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How to better diffuse technologies in Europe

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The Lisbon Strategy puts emphasis on R&D policies with its 3% target in order to become the most knowledge intensive economy. These goals of the Member States within the European Research Area could be supported by increased technology diffusion policies such as:
- Setting up knowledge transfer institutions,
- Development of Higher education and lifelong learning,
- Awareness arising about technology diffusion management,
- FDI encouragement for knowledge transfer and best management practices.

Diffusion policies would be of benefit in particular to the catching-up countries that lack resources to reach the 3% target and need to develop absorptive capacities to adopt advanced technologies faster.

The member countries of the European Research Area (ERA) and the EU Commission have put innovation at the top of the policy agenda. The Lisbon Strategy includes the ambitious 3% target for national R&D intensity and national government have turned this into their own national goals. Governments have begun new initiatives and new policies to increase spending on R&D by both public and private sector. Supporting R&D and, thus, invention and innovation is just a first step. To achieve additional employment and income growth, R&D must be transformed into new products, processes and technologies which are adopted by firms, households and governments. The factors which enhance the implementation of new knowledge can be quite different from the factors which stimulate invention and innovation. The question at stake for catching-up countries may be in view of economic growth and employment the priority for investments in technology creation by R&D or investments in institutions that favour the diffusion of technology.

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Invention, innovation and diffusion are not necessarily intertwined. The history of technology is full of examples demonstrating that countries, firms and individuals which were leading in invention are not necessarily also leading in innovation or in the widespread diffusion of new technologies. One well known example is the fax machine, which was first developed in Germany but was turned into a worldwide successful product by Japanese companies. Similarly, the anti-lock brake system (ABS) was invented by US car makers but became prominent primarily due to German automotive suppliers.

The worldwide diffusion of information and communication technologies (ICT) has significantly reduced the barriers to access information and has speeded up the diffusion of knowledge on recently developed technologies. This might make one think that the location of invention is no longer important to the successful transformation of invention into employment and income growth.

First of all, the fashionable idea that we live in a completely networked, dematerialized information society is not the best starting point and not a satisfactory basis for policy making. The adoption of a new technology often takes longer than the diffusion of knowledge. Diffusion of innovation is still a gradual process involving significant time and adjustment costs. Often, old and new technologies exist in parallel for a long period during which both are incrementally improved and adjusted.

Empirical evidence suggests that technology diffusion still has a locational component. Innovations are usually generated in high-income countries which are also the starting point for diffusion. Neighbour countries, trade partners (especially in the field of advanced capital goods) or countries with strong social ties to each other more rapidly adopt new technologies from the leading countries.

However, the speed of convergence of international technology adoption has significantly increased in the last decades. And so, the time advantage from which countries can profit from faster technology adoption has now become notably smaller. Despite a considerable heterogeneity across technologies, the overall pattern of international technology diffusion suggests that countries which are leaders in the adoption of a forerunner technology will also become leaders in the adoption of the next generation technology. In view of ERA this trend may receive policy attention to offering development potential for catching-up regions and countries.

To improve technology diffusion, the absorptive capacities for new technologies have to be increased. In this context, knowledge transfer institutions play a crucial role like for example the Fraunhofer institutes in Germany, TNO in the Netherlands or Innova in Sweden. In addition to supporting knowledge transfer institutions which also may have a role in R&D, governments should also target three policy areas, namely education,

the improvement of management practices, and FDI as a mechanism for technology diffusion.

- **Support technology diffusion by investments in education**

Several studies have frequently examined the role of human capital in technology diffusion. Economies with highly educated workers may be more capable of quickly and efficiently adopting new technologies. Therefore, the most obvious candidate to explain the successful adoption of technologies is the level of education of the workforce.

Looking at more recent technologies, *tertiary education* plays an important role in fostering technology diffusion. For example, empirical studies suggest that the diffusion of ICT is strongly enhanced by a sufficient supply of workers with at least a college degree. Hence, investment in education represents one major building block not only for future innovation but also for technology diffusion.

In order to exploit the full potential of new technologies, no longer the specific skills with respect to a specific technology but the ability to learn and to reconfigure skills is essential. Generally speaking, diffusion and adoption of successive generations of technologies is enhanced if the initial investment in education takes the form of *general human capital* rather than (technology-) specific human capital. A significant stock of human capital which is only related to a specific generation of technology might give rise to technological lock-ins which prevent or retard the adoption of new technologies.

Moreover, *lifelong learning* is also crucial for technology diffusion. Governments should provide incentives for employers and employees to invest in education and re-training to prevent lock-ins and to keep the existing stock of human capital in line with the diffusion of new technologies.

- **Improve management practices for technology diffusion**

The overall performance of most countries is determined not by the performance of its best managed companies, but by the size of its "tail" of poor performers. This means that management practices are essential for the efficient use of the labour force's competences and the opportunities generated by the adoption of new technologies. Empirical evidence shows that the diffusion of organisational innovations (e.g. management practices) is slower than the diffusion of new technologies. A recent international survey of management practices conducted by the London School of Economics and Political Science (LSE) indicated that, in comparison to EU firms, a larger share of US firms implements management practices which help to *adopt ICT effectively*. This advantage is especially prominent in human resource management practices – an area which is important for knowledge economies.

- **Regard FDI as a mechanism for technology diffusion**

With respect to the improvement of management practices, *Foreign Direct Investment (FDI)* plays an important role in knowledge transfer .Foreign run companies can be a driving force for the regional adoption of international best management practices.

Moreover, competition significantly stimulates the adoption of such practices. By developing environments that promote best management practices across all firms and by paying as much attention to the laggards as to the leaders in the business sector, governments can drive the competitiveness of their entire economies.

How can technology laggards in the European Research Area be advanced?

The welfare generated by new products, processes and technologies results mainly from their widespread adoption throughout the economy. A significant share of the associated costs refers to development and early adoption stages. This raises the question as to whether strong R&D performance is necessary for the broad diffusion of new technologies. The vast majority of firms will never undertake R&D but adopt new technologies by investing in capital goods, learning from others, etc. This free-riding seems to be a useful strategy for technology laggards at first sight. However, a free-rider policy that only emphasises the adoption of technologies developed in other countries will not be effective without significant national R&D. This is because countries need an absorptive capacity to adopt new technologies. In the case of General Purpose Technologies this is especially true i.e. new technologies that affect the entire economy such as ICT, where co-inventions and modifications are needed to realise the full potential of the technology. Hence, innovation policies and diffusion policies are rather complements than substitutes. Both policies can be justified on the basis that they address market failures such as imperfect information, market structures, and externalities. Despite this, diffusion policies are far less common than R&D policies.

Diffusion policies stress the importance of creating an infrastructure which supports the rapid spread of awareness and knowledge of innovations. Such policies primarily address small and medium-sized enterprises (SMEs). Typical programs in this field should include the following:

- To provide consultancy services to SMEs in order to facilitate the adoption of specific technologies
- To encourage the formation of clusters of regional firms in order to facilitate the interchange of knowledge and ideas and to promote networking

The importance of R&D policies has already been underlined by the 3% target of the Lisbon strategy. However, for diffusion policies remains a further need for action for policy makers. Technology diffusion has particular

relevance for technology laggards. As a first step, mutual learning may emerge from the evaluation of technology diffusion policies in the regions and the exchange of results.