

## 8. Innovation, efficiency and economic integration

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### 1. AN INTRODUCTION TO PRODUCTIVE EFFICIENCY

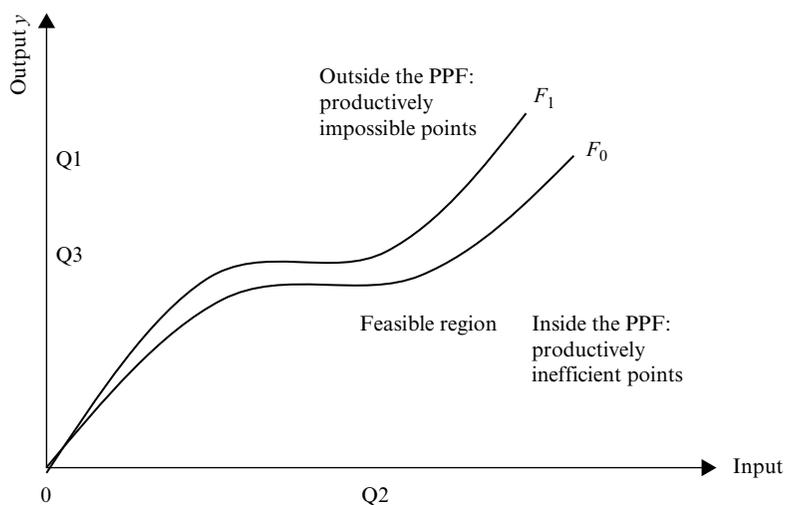
Nowadays, the economic role of innovation and efficiency enhancement in economic integration and convergence is even more important, taking into consideration the slowdown and the effects created by the current financial crisis. Within this framework, the key factors influencing the integration and convergence process are creation and diffusion of innovation, along with productive efficiency enhancement, mainly around three key areas: innovation and research, strengthening networks and clusters; and efficient use of production factors.

Within this framework, when one considers productivity comparisons, an additional source of productivity change, called technical change, is possible. This involves advances in technology that may be represented by an upward shift in the production frontier. This is represented in Figure 8.1 by the movement of the production frontier from  $0F_0$  to  $0F_1$  in period 1.

In period 1, all firms can technically produce more output for each level of input, relative to what was possible in period 0. When we observe that a producer has increased productivity from one period to the next, the improvement need not have been from efficiency improvements alone, but may have been due to technical change or the exploitation of scale economies, or from some combination of these three factors (Coelli et al., 2005).

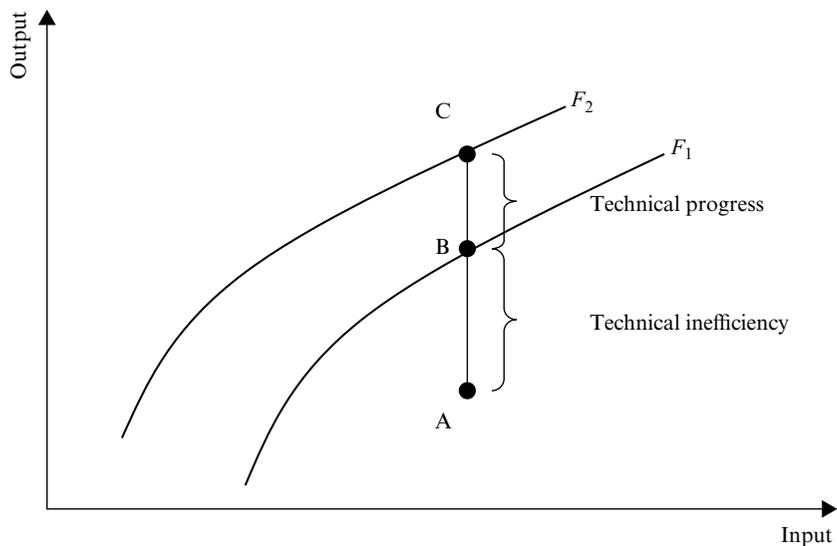
The optimum level of production is defined in terms of the production possibilities frontier (PPF). Technological change is assumed to push the frontier of potential production upward, while efficiency change will change the capability of productive units to improve production with available inputs and technology. Figure 8.2 illustrates this idea.

As illustrated in Figure 8.2,  $F_1$  and  $F_2$  are production frontiers in periods 1 and 2, respectively. Technical efficiency, which is represented by a movement towards the frontier from A to B, refers to the efficient



Source: Based on Coelli et al. (2005), p. 6.

Figure 8.1 Production frontiers and technical efficiency



Source: Mahadevan (2002), p. 7.

Figure 8.2 The frontier and non-frontier total factor productivity growth measure

use of inputs and technology due to the accumulation of knowledge in the learning-by-doing process, diffusion of new technology, improved managerial practices and so on. Thus AB shows technical inefficiency in period 1. The absence of technical inefficiency in the non-frontier approach is related to the implicit assumption of long-term equilibrium behavior whereby producers are said to be fully efficient as they have had time to learn and adjust their input and technology use appropriately. Thus the non-frontier total factor productivity (TFP) growth measure is only made up of the movement from B to C, which represents technical progress due to technological improvements incorporated in inputs. Hence technical progress and TFP growth are used synonymously when the non-frontier approach is used. Unlike the non-frontier approach, the frontier approach is able to decompose output growth not just into input growth and TFP growth; it goes a step further to decompose TFP growth into various efficiency components such as technical progress and gains in technical efficiency.

## 2. PRODUCTIVE EFFICIENCY DETERMINING FACTORS

In the modern knowledge economy, growth depends extensively on the presence or the formation of a network and environment favorable to innovation, which is based on endogenous development capabilities. Even though the producer-specific factors are important determinants of innovation activity technological opportunities and favorable entrepreneurial environment have a positive effect on innovation activity as well. Technological change, innovation and technology creation and diffusion are important factors in economic progress.

Combining the production functions in order to create and disseminate innovations leads to improvements in productivity and efficiency. However, at a given moment of time, when the technology and the production environment are essentially the same, producers may exhibit different productivity levels due to differences in their production efficiency. Within the growth process, therefore, the efficiency of production resources becomes a critical element in growth, through utilizing the available, yet scarce, resources more productively. Within this framework, productivity represents the estimation of how well a producer uses the available resources to produce outputs from inputs. However, the productivity theory literature has emphasized factors such as productive efficiency, mainly through technological spillovers, increasing returns, learning by doing, and unobserved inputs (e.g. human capital quality), whereas the

empirical industrial organization literature has emphasized the degree of openness of countries to imports and industry structure (Koop, 2001).

Consequently, one of the main tasks is to investigate the relationship between inefficiency and a number of factors which are likely to be determinants, and measure the extent to which they contribute to the presence of inefficiency. These factors are neither inputs to the production process nor outputs of it, but nonetheless exert an influence on producer performance. Such factors are widely referred to as efficiency explanatory variables.

Within this framework, based on Wang (2007), since R&D is one of the most crucial elements in promoting growth, it is argued that any production unit that uses R&D resources inefficiently may be subjected to a growth penalty in the form of a much smaller benefit from R&D investment. If R&D resources are not used effectively, additional investment may be of little help in stimulating economic growth. Literature has already been devoted to investigating the economic aspects and effects of R&D investment. It has been considered that R&D could result in better production technology and also raise the productivity as well as the rates of return on investment at both the producer and industry levels.

Technology and innovation play an important role in productive efficiency with a multiple role: as motive force they direct the producers to ambitious and long-term objectives, lead to the renewal of methods of production, supply and distribution, and management and marketing, as well as industrial structures and the appearance of new industries of economic activity, achieving a wider spectrum of products and services, as well as relative markets. Inputs affect the intermediate inputs, which consequently affect and define the productivity and competitiveness level. As mentioned earlier, technological change, innovation and technology creation and diffusion are an important factor in economic progress.

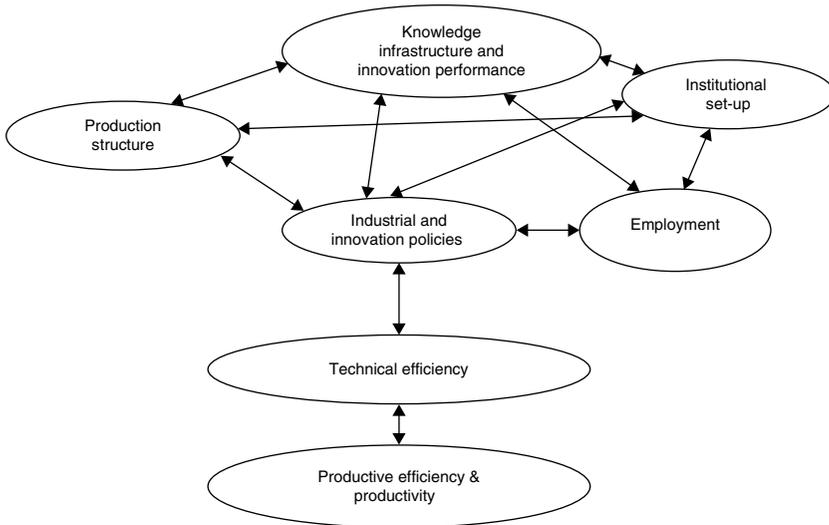
On the other hand, as broadly described in Gallié and Roux (2010), in the last two decades R&D cooperation has attracted a considerable amount of attention. Many empirical studies, in economics or in management, have investigated the motives for and potential benefits of cooperation as compared to internal R&D. Cooperation enables firms to internalize knowledge spillovers, facilitates knowledge transfers between them (in particular between firms and universities), helps them gain access to complementary knowledge and technologies, generates scale economies of research, enables firms to speed the commercialization of new products or technologies, to avoid duplicative R&D efforts, to share costs and risk and to gain access to foreign or new markets. After R&D collaboration, cooperation was most often captured as a homogeneous object (i.e. R&D cooperation versus internal R&D).

Following the main findings from the literature survey, there are two complementary sets of conditions that need to be satisfied for industries to sustain productivity and efficiency in a competitive environment. The first is that they must have suitable levels of both physical infrastructure and human capital. The second is that, in the new knowledge-based economy, they must have the capacity to innovate and to use both existing and new technologies effectively. Industrial and innovation policy is aimed at strengthening the competitiveness of producers by promoting competition, ensuring access to markets and establishing an environment which is conducive to R&D. As recognized, lack of innovative capacity stems not only from deficiencies in the research base and low levels of R&D expenditure, but also from weaknesses in the links between research centers and businesses, and slow take-up of information and communication technologies. Knowledge and access to it have become the driving force of productivity, much more than natural resources or the ability to exploit abundant low-cost labor have become the major determinants of economic competitiveness, since it is through these that industries can increase their productive efficiency. Innovation, therefore, holds the key to maintaining and strengthening efficiency, which in turn is essential for achieving sustained economic development.

These environmental factors are spatially confined externalities with different scales of influence. Some factors, such as the legal and cultural framework or large research institutes, operate mainly at national level, generating national systems of innovation (Lundvall, 1992). Other factors, such as skilled labor supply and networks linking firms and support institutions, have a more limited territorial span, and are the basis of regional systems of innovation (Braczyk et al., 1998).

### 3. PRODUCTIVE EFFICIENCY AND ECONOMIC INTEGRATION: THE CASE OF THE EUROPEAN UNION

As technical efficiency enhancement becomes an increasingly important issue, production must draw on a wide range of production ideas, component technologies and complementary capabilities. Within this framework, it is rather difficult for any single industry to incorporate and take advantage of the relevant technological advances, as well as the underlying industrial and innovation policies. This means that the actions of industries involve the targeted development of specialized knowledge assets, which are integrated from a wider range of knowledge areas (Kessler et al., 2000).



Source: Own elaboration.

*Figure 8.3 Productive efficiency and institutional framework*

European technology and innovation policies are no longer exclusively in the hands of national authorities: increasingly, national initiatives are supplemented by or even competing with regional innovation policies or transnational programs, in particular the activities of the EU.

At the same time, industrial innovation increasingly occurs within international networks. Research, technology and innovation policies of European countries clearly reflect the profiles of their national (and regional) ‘innovation systems’, understood as the various institutions, corporate actors and processes contributing to industrial and societal innovation. Figure 8.3 highlights the interactions among the main policy elements regarding the enhancement of technical and productive efficiency.

The spectrum of the implemented instruments of research, technology and innovation policy is widely differentiated in the meantime, reflecting the scope of institutions and interests involved: it stretches from public funding of research institutions over various forms of financial incentives to the conducting of research and experimental development in public or industrial research labs, up to the design of an innovation-oriented infrastructure, including the institutions and mechanisms of technology transfer. In many European countries, these instruments have dominated the practice or research and technology policy for the last three decades.

As further instruments one could mention efforts to guide public demand, measures in education and further training and the regulatory possibilities available. In the twenty-first century, though, national and (regional) innovation systems are experiencing revolutionary shock waves: the growing pull of internationalizing economic relationships has mixed traditional regional or national divisions of work between industrial enterprises, educational and research institutions as well as administration and politics, and it has debased many of their traditional strengths. Internationalization, however, has so far not led to a uniformity of the national innovation systems, which would finally mean their abolition. The various national and regional innovation cultures and related policy arenas react very differently, which partly leads them into crises, partly stabilizes, but partly also reveals unexpected, novel chances in a transformed international context. At the same time, European transnational innovation policies have been entering the stage, increasingly since 1985, and now cover the whole range of instruments (Kuhlmann, 2001).

#### 4. PRODUCTIVE EFFICIENCY AND INNOVATION POLICY: THE CASE OF THE EUROPEAN UNION

Innovation policy seeks to help firms or industries to improve their capacity to innovate. This includes the provision of scientific infrastructure in research and education, and direct and indirect support for research and technological development. It also includes a wide range of policies which aim to build networks, to make markets more conducive to innovation, to facilitate the transfer of technology, to help firms to acquire relevant capabilities, and to provide a supporting infrastructure in areas such as standards and intellectual property. Public innovation policy aims to strengthen the competitiveness of an economy or of selected industries, in order to increase societal welfare through economic success (Kuhlmann, 2001). Hence the EU has made innovation a top priority through several strategies, funding opportunities and assessments. The pressures of globalization have brought innovation to the fore as a key element in increasing productivity along with technical efficiency and underpinning industrial competitiveness, taking into consideration the underinvestment in business R&D and other innovative activities, strongly linked to the fragmented condition of European markets.

Innovation policy is essential for EU productive efficiency and an important driver in enabling the EU to enhance competitiveness, increase efficiency and growth and consequently to compete on a global scale. However, policy makers have also underlined the need for interaction

between innovation policy and other policy areas to improve the environment for innovative enterprises (Chesbrough, 2002; Nilsson, 2004; Georghiou, 2006).

On the other hand, Europe's national innovation systems differ substantially, as do their innovation performances. Therefore member states have undertaken great efforts to improve their innovation support measures by investing in research and implementing new or better instruments in support of innovation. This level of financial engagement is at risk in the current global economic crisis and, as a direct impact, the innovation gap in the EU is widening again. The implication of this is that innovation policy must consider the needs of a wide set of industries – policy initiatives need not be confined to a small group of highly innovative sectors. The EU is challenged in the global arena by emerging economies when it comes to capturing and capitalizing on knowledge and technology in the context of innovation. In the past few years, the budget for R&D has been increased and several initiatives have been launched to strengthen Europe's competitiveness. So far, however, these efforts have not made the EU more competitive.

The majority of public initiatives are still mainly developed in national policies offered by national institutions. While in recent years member states increasingly tended to compete with each other in the field of innovation policy, strong industrial or financial capital actors have been appearing more frequently on the scene – multinational enterprises, international strategic alliances of national enterprises – who act globally and across the national innovation systems. In the member states of the EU this policy initially took the form of initiatives for stimulating research, improving innovation financing and promoting technology absorption and innovation management.

Additional priorities such as intensifying the cooperation between research, industry and universities, promoting 'clustering' and other forms of cooperation among enterprises and other organizations involved in the innovation process, and encouraging the start-up of technology-based companies were added to the national innovation policy (Nilsson, 2004).

As part of the Europe 2020 strategy, in 2010 the Commission launched an ambitious new industrial policy that highlighted the actions needed to strengthen the attractiveness of Europe as a place for investment and production, including the commitment to monitor member states' competitiveness policies. The changing nature and scope of global innovation activities creates very significant consequences for EU innovation policy, requiring a substantial review of the pillars of EU innovation policy, involving both the scope and the governance of innovation at the EU and national level (Anvret et al. 2010).

The EU has identified the following key areas where the competitiveness of the EU economy could be further strengthened in order to make significant progress towards the Europe 2020 goals (European Commission, 2011):

- facilitating structural changes in the economy, in order to move towards more innovative and knowledge-based sectors that have a higher productivity growth and have suffered less from global competition;
- enabling innovation in industries, in particular by pooling scarce resources, by reducing the fragmentation of innovation support systems and by increasing the market focus of research projects;
- promoting sustainability and resource efficiency, in particular by promoting innovation and the use of cleaner technologies, by ensuring fair and undistorted pricing of energy and by upgrading and interconnecting energy distribution networks;
- improving the business environment, in particular by reducing the administrative burden on businesses and by promoting competition among service providers that use broadband, energy and transport infrastructure;
- benefiting from the single market, by supporting innovative services and by fully implementing the Single Market Regulation, in particular the Services Directive;
- supporting small and medium-sized enterprises (SMEs), in particular by favouring access to finance, by facilitating internationalization and access to markets.

EU industry must accelerate its efforts to adopt these technologies to keep its competitive edge in the world, with research and innovation driving productivity growth and industrial competitiveness. A transition towards a sustainable, resource-efficient economy is paramount for maintaining the long-term competitiveness of European industries. Overall, European member states have made significant progress in defining and implementing consistent national legislative frameworks for stimulating efficiency. However, some lack the experience and the administrative capacity to do this and for these countries the framework legislation at the EU level can provide guidance and support.

The quality and availability of infrastructure (energy, transport and broadband) make an important contribution to an efficiency-promoting environment. Industrial sectors need a modern public administration, able to deliver efficient and high-quality public services (European Commission, 2011). Coordinating clusters and networks improve industrial

competitiveness and innovation by bringing together resources and expertise, and promoting cooperation among businesses, public authorities and universities. EU industrial and innovation policies should aim to overcome existing market failures and funding gaps, especially to supply the bridge between technical efficiency and productivity enhancement.

## 5. POLICY IMPLICATIONS AND CONCLUDING REMARKS

Nowadays, the role of manufacturing industries in the economy is even more important, taking into consideration the slowdown in the world economy and the effects on the business environment created by the financial crisis. Thus manufacturing industries have a very important role in creating opportunities, making an important contribution to economic growth and development. However, due to their nature, manufacturing industries are characterized by great heterogeneity since they differ in their endowments of resources as well as on the risks involved in their productive activities. For this reason, it is of great importance, on the one hand, to analyze their efficiency level and potential, and, in addition, to analyze the factors that determine their efficiency potential.

The key factors influencing the competitiveness of the EU manufacturing industry are access to innovation, R&D and international trade. The main recommendations revolve around three key areas: innovation and research, and strengthening networks and clusters; responsible use of natural resources; and the need for open world markets with fair competition. Clustering, collaboration and the formation of strategic alliances are becoming increasingly important. Continuous R&D and innovation efforts are essential elements in guaranteeing the long-term competitiveness of Europe's manufacturing industries. European research, technical development and innovation policies should focus on developing the framework conditions that stimulate innovation, entrepreneurship and, thus, growth and employment. Innovation for sustainable manufacturing requires paying attention to the interfaces of R&D policies with other critical policy fields. Strong emphasis needs to be placed upon the management of the interfaces of R&D policy and other policy realms – competition policy, intellectual property rights, standardization, education and training, environmental policy, the labor market, employment and social policy – to facilitate the creation of a sustainable European manufacturing industry environment, along with fiscal instruments and incentives. Understanding future challenges and issues is important in future developments in manufacturing. Industrial change driven by new technological

opportunities will impact on the manufacturing structures in the EU contributing to sustainable growth and improving technical efficiency.

The potential for technical efficiency enhancement is considered to a large extent to depend on the EU's capability to transform the economy into one that makes more productive use of its resources. Much will depend on the capacity of markets to facilitate the reallocation of resources to industries that show rapid productivity growth. However, it is difficult to predict which industries will be the most productive in the future, as technology and innovation trends are inherently difficult to forecast. For now, a productive use of a larger input from skilled employment and the exploitation of information and communication (ICT) investments in manufacturing industries appear the most successful policy avenues for a European productivity revival.

Promoting technical and productive efficiency in the EU has resulted in a growing challenge for policy makers. Productive and regional disparities and inequalities are an increasing issue for the EU to resolve; as a result, policy makers have to adapt the policy agenda considering industrial and innovation policy in order to enhance technical and productive efficiency capabilities.

Moreover, efficiency and policy planning is a major matter which, due to its wide interpretations and implications, should have a clear mix of principles and priorities, mainly focusing on the effectiveness of the related EU policies. EU industrial and innovation policy should aim to bridge the technical efficiency gaps, both at industrial and country level, benefiting economic cohesion, allowing member states with a backwards economy or backwards industries to modernize and thus compete in European and international markets, promoting convergence, competitiveness and cooperation. Infrastructure, innovation and investments should be among the main goals.

European governments are in need of a more coherent, more coordinated approach towards industrial technical efficiency support. However, the pressure on public budgets adds to the urgency of this matter in different policy areas of industrial and innovation policy. The range of explicit innovation policies being applied is very much concerned with the supply side and even more with R&D support of various types, ranging from funding of science in public institutions through to fiscal incentives for firms to increase R&D spend. A comprehensive approach to industrial and innovation policy can be achieved by supporting markets for innovative goods and services, and excellence in research in new technologies, including ICT, introducing a more focused strategy to facilitate the creation of areas for action, and in particular introducing a more focused strategy to facilitate the creation and marketing of new innovative products

and services. Within the domain of industrial and innovation policy, regulatory reform is seen to affect innovation indirectly by affecting the funds available for investment and market size and structure, and directly through its impact on the promotion of technical efficiency and productivity (Lengrand, 2003).

An open, efficient and competitive business environment is a crucial catalyst for growth in a global context. Improving the business environment covers policies in areas ranging from improving infrastructure to shortening the time needed to obtain a building license. In many cases, better institutional mechanisms need to be functioning as a single research area, business environment and innovation system. There need to be strategic approaches that promote closer interaction not only among sectors but also among policy makers (from different policy fields and different levels of government). European innovation and industrial policy is therefore recommended to develop strategic approaches that integrate R&D, innovation and industrial policy along with a more coherent EU strategy for innovative competitiveness, giving special attention to ICT in innovation and industrial policy (ETEPS, 2011).

At the national level, governments could set up agencies funded by public bonds with the mission to provide venture capital, investment credits and R&D support to new activities in the above fields. Productive efficiency and competitiveness would be strengthened by:

- pooling scarce resources to help to achieve critical mass in bringing innovation to the market; and by increasing cooperation in innovation to create large-scale demonstration projects and pilot test facilities;
- reducing the fragmentation of innovation support systems, facilitating bringing innovative solutions to the market, and increasing the market focus of research projects;
- developing support for innovative services based on measurable outcomes;
- facilitating the growth of manufacturing industries by ensuring that regulations do not pose obstacles to expansion; by favoring access to appropriate finance; and by providing support services for accessing new markets, and publicizing these.

A new generation of policies must overcome the limitations and failures of past experiences, such as collusive practices between political and economic power, heavy bureaucracy, lack of accountability and entrepreneurship. They have to be creative and selective, with decision-making mechanisms that are more democratic and inclusive of different social

interests. These new approaches to industrial and innovation policies could play a key role in pulling Europe out of the current crisis. The politics behind such a new departure must be based on a wide social consensus over the distribution of the productivity and efficiency gains deriving from new technologies and economic activities (Pianta, 2010).

Industrial and innovation policy programs and projects claim to contribute to technical efficiency. This implies that policies should concentrate on areas in which there is expansion and therefore good prospects for growth. Community businesses should become more competitive, and scientific and technological progress is expected to offer a medium- or long-term potential for dissemination and exploitation (Kuhlmann, 2001). An open, efficient and competitive business environment is a crucial catalyst for growth in a global context. Rising to these challenges can improve the competitiveness of European manufacturing industries, and the Commission aims to help the member states to use their limited resources efficiently in order to increase the global competitiveness of their industries. Addressing these challenges will improve the growth prospects of industries. A competitive industry can lower costs and prices, create new products and improve quality, thus contributing decisively to wealth creation and productivity growth throughout the economy.

The difficult fiscal environment sets limits to policy action, but robust growth will reduce the burden of public deficit and debt, in line with the goals of the Stability and Growth Pact. For this an environment that favors new ideas and new businesses is required. Innovation is the primary driver of a successful and sustainable industrial policy. A strong lead in R&D and innovation is Europe's key competitive advantage and of central importance in finding solutions to economic challenges (European Commission, 2011). With increased globalization, one can only hope that industry will be an engine for the spreading of social progress, environmentally friendly technologies and innovations worldwide (Soete, 2007). To achieve a truly sustainable, positive effect for manufacturing industry and the workforce it employs, the EU and its member states should aim to avoid the relocation of manufacturing activities and related services (e.g. R&D, ICT) and support the permanent upgrading of European manufacturing industries.

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