to the question of maximizing global welfare of current and future generations

A typical application of the tolerable windows approach starts with an explicitly normative definition of guard-rails that exclude intolerable impacts of climate change on the one hand and unacceptable socio-economic consequences of mitigation measures on the other

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applied to restrict the actual outcomes of climate protection strategies instead of specifying highly technical aggregation factors beforehand (as in the CBA case).

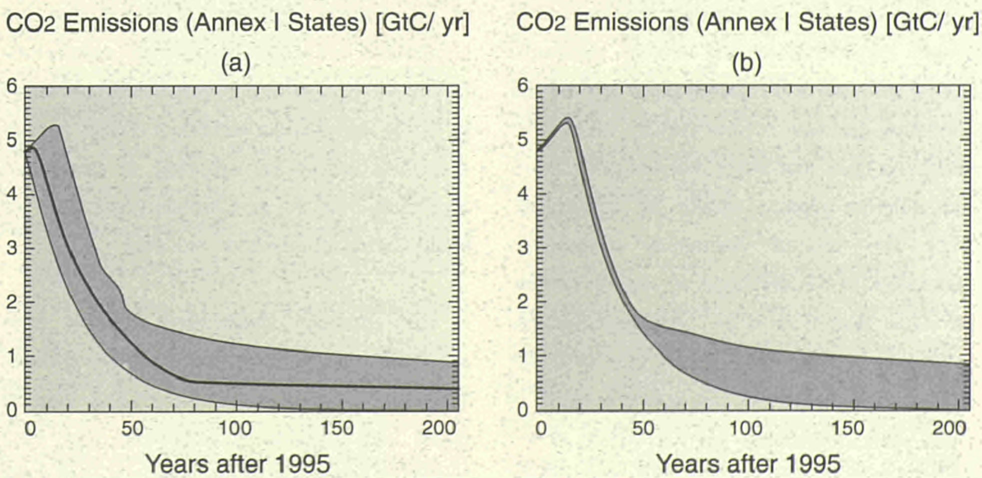
The democratic right of policy-makers to specify the normative settings does not, however, imply that they should do so uninformed. Thresholds concerning potentially catastrophic climate change impacts are suitable candidates for guard-rails that can be defined in an almost systemic way. Since significant impacts may occur well below these thresholds, (almost purely) normatively defined guard-rails can also be used to restrict regular climate change. In the latter case, knowing the results of highly disaggregated simulation models can provide a basis that enhances the policy-makers' ability to specify guard-rails.

The democratic right of policy-makers to specify the normative settings does not, however, imply that they should do so uninformed

With respect to the analytical complexity of the climate change issue, we would mention that the definition of guard-rails is not restricted to the highly uncertain climate impacts or uncertain implications of mitigation measures. Guard-rails can also impose restrictions on intermediate and more reliably computable indicators (such as global temperature change or emission reduction rates). This enhances the applicability of the guard-rail approach to the climate change issue where scientific uncertainties seem to be omnipresent. In addition, some of the guard-rails corresponding to these indicators can be prudently defined without referring to climate impacts at all. For example, global mean temperature may be restricted in order to stay within humanity's 'climatological field of experience' (cf. WBGU, 1995) or within the range of applicability of the simple climate models used in integrated assessments. In this way, aspects of the qualitative precautionary principle can be taken into account by the tolerable windows approach.

The tolerable windows approach was originally proposed by the German Advisory Council on Global Change (WBGU) in a statement on the occasion of the First Conference of the Parties to the FCCC in Berlin (WBGU, 1995) by one of the authors (H.-J. S.) of this article. Subsequently, similar approaches (e.g., "safe-landing analysis") were applied by various research groups (e.g., J. Alcamo, 1996; Y. Matsuoka et al., 1996) world-wide.

Figure 2. Necessary emission corridors derived by taking into account the climate and socio-economic guard-rails formulated by the WBGU (see text)



Source: WBGU, 1997

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In what follows we would like to present some illustrative results of the ICLIPS (Integrated Assessment of **Cli**mate **P**rotection **S**trategies) project, which is responsible for the further development of the tolerable windows approach.

According to the normative judgements in the example below (discussed in detail in WBGU, 1997), global mean temperature change should be less than 2 °C (relative to the pre-industrial level) and the rate of global mean temperature change should not exceed a value of 0.2 °C per decade. The so-defined 'WBGU climate window" is supplemented by a provisional socio-economic constraint requiring that the rate of emission reduction (a proxy for the resilience of the socio-economic system) should be less than 4% per year. In addition, it is assumed that developing countries will have no reduction commitments until equality is reached according to the "equal emission per capita" principle (on the basis of the population of 1992).

By applying appropriate mathematical methods (Toth et al., 1997; Bruckner et al., 1998), necessary emission corridors (Fig. 2) can be determined, which characterize the scope for action that remains if all the pre-defined guard-rails are obeyed simultaneously. Every climate protection strategy that is compatible with these constraints stays within the corridors, i.e. every strategy leaving the corridor is obviously not admissible.

The green area in Fig. 2a depicts the carbon dioxide emission corridor of the industrialized nations (strictly speaking the nations belonging to Annex 1 of the FCCC). According to our model and taking into account the normative inputs, greenhouse gas emissions must be reduced substantially in the long term.

Although the corridor (Fig. 2a) reflects clear short term flexibility, waiting 15 years without implementing emission reduction measures at all would result in a corridor that looks more like a straitjacket than a corridor with ample choice as clearly shown in Fig. 2b. In its statement at the Kyoto Climate Conference (WBGU, 1997), the WBGU therefore recommended a moderate climate protection strategy (black line within the corridor of Fig. 2a). According to this climate protection strategy (corresponding to roughly 1% per year global emission reductions), emissions of industrialized countries should be reduced by about 80% by the year 2050.

The WBGU climate window can be compared with threshold curves beyond which a complete and permanent shut-down of the North Atlantic thermohaline circulation (THC) cannot be excluded (Fig. 3). In order to emphasize the high degree of uncertainty involved, two different threshold curves were calculated by using the CLIMBER climate model developed at the Potsdam Institute for Climate Impact Research (Ganopolski et al., 1998b). The more restrictive curve (HHS) corresponds to high hydrological sensitivity. The other is related to a low value of this parameter (LHS), which —for a given change in the temperature of the Northern Hemisphere— characterizes the amount of additional freshwater input to the North Atlantic. This freshwater input is ultimately responsible for a weakening of the THC.

Making some simplifying assumptions (discussed in detail in Toth et al., 1998), a first impression of how a necessary global emission corridor for not violating the thermohaline circulation criterion may look like can be obtained from Fig. 4. According to the corridor shown (which is still provisional), we would have to leave the business-as-usual path (IS92e scenario) in about 6 decades at the latest.

From our point of view, it is therefore very important to investigate other possible mechanisms that may lead to climate

By applying appropriate mathematical methods necessary emission corridors can be determined, which characterize the scope for action that remains if all pre-defined guard-rails are obeyed simultaneously

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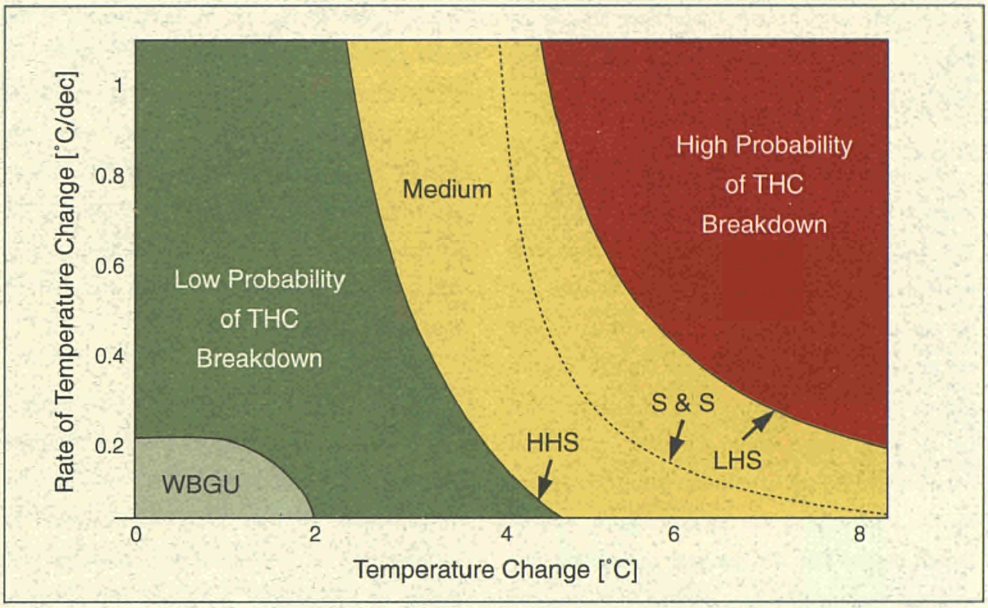
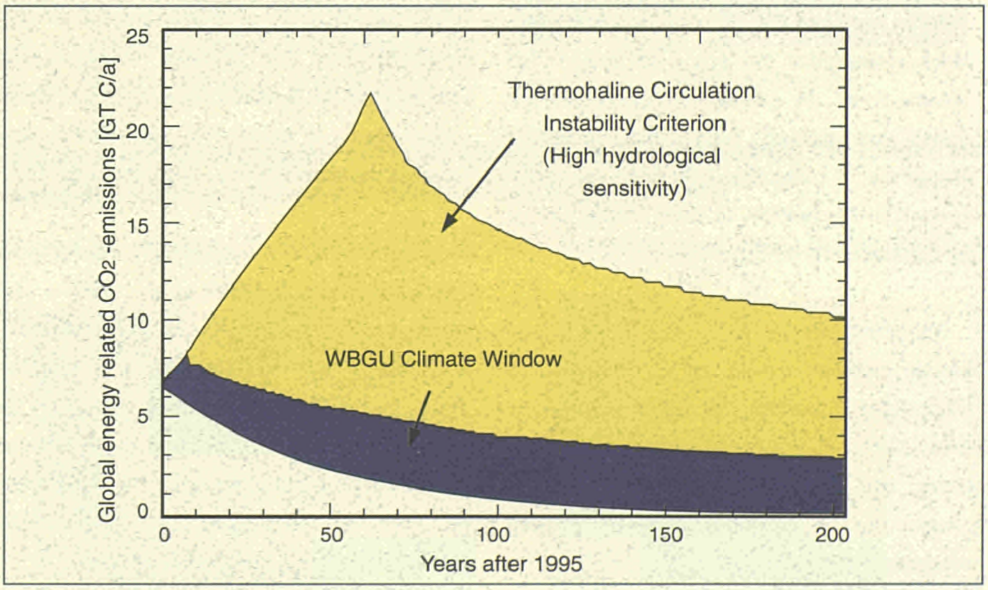
Figure 3. WBGU climate window and threshold curves for the thermohaline circulation under different hydrological sensitivity assumptions (see text)



Source: WBGU, 1995; Ganopolski, 1998a. For comparison, the original instability curve which motivated our investigation is also depicted (S&S, Stocker and Schmittner, 1997a and 1997b).

Figure 4. Necessary emission corridors for not leaving the WBGU climate window (blue part) and for not transgressing the thermohaline circulation stability threshold (high hydrological sensitivity case; blue and yellow part), respectively



Source: Toth et al., 1998. The corridors have been computed by assuming a maximum rate of annual emission reduction of 2% and a scenario for SO_2 emission reduction at the rate of 2% per year starting in the year 2000. The underlying global greenhouse gas emissions are bounded from above by the IS92e scenario.

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instabilities, instead of trying to give a more detailed, but potentially misleading picture of regular climate change. At present, however, we have relatively little knowledge concerning other possible instability mechanisms. One sensible approach would therefore be to stay away from the THC instability thresholds and to apply, for instance, the WBGU climate window, which is based mainly on paleoclimatological considerations and which rules out the possibility of global mean temperature exceeding values experienced in the late Quaternary period which shaped our present day environment. This however would imply reducing global emissions substantially, so that the Kyoto outcome can be considered only as a first step in this direction.

Conclusion

A general consensus holds that in the light of the complexity of the climate change issue the best integrated models can offer policy-makers is insights about the nature, basic relationships, and key dynamic features of the problem. We hope to have shown here that, even in its early phase of development, the TWA approach can provide valuable insights for the policy process in its search for appropriate climate protection strategies.

Keywords

climate change, decision making, cost-benefit analysis, tolerable windows approach, guard-rail approach, integrated assessments, emission corridors

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Financial Innovations and Economic Development: The Role of Microfinance Institutions

Mario Zappacosta, *IPTS*

Issue: The global trend toward economic liberalization has given rise to a need for financial engineering and innovations able to provide financial services to sections of the population that are currently effectively excluded from access to standard sources of credit. Among recent innovations, microfinance institutions are generally acknowledged to be an important instrument in poverty reduction in developing countries, especially through their support to micro and small-scale private initiatives.

Relevance: Policy-makers, international development agencies and EU services dealing with developing countries are increasingly interested in cooperating with microfinance institutions that are financially sustainable and viable. In order to formulate practical recommendations, useful also for actions in EU Less Favoured Regions, it is crucial to define indicators to assess MFIs performance and – drawing on experiences of international best-practice institutions – discuss the role of MFIs for technology diffusion in particular, and economic development, more generally.

Introduction

Some 40 years ago credit was thought to be a crucial part of a package of inputs needed to boost national production in developing countries and so drive their economic development. Bilateral and international donors supported subsidized credit – mainly aimed at agriculture - with large sums of money. Optimism persisted for several decades until the early 1980s when problems of loan recovery, institutional weakness and dependency on outside funding began to emerge in numerous credit programmes. In addition, a section of potential clients of credit programmes was largely ignored, such as self-employed entrepreneurs and women. The gravity of these problems became more apparent and pessimism grew until in the late 1980s major donors began to abandon credit efforts and instead increasingly focused on improving local financial markets (Von Pischke, 1995).

During the 1990s the increasing competition due to the worldwide globalization process and the mounting shortage of international donations and subsidized credit called for new financial innovations based on local autonomy, decentralization and community participation. The provision of financial services dealing with very small deposits and loans -so-called microfinance- is being increasingly acclaimed as an effective means of poverty reduction. The establishment and support of financial mechanisms enabling micro

Some 40 years ago credit was thought to be a crucial part of a package of inputs needed to boost national production in developing countries and so drive their economic development

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Today, financial mechanisms enabling micro and small enterprises (MSEs) to fully participate in the market economy are a major theme of contemporary development assistance

Microfinance institutions (MFIs) engage in relatively small financial transactions to serve micro and small enterprises (MSEs), including low-income households, small farmers and those who in general lack access to the banking system

and small enterprises (MSEs) to fully participate in the market economy is a major theme of contemporary development assistance. In this framework, there is growing interest by international institutions and national development programmes in understanding how financial services for MSEs can best be provided (European Commission, 1998).

Microfinance Institutions

Microfinance is a local process based on local institutions, increasingly from the private sector, that act as intermediaries collecting resources (savings, funds) and reallocating them (loans) in the same community of origin.

The main goal of microfinance institutions (MFIs) is to provide flexible and appropriate financial instruments, not usually available from commercial banks, to a greater numbers of MSEs to meet local needs. MSEs usually have much more limited access to formal banking system than large enterprises. Banks prefer not to deal with small loans and deposits due to their high transaction costs and repayment risk. In addition, bank branches are usually located in urban areas and are not able to serve potential clients that live in rural villages.

MFIs are mainly from the non-bank sector and cover the financial market segment existing between the formal (commercial) bank system and the informal credit sector. The panorama of MFIs is highly diversified, including co-operatives, savings & loans institutions, village banks, credit associations, credit unions, non-governmental organizations (Otero and Rhyne, 1994).

MFIs engage in relatively small financial transactions to serve MSEs, including low-income households, small farmers and others who in general lack access to the banking system. In developing countries, the MSE sector employs over 500 million of the economically active population and only about 10 million of them have access to financial services from sources other than moneylenders (Otero and Rhyne, 1994).

Improved access to sound financial services is a key factor in technology adoption and development. It enables entrepreneurs to manage risk and to freely invest in new innovative projects. By contrast, empirical evidence has shown that traditional subsidized credit programmes aiming to induce targeted entrepreneurs to engage in specific types of economic activity and to adopt specific technologies have generally failed (FAO/GTZ, 1998).

The traditional model of considering credit just as an input needed to develop income-generating activities, frequently directed at a specific population segment and as a component of an integrated project, changed toward the support of financial decentralized institutions and the development of a local financial system (FAO/GTZ, 1998). This change coincided with the move from a one-way flow of grant funds to project beneficiaries – *finance as charity* – to reciprocal contracts between institutions and clients who buy financial services – *finance as business* (Bennett and Cuevas, 1996).

The recent approach to finance as a development instrument places fewer restrictions on the use of credit, recognizing that micro and small entrepreneurs know best how to use the money in their situation and, consequently, select the most appropriate technology (FAO/GTZ, 1998).

MFIs' clienteles work with small loan volumes, frequently have problems of adequate collateral

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provision and are often geographically scattered across rural environments. Moreover little information is formally available regarding borrower's creditworthiness in many cases. These are the main reasons for high transaction costs and, consequently, the limited interest of the commercial banks.

In order to be competitive, MFIs adopt decentralization techniques that enable them to reduce transaction costs and increase their outreach and sustainability. Principal innovative characteristics of MFIs can be summarized in the following two groups:

1. **Administrative structure.** Locating lending offices near to clients, using simplified credit procedures and providing loans with opportune timing contribute to lower transaction costs. MFIs often directly involve clients in loan-processing procedures, such as project assessment, clients' selection and repayment collection.

2. **Risk management.** Many MFIs do not require formal collateral for access to loans, instead they rely on special techniques to motivate repayments. Peer group lending, joint liability and the prospect of access to follow-on loans are the main incentives for better borrower performance. Additionally, group formation plays a pivotal role in reducing the cost of gathering creditworthiness information about clients and the feasibility of their projects.

Assessment Criteria for MFIs

A rigorous evaluation of the impact of MFIs on MSEs is made difficult by the methodological problems caused by the fungibility of money (Yaron, 1992). Additionally, it is difficult to assess the effects of credit, for example in labour productivity growth or new job creation, because several factors act simultaneously, such as technical assistance or organization structure. In general terms, MFI performance can be assessed using the following five indicators:

1. *Self-sustainability.* This embodies the institutional capacity to be independent of donor or government subsidies. In the long run successful MFIs cannot depend permanently on subsidies. They need to raise their own funds, insist on full loan repayment, cover their financial and administrative costs by adopting positive interest rates and strictly enforce credit rules.

2. *Outreach.* This refers to the central purpose of MFIs: to provide large number of people access to quality financial services. It can be measured evaluating the average loan size (as proxy of clientele income level), the portfolio structure (as loans distribution among clients), the number of clients and its growth, the growth of savings, the variety of financial services offered, etc. All these indicators give evidence of the type of clientele reached and the general satisfaction with the services received.

3. *Savings Mobilization.* It is essential for MFIs' independence and sustainability to offer savings facilities according to the needs of their clientele. Micro and small entrepreneurs usually adopt non-monetary forms of savings (land, livestock, jewellery) because of the lack of flexible and accessible savings facilities and positive and attractive interest rates. However, if they can be satisfied that their assets are securely held, will maintain value, are relatively liquid, and conveniently located, they will prefer to save in monetary forms. Additionally, they can use their deposits as collateral for loans.

Depositing savings in MFIs instead of commercial banks also represents an advantage for the whole community. MFIs return savings as loans to the same group from which they draw them, increasing the resource availability for productive investments, while banks usually

The new financing model places fewer restrictions on the use of credit, recognizing that micro and small entrepreneurs know best how to use the money in their situation and, consequently, select the most appropriate technology

The main innovative characteristics of MFIs relate to their simplified administrative structure and their use of risk management techniques other than traditional collateral

The performance of MFIs can be assessed in terms of their self-sustainability, the number of people they reach (outreach), the extent to which they mobilize savings by encouraging them to be kept in liquid form, their market orientation and their management information system

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prefer to reallocate savings in other groups or regions, where they calculate the repayment risk to be lower (Otero and Rhyne, 1994).

Capital accumulation is also an indicator of institutional sustainability, showing borrowers' trust and their desire to establish a long lasting relationship with MFIs.

4. *Market Orientation.* Defining clientele preferences is fundamental in order to select the most appropriate financial mechanism and products. Depending on the clientele, MFIs should cover the full range of financial services, including insurance and credit not-directly for production oriented needs, such as extraordinary household expenses. Moreover, the micro-enterprise and the household concepts frequently overlap, especially in the rural sector, and their financial needs are often not easily distinguished.

Appropriate credit is a powerful mechanism for promoting new technologies. In agriculture, for example, small farmers with adequate access to credit and insurance are characterized by a faster adoption of high-yielding varieties

As a business activity, MFIs are not the proper instrument to reach the very poorest 10-15% of the population. The needs of the non-entrepreneurial poor, which completely lack of financial resources, have to be covered by non-financial services in the form of social security (Bennett and Cuevas, 1996).

5. *Management information system*: Due to their strategic location, MFIs usually have good and direct information about their clients' history and projects at relatively low cost. The more the outreach increases and the number of clients and loans grows, the more MFIs need to adopt proper management information systems which enable them to process information and, consequently, reduce the time taken and the cost of the procedures.

MFIs and new technology

The provision of appropriate financial services – as savings, credit, insurance, money transfer – as well as other financial contracts – as supplier credit, leasing, inventory credit, inter-linked trade/credit arrangements, etc) are powerful mechanisms with which to promote the diffusion of new technologies. Micro and small entrepreneurs are heavily exposed to risk and are not able to offset income fluctuation by consumption smoothing, therefore they have to smooth income by avoiding risky opportunities, even if it means sharply reduced future profits. Access to loans and savings facilities helps micro and small entrepreneurs to cope with risk and gives them the chance to move from traditional to new technologies. In agriculture, for example, small farmers with adequate access to credit and insurance are characterized by either a faster adoption of high-yielding varieties and a more positive attitude towards carrying out their own experimentation in order to adapt and/or develop new production techniques (The World Bank, 1998).

As well as promoting the diffusion of technologies among their clientele, MFIs themselves have great potential for adopting new information and communication technologies (ICTs) in order to reduce their transaction costs and risks in dealing with small clients. ICTs may improve banking practices by providing better client information, computerised loan/savings accounts, management information systems, lending procedures, client training, etc.

In particular, monitoring day-to-day loans at branch office level can represent an enormous workload: for example, a branch with 2,500 members, each of whom may have four loans and four savings schemes, needs to process about 20,000 micro-transactions per week. The falling prices of electronics and increasing power of personal computers mean that a growing number of MFIs are able to afford to computerize their procedures and adopt specific

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Box 1. The FAO MicroBanking System

The FAO MicroBanking System was first developed by the Food and Agriculture Organization of the United Nations (FAO) in 1988. It is a banking software package for small and medium-sized financial intermediaries and it represents a pioneering low cost approach towards automation. The system combines real-time transaction processing, general accounting and information retrieval functions with low-cost personal computer hardware. As of the end of 1998, it has been installed in more than 1,000 institutions in 26 developing countries in Asia, Africa and Latin America.

Source: FAO/GTZ, 1998

software for financial management produced by specialized organizations (see Box.1).

In the future, MFIs will also increase their use of the Internet and other new ICTs in order to lower their transaction costs and share information between headquarters, branch offices and clients. In developing countries, market competition with appropriate government regulation and incentives may stimulate the private sector to provide the infrastructure and services and expand the use of new ICTs. In particular, wireless technology seems to have great potential, providing services without incurring the high costs of installing fixed lines – especially in regions with sparse population and difficult climatic and soil conditions – and with lower maintenance requirements.

For example, in Bangladesh, a cellular phone network has already been launched with the aim of reducing the isolation of rural villages. Sponsored by the Grameen Bank, an internationally recognized example of a successful MFI, the project is planning to provide GSM 900 mobile phones to 68,000 villages. It means, by establishing village pay phones managed by selected member borrowers of Grameen Bank, to reach approximately 100 million rural inhabitants. This project offers a double benefit: on one hand, by selling telephone services, villagers have an additional income-generating activity and, on the other hand, they have the opportunity to better communicate and share information (The World Bank, 1998).

Promoting a favourable environment for sound MFI development

International best-practice experience shows that successful MFIs usually benefit from a favourable economic and policy framework. In order to pursue this basic condition, national governments can play a crucial role in determining macroeconomic stability, creating an enabling environment for private sector development, designing appropriate financial and sectoral policies, and enforcing an appropriate legal and regulatory/supervisory framework (European Commission, 1998; FAO/GTZ, 1998). In particular, they can encourage sound MFIs development by adopting some of the following policy actions:

- Interest rate deregulation and elimination of ceiling rates allow MFIs to charge full-cost interest rates, which contributes to their financial sustainability. In fact, there is evidence that micro and small entrepreneurs pay higher interest rates to informal moneylenders than the rates needed for institutional viability (Otero and Rhyne, 1994) and that their problem mainly is to gain better access to sound financial services.

The falling prices of electronics and increasing power of personal computers mean that a growing number of MFIs are able to afford to computerize their procedures

Experience shows a favourable economic and policy framework is usually beneficial for MFIs, making the role of national governments quite crucial

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MFIs should be self-sustaining and not used as instruments for giving aid or as an alternative to social security. Nevertheless, institutional support is valuable in areas such as infrastructure and training

- Effective monetary policies to control inflation rates have a positive effect on confidence in the financial system and increase domestic savings.

- Persistent distortions in key macroeconomic variables – i.e. overvalued exchange rates, adverse terms of trade, sector-biased policies – alter prices and induce financial markets to channel resources to inefficient production activities. Reducing these distortions improves the profitability of investments and, consequently, the clients' repayment performance.

- In many developing countries, savings collection is restricted to formal bank institutions. An appropriate legislative reform is needed and, consequently, a local monitoring and supervision system should be set up in order to protect savers from fraud.

- Improving the legal system to better enforce contracts reduces uncertainty and has positive effects on MFIs' transaction costs and may reduce the need for collateral.

- Integrating MFIs in the national financial system contributes to increasing their outreach and sustainability. When MFIs operate in a way that is transparent and accountable, banks may be interested in doing business with them and give access to commercial loans or equity investments. In addition, banks can provide extra liquidity to MFIs in order to manage covariance risk due to the high degree of homogeneity of both MFIs' clients and financed projects. In fact, their limited size means many MFIs cannot pursue a sound strategy of portfolio diversification. They may face severe problems of repayment, due to systemic risks affecting the majority of their clients at the same time - such as price changes, flooding, drought, etc. - and shortages or surpluses of financial resources, due to the high concentration of demand and supply at certain times of the year.

- MFIs are frequently still misused to fulfil social equity purposes and technical assistance. A clear definition of MFIs' rights and obligations is therefore required. In addition, it is necessary to overcome the deficits in the knowledge of potential users about the existing supply of financial services and the access to them. This calls for actions oriented to providing so-called "public goods", such as information and human resources development, which should be directed at potential users at various levels (local, regional, and national).

- Finally, governments have to ensure appropriate regulation against monopoly power in ICTs, which is the current major obstacle to reducing prices and therefore is blocking the access to new technologies.

The role of international institutions

International institutions can make a direct contribution to establishing and supporting sound MFIs by both providing financial resources and promoting the institution building process. In general, there is a wide consensus that these institutions should shape their actions in order to stimulate market forces and not to bias them.

The preference should be for channelling financial resources via loans while subsidies and grants should be considered only as temporary instruments even if their role is important in some special cases, such as providing start-up or seed capital. In general, it is preferable to avoid long term subsidies to lower real interest rates and to cover operating costs. These types of subsidies are easy to introduce but almost impossible to remove (Schneider, 1997).

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Skills development is an important factor influencing the performance of MFIs: both MFI staff and clients need special training in order to pursue efficiency. The integration of under-served groups into the financial market entails costly investments helping beneficiaries to become clients, improving their confidence, knowledge, skills and information and developing the right attitude needed in contracts involving reciprocal obligations. Additionally, the adoption of computerized management information systems calls for local hardware and software technical skills in order to provide the adequate assistance. International institutions may provide loans or grants to cover all these costs.

International institutions should promote the establishment of "second floor" financial institutions with the goal to provide common services to a group of MFIs and build the bridge with commercial banks.

International institutions have also a role in advising governments in introducing appropriate regulation or deregulation policy actions, insisting that financial and social services are to be provided by different institutions, and disseminating "best practices" through conferences, training courses and printed material.

The actions carried out by different international institutions need to be coordinated. The growing numbers of programmes and projects that are directed to developing countries can be undermined by reciprocal competition with a negative impact on MFI development.

Finally, building sustainable MFI is a long-term process. The introduction of financial innovations and their expected results need time to be visible and, consequently, international institutions need to commit themselves on a long-time horizon.

Concluding remarks

The worldwide enthusiasm about microfinance and its potential in promoting economic development by providing financial services to small and medium size entrepreneurs calls for a critical reflection. Making funds available is not in itself a final objective; there is a need to create and strengthen sustainable and viable institutions and to adequately mix financial with non financial services and actors. International institutions, local governments and commercial banks need to actively co-operate with MFIs, developing synergies accordingly to their mandates and skills, in order to build successful stories of micro financing.

MFIs performance and main characteristics of their external environment need to be analysed in order to prioritize actions to be undertaken by local governments and international institutions. The main focus should be on institution building and financial system development rather than subsidized credit provision as in the past.

In conclusion, far from being a panacea to solving development problems, MFIs need to be included in the broader set of instruments policy makers can use in order to promote economic development. It is also possible to envisage a potential role for MFIs in European Less Favoured Regions and, especially, in the Central and Eastern countries that are due to join the EU in the future.

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financial market innovations, microfinance, microfinance institutions, micro and small enterprises

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Technology Policy: From Acceptance To Acceptability

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Issue: Against a backdrop of increasing public reluctance to accept certain key technologies, new approaches to technology assessment (TA) have been developed in order to design tech-no-logy policy in such a way as to avoid or limit technology-related conflict as far as possible. These approaches tackle the acceptance problem by involving the "stakeholders" in technology develop-ment in the dec-ision-making process, on the assumption that the outcome should automatically meet with public acceptance.

Relevance: Though such acceptance-oriented approaches to TA are, at the moment, dominating the discussion, they do not always adequately cover all the types of problems involved in technology policy making. In particular, long-term challenges cannot be dealt with solely by looking at current levels of acceptance, as these levels may vary over time. Overemphasis of the question of acceptance may tend to perpetuate present states of affairs and shift the focus away from how we wish to live in the future. By embracing the concept of normative *acceptability* some of these shortcomings may be overcome.

Acceptance-Oriented Technology Policy

Technology policy is today often oriented toward the present-day or assumed future level of acceptance of technology (see for example, Todt and Lujan, 1998; Bröchler 1998). Many studies on the acceptance of key technologies or technology in general have been conducted since the early eighties. In some countries monitoring procedures have been established to observe any change in the level of acceptance among the population.

Intense discussions have taken place within the political system, among the public and in industry (noticeably in particular in Germany, where they have been motivated by serious technology-related conflicts, especially in the areas of nuclear energy and biotechnology). Both policy makers and industry are concerned by the apparent decrease in acceptance of modern technology, as they fear that obstacles to implementation of new technologies may result in a loss of competitiveness in global markets.

Technology policy oriented in such a way as to take acceptance aspects into account can be designed in two different ways:

1. **The adaptive approach**: The experience of technology conflicts since the seventies concerning certain key technologies such as nuclear technology or genetics (which have

Policy makers and industry are concerned that the possible consequences of a lack of public acceptance of key technologies could be, among other things, a loss of global competitiveness

Two approaches have traditionally been taken to public acceptance of technology: an adaptive approach and a shaping approach

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Both approaches try to include stakeholders in the decision-making process on the assumption that this will lead to greater acceptance of the technology concerned

One drawback of acceptance-based approaches is that they consider only current levels of acceptance and are unable to deal with changing perceptions

sometimes led to violent confrontations in some countries), raised the question whether it would be possible to avoid such conflicts before they arise. The idea behind this approach is that technology conflicts could be avoided by taking into account the presumed acceptance of technology development and design, i.e. by developing technology in accordance with public values and concerns.

2. **Shaping approach**: Instead of regarding existing public acceptance as a rigid determining factor for technology policy-making, attempts have been made to influence this level of acceptance – to 'construct' acceptance through information, increased investment in the 'public understanding of science', in science centres and museums, certain types of technology-related education and by giving prizes for inventions.

Both approaches involve activities to include the **stakeholders** of technology development (consumers, citizens, political parties, authorities, social movements - all groups or persons affected by technology policy decisions) in the decision-making process. The degree of involvement ranges from real participation in the decision-making processes to measuring the rates of acceptance by acceptance polls. The assumption is that if the people concerned are involved in the decision-making process, the result should be acceptable to them. These approaches, however, cannot adequately tackle all the different problems involved in technology policy making. Indeed, overemphasizing acceptance can have unexpected consequences.

Shortcomings of an Acceptance-Oriented Technology Policy

Of course, acceptance of technology and technology policy is an important factor in managing technology in society. However, no matter how reasonable it may be to consider acceptance as a guiding rule for political strategy, policies relying exclusively on acceptance, or at least overestimating its importance, are insufficient to deal with the complex problems involved. Below, some main arguments supporting this view are outlined, revealing a deep dilemma in the field of technology policy making (Grunwald 1999).

Firstly, the promised goal of avoiding technology-related conflicts before they arise (see above) cannot be guaranteed reliably because only **current** acceptance levels can be determined. The rate of acceptance, however, may decrease and technological ventures may, in the worst case, lose acceptance completely, even though acceptance was given at the outset. Predictions of the rate of acceptance are virtually impossible because social acceptance may be highly volatile. Acceptance is related to the perception of benefits and risks of the technological options. This perception depends on many factors in the given situation, such as the subjective sensitivity to risks, subjective expectations of usefulness, the temporal or spatial distance from the risks, whether the hazardous solution has been freely chosen or enforced, and whether an accident in the area concerned has happened in the recent past etc. Perceptions of risk can be changed rapidly by contingent events (consider the role of the Three Mile Island and Chernobyl accidents in decreasing acceptance of nuclear power), thus introducing an element of unpredictability into the acceptance of the technology concerned. Given this fact, focussing on the acceptance factor neither precludes future acceptance problems nor prevents technology conflicts.

Secondly, a focus on current acceptance is fundamentally anti-innovative in the sense that incremental options are preferred because it is

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easier to gain acceptance for them than for innovative leaps. This means that technological options may be ignored, if they are apparently not sufficiently acceptable to the public at the time the decision is made. This approach may have the perverse upshot that solutions for certain problems which are ideal from a technological, economic, political or ethical point of view are not included among the set of options before the decision is to be made. Clear assessments and unbiased decisions are therefore difficult to make.

Thirdly, acceptance-oriented technology policy runs into the well-known problem that the demands of individual stakeholders and the 'common good' may be contradictory (whatever this may mean in each specific case). If technology policy making relies mainly on the acceptance factor, it presupposes that the mere aggregation of presumed individual advantages – which, in most cases, decisively influence acceptance – automatically constitutes the common good. It is, however, very easy to find examples where this is not the case. The theory of collective decisions has shown that it is not possible to aggregate individual preferences in a reasonable way to get a well-defined common welfare function (cf. Arrow's theorem). Factual acceptance does not automatically create the "common good".

These arguments show, for instance, that an acceptance-oriented approach to technology policy cannot give reliable long-term orientation for technology development. Nevertheless, this kind of orientation is an indispensable stabilizing factor if technology is to be given a reliable framework in an otherwise ever faster changing and increasingly flexible world. Continuity and reliable long-term planning security in order to achieve specific political aims or to allow investments in future technology cannot be reached in a merely incremental way. Technology policy making is thus faced with a dilemma: without any acceptance at all, measures and decisions are condemned to failure in a democratic society. But, a policy completely based on acceptance cannot guarantee the long-term orientation required (Grunwald 1999). In sum, in addition to the acceptance factor, there must be some kind of policy orientation which is not based on acceptance alone. This leads to the concept of acceptability.

From Acceptance to Acceptability

The main question emerging from the preceding sections is how to handle short-term acceptance problems on long-term agendas. For this purpose, a normative basis is required in order to override a lack of acceptance during certain stages in the development of a technology. But how should this normative basis be established? Who should be empowered to decide whether the plans in question should be allowed to go ahead in spite of low public acceptance in certain fields? What should be done in order to take into account the attitude of the public at large without falling into the trap of focusing exclusively on the acceptance factor with the ensuing shortcomings mentioned above? To arrive at an answer it is necessary to refer back to some philosophical ideas about rationality and society (Rescher 1988, Grunwald 1999).

The way suggested is to shift the level of acceptance required: what an individual is willing to accept is primarily a subjective decision according to personal preferences. However, the question of the extent to which it is reasonable to expect public acceptance of a particular technological development is of wider, political interest. Rational technology policy is a policy formulated on the basis of **justified standards of acceptability**. The basic idea is that there are

This approach will also tend to favour more conservative, incremental changes over innovative leaps

Also, it is not possible to arrive at the common good simply by summing individual preferences

Thus, the acceptance-oriented approach is unable to give the reliable long-term orientation technology development needs

The basic idea is that there are implicit, accepted norms and presuppositions in society which can be used to elicit criteria for acceptability

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Rational technology policy needs to be formulated on the basis of justified standards of acceptability

The advantage of this approach is that the concept of acceptability, unlike the immediate acceptance of a technology, is not dependent upon transient moods in society or chance events

The outcome must be accepted if the predetermined procedures have been agreed upon and correctly applied (an example of this approach is road planning)

implicit, accepted norms and presuppositions in society which can be used to elicit criteria for acceptability by examining currently existing cultural concepts of rationality (Habermas 1991). The question then is no longer what kind of technology will be accepted but: whether it is reasonable that acceptance of this or that kind of technology or technology policy should be demanded.

For example, consider the challenge of defining environmental standards for some toxic substances. It seems very hard to define such standards according to factual acceptance. Instead (as has been worked out in Renn/Pinkau 1998), it is possible to base recommendations in this field on underlying cultural rationality standards like pragmatic consistency requests, justice principles and risk/chance analyses showing that certain environmental standards should be acceptable. These investigations may then be used to start social learning processes involving participation (see below).

The advantage of this approach is that, since underlying cultural foundations are relatively stable, the concept of acceptability, in contrast to immediate acceptance of technologies is not dependent upon transient moods in society or chance events. The acceptance factor can thus be taken into account not on the basis of immediate, factual acceptance of a certain technology but by establishing justified criteria for procedures in technology development (Grunwald 1999).

Basing technology policy not simply on factual acceptance but on a normative basis for reasonably justified acceptability criteria raises the question as to whether there might occur a conflict between relying on normative acceptability and the idea of democracy. The answer to this question is no, because a normative basis created in the way mentioned above evolves from the rationality concepts inherent in social practices as manifested by people themselves. Such rationality concepts are not forced upon people. Instead, there are democratically accepted procedures for handling conflicts between the 'common good' and the individual interests of the people concerned (see the example below). The crux is that the results of legitimated procedures – and this is part of the underlying cultural consensus on democracy – must be accepted even if they are unwelcome. **Thus acceptance of the procedures means acceptability of the ensuing results.**

If this were no longer to be granted in a certain field, the procedures would have to be changed – a learning process in society has to be set up with the result of new or modified, re-legitimated procedures. For example, this may occur, if legitimate decisions in technology policy lead to a dramatic rejection by society or if the decision-making procedures have to be modified for other reasons (for instance, in order to improve the chances of participation).

For example, consider the procedures to be followed in planning a highway. There are accepted procedural steps with the consequence that if they are followed correctly the result has to be accepted by the people affected. Procedures of this type are the means society uses to define the "common good" and to decide to what extent the public can be expected to accept a certain technological development after considering the interests of society as a whole, allowing for the fact that certain groups within the population may be burdened with the consequences of such decisions. In this way, partial non-acceptance or low levels of acceptance of the results may be overruled by the pre-acceptance of the legitimated procedures used to attain them. Of course, this approach is restricted to undramatic situations in which acceptance is lacking.

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Otherwise the decision-making procedures have to be changed (as alluded to above).

Therefore, there is no contradiction between a normative approach as defined above and established democratic procedures. Instead, the analysis presented here corresponds very well to the democratic conception of society. It demonstrates that the results of democratic procedures in technology policy may be legitimate even if they do not lead to widely accepted results for the development of technology.

Conclusions

Initially, technology assessment (TA) at national level was intended to help national authorities manage technological change. The emphasis of TA was on dealing with acceptance problems by improving prediction and planning; it was not at all concerned with problems of ensuring legitimacy. Because it was simply based on expert views the question of legitimacy arose. This issue has developed into one of the most interesting questions in the present TA debate (Todt and Lujan (1998) are completely right to point out this question).

Recent TA approaches take into account the stakeholders' views to broaden the perspectives for shaping technology and to reach better accepted technologies. The idea of participation has accompanied TA throughout its history. This approach was first applied in the Scandinavian countries and the Netherlands. At present, participatory concepts of TA are used in practice in almost all EU-member states and elsewhere, although they are implemented in different ways, depending on the particular political culture.

TA concepts including participation (e.g. consensus conferences, constructive or interactive TA) deal –(among other things) with the question of how to arrive at a legitimate technology policy. However, they do not provide a satisfactory answer as to how the normative basis of technology policy making should be established. TA relying mainly on factual acceptance is merely processing present-day acceptance levels and does not allow for reflection on proposed and intended technology development or address the question how we wish to shape society's future by means of technology (Grunwald 1999).

Instead of allowing existing acceptance to govern technology policy decisions, it is more important to consider the perspective of setting goals and aspirations for political, social and technological action according to the underlying rationality standards of society. Having established the purpose, goals and aspirations of technology development and social progress, the normative orientation (e.g. acceptability standards) for actual decisions can be achieved by backcasting (i.e. 'forecasting' retrospectively). Within this approach TA should, wherever possible, take place in the early stages of development, when measures can be taken so as to allow social input to have an effect without serious economic consequences. This includes an anticipatory search for alternative decisions and preventive measures to avoid ruinous investments in technology policy. In this way continuous reflection accompanying technological development enables the evaluation of short-term developments against the background of long-term and relatively stable social constellations (Grunwald 1998).

For participatory TA, this means that involving the stakeholders should not be restricted to taking into account their acceptance behaviour. Participatory TA should – and some recent work on TA seems to point in this direction (Grin *et al.* 1997) – produce and process acceptability criteria instead of striving to achieve acceptance. In this sense, TA should address the acceptance problem

The results of democratic procedures in technology policy will be legitimate even if they do not lead to universally accepted results for the development of technology

Rather than taking acceptance alone into account, the purpose, goals and aspirations of technology development and social progress should be considered

Current practice in technology assessment (TA) uses stake-holder participation to obtain legitimacy for technology policy

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Participation should lead to a common understanding of what is to be done and of the criteria to be applied even in the absence of complete, immediate acceptance

neither by means of an adaptive nor by a shaping approach but should set up **social learning processes**. Generating acceptance or transforming acceptance into decisions may be suitable for very special situations; but in many cases, TA must go far beyond such simple schemes. The degree of participation and its particular realization seems to be dependent on the context. Participation, in general, should lead to a common understanding of what is to be done and of the criteria to be applied for establishing the appropriate plan of action also in the absence of complete, immediate acceptance. It should involve collective learning instead of merely mediating or compromising to attain technology acceptance.

Learning implies argumentation: questioning one's own position and a willingness to adapt this position in certain situations. It also means that policy makers, laypersons and experts all need to learn from one another. These brief remarks show the advantage of the approach proposed as well as its problems. The advantage is that the "best" solution available is looked for, agreed upon and can be sustained over the time, and perhaps adapted to changing conditions. The problem is that arguing and learning are difficult- much more difficult than relying simply on acceptance or on basing technology policy simply on authoritarian dictate. Nevertheless, they offer an attractive vision of a part of an evolution towards a 'learning society'.

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Keywords
technology assessment, technology policy, acceptance, acceptability, rationality standards, public risk perception

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The Interrelation between Technology and Total Employment: Some observations

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Issue: An analysis of the variables determining the impact of new technologies on total employment shows that there are a variety of factors influencing overall employment volume, and that the effect depends on both the type of the innovation introduced (process or product) and the context considered (micro- or macroeconomic).

Relevance: Better knowledge of the effects of technological innovations on employment would enable firms, public authorities and trade unions to put into practice strategies and policies aimed at limiting the extent to which the introduction of change may become a cause of tension in the workplace.

Technological change has long been a cause for concern, with opinions divided over whether it creates or destroys employment

The effect of technological change depends on whether the change involves changes to the process (process innovation) or the development of new products (product innovation) and whether you examine the micro- or macro-economic level

From the outset the history of technological change has been a cause for concern. On the one hand, the introduction of new technologies has shown itself to the driving force behind the economy, and without it economic growth would generally be weak and the standard of living would decline. On the other, technological change has been blamed for high levels of unemployment. The question therefore is: does technological change create jobs or destroy them?

In the light of the wide range of contributions that have been made on the subject, what stands out is that the interrelation between technology and total employment is a complex one. In order to study all the implications of technological change for employment it is necessary to look at the subject from a number of points of view and take into account the fact that not all technologies have the same effect. In this article, we have set out to show the different implications of technology for total employment depending on the type of innovation applied and the scope of the study.

Process and Product Innovation

Analysing the effect of new technologies on employment it is clear that not all technologies have the same relationship to employment. Indeed, we can distinguish between process innovations, which improve production processes, and product innovations, which influence the manufacture of new products. Similarly, there are differences on the microeconomic level – i.e. at the level of individual firms - and the macroeconomic level– i.e. the level of the economic system as a whole.

We shall start our analysis by looking at the introduction of innovations entailing the adoption of new or greatly improved production methods

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(Process Innovations). When a new technology is introduced into a production process it may be expected that this will reduce the factors of production required per unit of product. As is well known, economic efficiency implies that a production process does not use more productive resources than are strictly necessary for the chosen technology; consequently, any innovation in production processes will imply a saving in factors of production.

If the analysis is limited to the level of individual firms, assuming that output remains constant, the application of a technological innovation supposes that less labour will be needed per unit of product. Thus, the first effect of a process innovation will be a reduction in employment. However, this situation may change over time if the reduced cost involved in producing goods and services is reflected in prices, as the decrease in prices will lead to an increase in demand, and therefore the additional factors of production needed to satisfy this greater demand may compensate for the initial reduction in employment.

Therefore, it is difficult to predict the long-term effects of introducing a technological innovation into production processes as they depend on various factors: a) the transmission of the cost reduction to prices, which, in turn, depends on the firm's monopoly power and the importance of economies of scale; b) the price elasticity of demand (if this is greater than one, the reduction in prices will bring about positive variations in employment); and c) the elasticity of substitution between factors of production (OECD, 1988).

Not all innovations are intended to improve production processes. Some are destined to enable the creation of new products or to improve existing ones. Innovations of this type are referred to as 'product innovations'. The effects caused for employment depend on the novelty of the goods and services, in particular, whether they satisfy needs which did not previously exist, or if on the other hand, these new products or services are only substitutes for existing ones or others with similar functions.

In the case of a totally novel product expanding demand will stimulate production, and thus demand for the factors of production needed to fulfil it. This will therefore tend to increase employment by the firms concerned. The magnitude of the effect will depend on market structure, i.e. the more competitive the market, the less the effect of this type of innovation will be on employment. This is the result of the fact that firms will innovate only when they see the chance of obtaining sufficient competitive advantage over their competitors to compensate for the extra expenditure involved in developing and implementing the change. In the case of products which merely substitute for existing ones, the effect caused on employment is less clear, as shifting demand onto these products will cause a reduction in the demand for the obsolete products in favour of the new ones.

Compensating factors on the macroeconomic level

Any analysis seeking to investigate the effect of introduction of new technologies on total employment will be incomplete if only the microeconomic level is examined, as this would fail to consider the effects of technological changes in other firms and/or sectors of the economy. Although it is clear that introducing new equipment can imply an increase in labour productivity and, therefore, a reduced need for labour per unit of the given product, it is also true that there are numerous effects which tend to cancel out this initial negative impact. This means that it is particularly important to consider

Individual firms make changes to their production processes when they reduce costs by allowing the same number of units to be produced from fewer inputs (including labour)

The effect on labour may, however, be compensated by increased demand (e.g. because the product is cheaper or wages are higher)

When a firm produces a novel product this, if successful, will tend to open up a new market and so generate employment

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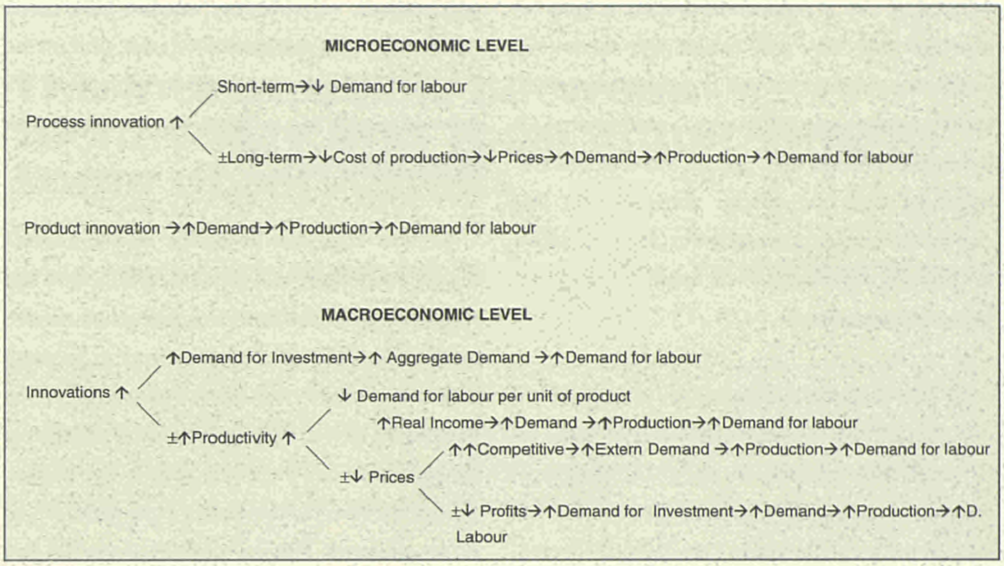
At the macroeconomic level there are a number of effects which will tend to cancel out the negative impact technology may sometimes have on employment in individual firms/sectors

Improved productivity tends to reduce prices relative to wages, thus boosting demand. In a global market it can also defend firms better against foreign competitors

Figure 1. Technology and employment volume



macroeconomic aspects, i.e. the economic system as a whole, when investigating the global effects of innovations on aggregate employment (see figure 1).

On the macroeconomic level economic theory shows a series of effects which can compensate for the tendency of the introduction of innovative technologies to reduce the demand for labour (Stoneman, 1983; OECD, 1988 and 1996):

a) The savings in unit costs caused by the increase in productivity might lower relative prices and, in turn, boost consumers' ***real income*** as a whole, and thereby increase global demand. Hence, the final effect on employment will be positive, but, as mentioned, it depends on the competition in the sector, on the ease with which economies of scale appear and on the elasticity of demand.

b) If the exchange rate against other currencies remains constant, the reduction in prices in the country concerned ***will increase the competitiveness*** at the country's firms, provided that other countries do not adopt similar technologies. At all events, adopting new technologies may protect a country from cost competition from foreign firms. At the sectorial level, and bearing in mind the increasing globalization of the economy, the increased competitiveness of innovative sectors assures them greater market shares, and thus higher levels of employment, than sectors which do not innovate.

c) Technological change **brings about *the creation of new industries*** whose role is to create and maintain the new technologies being used. The firms supplying innovative enterprises with equipment will have to increase production, and therefore will demand more factors of production including intermediate inputs to other economic sectors. This multiplying effect, which is spread throughout the production system, will generate an increase in overall employment.

d) In some cases, reduced unit costs will result in increased profits which, in turn, will lead to ***increased investment***, which will be positive for employment. This, however, would fail if a firm looked only for a certain level of profit and, therefore, did not invest further (note, however, that the portion of the profit not invested would, at

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a later stage, lead to increased consumption and demand and, therefore, increased employment). In any case, the creation of employment resulting from this new investment might be smaller than the loss of jobs caused by the initial application of the new technologies.

e) The increase in productivity obtained in innovative sectors may enable the trade unions to obtain ***an increase in wages***. This will increase income and therefore demand and, consequently, employment in other sectors.

f) If labour markets are flexible, an initial reduction in demand for labour will bring about a reduction in real wages or, at least, will put a brake on their growth; this might activate the mechanism of ***substitution of other factors of production by labour***. This movement depends on both the coefficients of substitution between factors and on the flexibility of the market.

In sum, as mentioned by the OECD on various occasions, any in-depth analysis of the impacts of technology on employment must take the macroeconomic system as a whole into consideration , as the loss of employment in one business, industry or region, may be compensated for (or more than compensated for) by the creation of jobs in other sectors of the economy. Note, however, that compensatory processes do not arise automatically, and unless they are helped along, they can involve a process which is rather painful for society.

Empirical evidence and policy implications

The analysis of numerous empirical studies carried out on the above question (which no doubt merit more detailed study in a separate article) shows just how difficult it is to evaluate the quantitative impact of technology on employment. Some studies have suggested that technology will have negative effects on overall employment, others have concluded that the reverse is true. These studies have been carried out on all levels (macroeconomic, sectorial and microeconomic), but their results cannot be considered conclusive; some do not include a sufficient number of firms to give results which may be extrapolated (the case of studies at the level of individual firms); others fail to consider the compensatory effects which are being produced in other sectors (in the case of sectorial studies); yet others give results which cannot be taken as definitive (as is the case of the macroeconomics studies).

At all events, many of these authors and studies do seem to confirm a number of points in relation to technology and employment:

1. A series of social, institutional, economic, cultural and organizational determinants appear to be conditioning factors in the interrelation between technology and employment. These factors play a determining role in the creative or destructive capacity of technology for employment.

2. Empirical evidence reveals that the relationship between technology and employment is closer in industries which are more technologically advanced.

3. The profitable use of the potential of new technologies to create employment requires significant investments in the training of workers and organizational and institutional change in order to better adapt new technologies to the production process.

4. In the process of employment destruction and creation, which goes together with the introduction of new technologies, it may be observed that new jobs have different characteristics from those destroyed. This fact is

The uptake of new technologies will tend to create a new industry to service them

Analysis of the impacts of technology on employment must consider the macroeconomic system as a whole, as the loss of employment in one business, industry or region, may be compensated for (or more than compensated for) by the creation of jobs in other sectors of the economy

Although many empirical studies have been carried out on the subject, their differing focus has made their results appear inconclusive

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A number of social, institutional, economic, cultural and organizational factors condition the relationship between technology and employment. For instance, introducing new technology will tend to demand a higher level of skills and flexibility from workers

A recent study on firms in Andalusia has actually shown the implementation of new technology to have had more effect on organizational structure than on total employment

New technology seems to be better at creating jobs in industries which are already relatively technologically advanced

manifested by an increase in higher skilled jobs and a decrease in less skilled ones; and in the change of task contents of each job, which is characterized by major greater job flexibility and workers taking on a greater range of tasks.

A recent study curried out by the authors into the impact the introduction of new technologies on the total workforce of industry in the Spanish region of Andalusia shows, among other things, that the introduction of innovations has not brought about the loss of jobs that might have been expected. An almost complete balance is reached between firms which create jobs through the introduction of new technologies and those in which jobs are lost (23.1% as compared with 22.7%). For the majority of firms (54.2%), the introduction of new technologies has not meant any change to the number of jobs, but it has altered their composition (26% of the firms studied having undergone changes in the structure of the workforce without any change in its size, whilst in 28.2 % of the remaining companies there was no direct influence on employment).

Moreover, the study shows that the impact of new technologies on employment varies greatly depending on the technological level of the sector in which the firm operates, i.e. the greater the technological content of the sector, the better the response to technological change in terms of job creation. In the most innovative sectors, the increase in production obtained as a result of (among other factors) new products, improvements in competitiveness, product quality improvement, etc., has compensated for initial job losses. The Andalusian study reaffirms the above conclusions to the effect that the response of employment to technology is better in more technologically advanced sectors.

The studies carried out on the subject make it clear that in order to be able to make good use of the job-creation potential of new technologies, economic and political changes are also necessary (new forms of organization, new skills, new techniques in enterprise management and new types of capital goods, etc.) so as to enable the creation of better conditions for the development of new technologies. Along these lines two global sets of measures have emerged (according to the OECD) which should be considered by the authorities in order to encourage the beneficial effects of advanced technologies. On the one hand, these are measures which centre upon encouraging the creation of, access to and dissemination of technological knowledge. Increased public investment in financing research, as well as into the strengthening of private sector research, and collaboration between public research organizations and business, are important means which should be developed. At the same time, it is necessary to encourage policies which promote the development of human resources and support organizational change as ways of obtaining greater flexibility. Investment in human capital through education and on-going training of workers are core activities in the process of assimilating new technologies into the economic system, paying special attention to SMEs, for this and other policies.

Conclusions

Although initially the application of process innovation will probably result in a reduced need for labour, the final outcome depends on a set of variables and/or mechanisms which may compensate for this initial reduction in labour through an increase in demand. Together with this, it is usually accepted that product innovations, in general, are beneficial for employment, although this depends on the character of products, in particular whether the goods and services are totally new or are merely substitutes for existing ones.

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In order to carry out a coherent analysis of the impact of technological changes on employment volume it is necessary to consider the economic system as a whole, as jobs which may be lost in one firm or region may be compensated for in other sectors or geographic regions. Thus, at the macroeconomic level or considering the economy as a whole, economic theory indicates a series of effects which may compensate for the process of reduced demand for labour caused by the application of new technologies: a) an increase in real income; b) improved competitiveness; c) creation of new industries ; d) higher levels of investment; and, e) mechanisms whereby some factors of production are replaced by labour.

The various focuses and ways of approaching the analysis of the interrelation between technological change and employment have generated a variety of studies of differing scope seeking to determine the role of technology in the creation or destruction of jobs. The results of the theoretical and empirical contributions differ greatly. It may, however, be said that there are at present no conclusions regarding the final effect of technological change on employment which would be universally accepted or which could be considered quantitatively adequate. However, the empirical evidence suggests that employment in the more technologically advanced sectors of the economy responds better to technological change, as does employment in those countries and regions with a stronger tradition of adopting new technologies.

Thus to conclude, the introduction of new technologies into production systems causes the simultaneous destruction and creation of jobs. The quantitative relationship, however, varies between enterprises, sectors, regions and countries, depending on competitiveness, relative position in the world economy, the institutional framework, government policies and business strategies, all of which have to work together to create a framework within which compensatory effects might be produced in the strongest and quickest way possible in order to avoid tension in the labour market.

The traditional view that product innovation is good for employment is complicated by the fact that new products will always tend to replace some other product(s) to a greater or lesser extent

The ease with which the compensatory effects can operate depends to a large extent on the institutional framework

Keywords

technology, process innovation, product innovation, employment, prices, cost, investment, demand, price elasticity, productivity, competitiveness

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Photovoltaic Applications and Policy Initiatives

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Issue: The world photovoltaic (PV) market has grown significantly in recent years. Although this trend is expected to continue in the future, estimates cannot be given with any real certainty.

Relevance: In this context the question that arises is the role that public and private funding plays in market development and how this funding should be used to ensure the best results. Although current EU energy policy favours PVs and renewables in general, additional measures oriented towards facilitating further market penetration could complement energy policy.

Photovoltaic (PV) technology, as an electricity generation alternative has undergone rapid progress and development in recent years. The world PV market has grown at an annual average rate of 24% over the last 5 years

Introduction

Photovoltaic (PV) technology, as an alternative option for generating electricity (directly from sunlight), has undergone rapid progress and development in recent years. The unquestionable advantages of PV systems as an emission-free (environmentally friendly) and reliable means of power generation, relying on an unlimited energy source (abundance), off grid, in small or large scale applications (versatility), etc., attracted the interest of investors and policy makers early on.

As a result, despite the high cost of PV modules, there has been considerable investment (mainly in the developed countries) in research and development in the PV sector. At the same time the spread of PV applications has been supported through direct or indirect funding via national or international programmes. The world PV market has grown at an annual average rate of 24% over the last 5 years (National Center for Photovoltaics, 1998). In 1997, specifically, growth reached 40% and sales of PV modules reached 125MWp (MegaWatt peak) capacity worldwide (Hill, 98). At the same time considerable reductions in module cost have been achieved (up to 25% over the last 5 years).

The main guidelines for the current policy promoting the spread of PV applications, are expected to remain virtually the same in the future, while a continuous decrease in the cost of PV modules may enable PV technology to become competitive for large, price-sensitive markets. Currently, the PV sector is passing through a transitional stage where improvements in PV cell cost and efficiency justify predictions that PVs may become competitive with conventional power generation. Optimistic estimates place this period at the end of the first decade of the 21st century.

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Current Technological Achievements

Today, R&D mostly focuses on optimizing the efficiency of PV cells, developing new materials for cell manufacture and investing in more efficient production lines. The general aim is to produce PV cells on an industrial scale in order to achieve both higher efficiency and low cost. The efficiency of cells is increasing gradually through process optimization, while the cost of cells depends on efficiency, size, production yields and throughput, together with the cost of raw materials.

Semiconductor materials used at present, for manufacturing PV modules can be divided into two main categories: (i) crystalline (mono and polycrystalline silicon) and (ii) amorphous materials used as thin films (amorphous silicon, Cadmium Telluride, CIGS - $CuInGaSe_2$). Crystalline silicon modules represent around the 80% of the market and achieve better efficiency (commercial cells have an efficiency of around 12-17%) compared to modules made from amorphous materials (efficiency around 6-8%), but are more expensive (Hill, 98). Their relatively low price makes thin film modules more attractive for applications where high efficiency is not the top priority. Also, the fact that there is a significant margin for further reducing the production cost of thin film modules, efforts are being concentrated on optimizing thin film technology. It is estimated that for plants with an annual production of CIGS modules of 200 MWp, the cost could be around ECU 0.5/Wp (Hill, 98).

New materials are also being developed at research level, but their production cost is, at present, too high for commercial applications. In addition, a variety of design-oriented PV modules of different colours and shapes has been developed to encourage wider introduction and prevalence of PV systems, particularly in applications where the external appearance of the system is important (Ishikawa, 98).

Key Issues & Strategic Considerations for the Diffusion of PV Applications

Although the cost of PV systems is currently relatively high, it is falling gradually and it can be further reduced via increasing scales of manufacturing. It is estimated that a growth of the PV market by a factor of 20 to 30 will lead to production plant of the scale needed to achieve costs of around 1ECU/Wp without the need for any technical breakthroughs (Hill, 98). By the year 2000 yearly production capacity, in Europe alone, may attain 150MWp, representing a tenfold increase on 1996 (Palz, 1998).

Nevertheless, unless the rise in the production capacity is followed by a proportional increase in demand for PV systems, sustainable market growth can not be guaranteed. Should demand remain at considerably lower levels compared to production rates, it is possible that the positive climate will be reversed.

Strategic initiatives integrated with existing policies could support suitable investments not only for further developing the PV market and technology, but also for ensuring a continuous and sufficient market growth.

Construction of PV Plants – Technology Transfer

Currently, over 90 per cent of the world annual production of PV modules is concentrated in the USA, Europe, and Japan (Singh, 98). New manufacturing plants are already under construction (mainly in developed countries such as the USA, Germany and Japan) and their operation is expected to play an important role in the reduction of PV module production costs.

However, it is equally important that market leaders should turn to the construction of more but relatively smaller PV plants in other countries (decentralization of PV industry), where there is a

Optimistic estimates predict that PVs may become competitive with conventional power generation by 2010

Today, R&D mostly focuses on optimizing the efficiency of PV cells, developing new materials for cell manufacture and investing in more efficient production lines

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Currently, over 90 per cent of the world annual production of PV modules is concentrated in the USA, Europe, and Japan. Decentralizing the industry could therefore be beneficial

Companies with a shared interest in the growth of PV sector can form a local cooperative network whose goal is to improve PV technology uptake

considerable potential for PV market expansion (e.g. favourable climatic conditions), so as to stimulate local demand and subsidies. These plants may use PV cells (or even modules) as raw material to produce end products, in order to satisfy mainly local or regional demand by customizing products to the specific characteristics of the local markets. Local investors can participate in such schemes and additionally local subcontractors can be used.

In this way, mechanisms for technology transfer will be created, leading to more efficient technology diffusion and dissemination. Simultaneously, the required capital investment will be divided between the developed economies (technology holders) and local investors. The decentralization of the PV industry will result in the transfer of state-of-the-art technology and contribute to job creation.

Strategic partnerships, such as joint ventures and franchising, can be widely used as tools for the decentralization of the PV industry as well as for technology transfer. Both models can combine the organization and resources of a big corporation and the flexibility and motivation of the relatively small entrepreneur.

Specifically, encouraging technology diffusion among local companies which are indirectly involved in PV applications can prove to be crucial. Such examples are construction companies, utilities and generally industries which are involved in the building sector (e.g. companies producing facades, windows etc.). These companies can integrate PV systems into their products and services. They have access to a large clientele and they can influence PV market accordingly.

Moreover, such companies can apply PV technologies when they design, produce and/or supply product systems incorporating these technologies, thus playing the role of the product developer by producing customized products adjusted to the local market peculiarities. For instance a company which produces external doors, windows and facades made from aluminium is a potential product developer for a PV system integrated into a building. In this and similar cases franchising can offer a new market driving force for PVs with relatively small investment requirements.

In this context companies with a shared interest in the growth of PV sector can form a local cooperative network whose goal is to improve PV technology uptake. This network can create 'One Stop Shop' companies where the customer interested in buying a PV system will be able to approach a single company able both to deliver a turnkey installation and provide after-sales technical assistance. These companies can organize campaigns to increase public awareness so that small-scale systems are seen on a par with ordinary appliances such as air-conditioning units and not as an extraordinary 'space-age' technology.

As an example -and perhaps also a stimulus for further research beyond the scope of this article- it is worth mentioning the case of Greek solar collector's market. The manufacturers of solar collectors in Greece have set up an association and have agreed on a common marketing policy. The campaign in favour of the installation of home solar collectors was accompanied by a tax credit introduced by the government. As a result the Greek market has recently experienced a tremendous growth: the Greek home solar collectors' market accounts for almost the 50 per cent of the European total. Financial incentives, in conjunction with strategic collaboration among manufacturers, have stimulated demand. Although PV systems and solar collectors are

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quite different systems, this case is a striking example of the extent to which networking can influence market growth.

Oriented Market Growth

The promotion of specific promising PV applications has also been identified as an important factor for PV market development. Such applications may include Solar Home Systems (SHS) and Building Integrated Photovoltaic (BIPV) systems:

1. SHS are small PV systems designed for off-grid applications providing power for a single household. SHS are modular and simple PV systems, intended mainly for developing countries as the least-cost option for rural electrification of large areas where population is dispersed and electricity demand is low. In 2010 this market segment is forecast to absorb around a fourth of overall shipments of PV modules.

   The two major barriers to SHS expansion are the affordability of electricity to rural customers and access to credit (Ciscar, 97). Utilities can play an intermediate role in the spread of SHS by taking over responsibility for installing and operating the SHS through setting up the necessary infrastructure. Thus, failures caused in the past by the mistaken belief that PV systems require little or no support, can be avoided (Fitzgerald, 98). Moreover, utilities would avoid the high cost that an extension in the electricity network would require. Economies of scale can be achieved via the development of standardized SHS kits, adjusted to the particularities of local conditions. Utility companies may offer financial credit to the customers (schemes such Third Party Finance (TPF) may be introduced), while they can also receive public funding for implementing programmes for the electrification of rural areas, and training local technicians in the installation and maintenance of SHS. Further research could examine the willingness of utilities to undertake such efforts and the incentives for them to do so.

2. BIPV systems are PV systems which are integrated into the structure of buildings. With buildings accounting for 40% of the total primary energy requirement in the EU (EUREC, 98), BIPV seem to be an attractive solution in satisfying part of their electricity demand, while buildings offer an excellent location for PVs. Incorporating solar energy into the building complements the overall energy efficiency of the design.

Apart from clean electricity generation, the main advantage of BIPV systems is the capital cost reduction that can be achieved by the substitution of conventional cladding elements. On the other hand, it is clear that in order to obtain the best results, the integration of PV systems should be studied and planned when designing the buildings. Indeed, significant efforts have been made worldwide by architects and building engineers to integrate PV systems into buildings and other structures. However, a lot of work has to be done in the areas of training and information dissemination.

For these reasons, BIPVs[1] have become a popular application of PV systems and they have been installed in a wide range of buildings, both new and old. In order to exploit the full potential of the BIPV market, close cooperation at local level among PV manufacturers, construction companies and utilities, architects and building engineers is crucial.

As regards BIPV systems and grid-connected PV installations in general, public intervention is important in order to form an appropriate

The networking approach has been used successfully in the case of the Greek solar collector market

Appropriate financial instruments and the involvement of utility companies are important factors in solar home and building-integrated systems

In the case of grid-connected systems public intervention has a role to play in setting up an appropriate framework, for example through new building regulations and restructuring the legal framework governing power generation

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Utility companies could offer Third Party Financing (TPF), for example, to help lighten the capital burden on users and installers

framework, for example through new building regulations and the restructuring of the legal framework governing power generation. A key issue is the rate which utilities should apply per kWh bought from the owners of grid-connected PV systems. Flexibility in tariffs and financing of grid-connected PV systems may be considered a prerequisite for substantial market growth. Net metering, green-pricing, tax credits, Third Party Finance are some of the financial instruments that can be used.

Funding – Support Programmes

The continuous growth of the PV market shows that funding programmes are headed in the right direction. However, as mentioned above, the PV market needs to expand by a factor of between 20 and 30 in order to achieve significant economies of scale and become competitive in larger markets.

Once policy has chosen to promote PV growth actively (whilst not disregarding other promising renewable-energy technologies), the next question raised concerns the actions that should be subsidized to achieve the desired result. The table bellow summarizes a number of possible actions or measures.

PV support programmes can be designed to encourage technology transfer and diffusion and the involvement of companies interested in the PV field -mainly as users and installers- thus enhancing market penetration of PV applications. Utility companies are a useful example. Technology transfer to these companies can accelerate PV market expansion, while utilities could be encouraged to offer TPF so that the end user need not be burdened with the high capital cost of a PV system. Alternatively, net metering can offer a simple, inexpensive mechanism for encouraging installation of small-scale, grid connected systems. By adapting net metering, utilities benefit by avoiding the administrative and accounting costs of metering and purchasing the small amounts of excess electricity produced by these small-scale installations.

PV funding programmes can equally support and encourage training and the establishment of the necessary infrastructure/appropriate framework in local markets, complementing the existing measures financing R&D projects and/or the installation of PV systems for demonstration purposes. In this way a versatile diffusion of PV technology can be successfully achieved, whilst also expanding the PV market. Simultaneously, a

Table 1.

Proposed Allocation Of Public Funding In The Pv Sector

SHS	BIPV Systems	Technology Transfer & Decentralization
• demonstration	• demonstration & dissemination	• joint ventures
• training, informing		• franchising
• legal & financial framework		• construction of PV plants
• infrastructure		• product development for local markets
• standardized kits	• product development	
• systems certification		
• Research & Development		

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rigid infrastructure would be created to provide integrated services and support to PV end users. Within this context training has to be seen as a necessary component for successful market development, and one which can ensure that the best available technology applied in each case and that PV systems are operated efficiently and reliably.

Conclusions

Current technological achievements and financial support bode well for the future of the PV industry. However, we hope to have shown that there are areas in which further initiatives can play a useful role. The aim in the first case discussed is the further development of local PV markets through the construction of new production plants and technology transfer at local level.

The second case identifies SHS and BIPV as two very promising PV applications (this list is of course not exhaustive), the role of which is expected to affect the future of the PV market. In both cases significant market growth can be induced by encouraging changes in the existing legal and financial framework, and through training and public awareness schemes. Also, funding demonstration projects in the case of SHS and demonstration and dissemination projects in the case of BIPV systems will remain an important factor for the future of these applications.

As an extension to the first and second areas, in the third we have listed supporting actions and underlined the importance of supporting the establishment of appropriate for the further development of the PV market.

Keywords
photovoltaic applications, strategic measures, market development, industry decentralization, funding programmes, oriented market growth

Note

1- There are other types of PV systems (e.g. PV central stations) which we cannot cover here for reasons of space.

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

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

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

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