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The fourth industrial revolution: How the EU can lead it

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Abstract

The fourth industrial revolution is different from the previous three. This is because machines and artificial intelligence play a significant role in enhancing productivity and wealth creation, which directly changes and challenges the role of human beings. The fourth industrial revolution will also intensify globalisation. Therefore, technology will become much more significant, because regions and societies that cope positively with the technological impact of the fourth industrial revolution will have a better economic and social future. This article argues that the EU can play an important role in developing an environment appropriate for the fourth industrial revolution, an environment that is vibrant and open to new technologies. Member states would profit from an EU-wide coordinated framework for this area. The EU has to establish new common policies for the market-oriented diffusion and widespread use of new technologies.

Keywords

Fourth industrial revolution, Technology policy, Industrial policy, Leadership

Introduction

Historically there have been four industrial revolutions (see Schwab 2016). The first began in the early nineteenth century, when the power of steam and water dramatically increased the productivity of human (physical) labour. The second revolution started almost a hundred years later with electricity as its key driver. Mass industrial production

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led to productivity gains and opened the way for individualised mass consumption. The third revolution followed 70 years later with information technology: the use of computing in industry and the development of personal computers. The fourth industrial revolution started 30 years later and is ongoing. Also known as the 'digital revolution', it combines technological and human capacities in an unprecedented way through self-learning algorithms, self-driving cars, human–machine interconnection and big-data analytics.

Like its forerunners, the fourth revolution is generating both enormous economic potential and fears about the changes involved. These fears are being harboured not only by workers across Europe but also by governments, which are uncertain about how to respond. From an economic and societal point of view, the relationship between human beings and machines will become completely new. Increasingly, machines are making decisions in various areas with less and less intervention by human beings in this decision-making process, and the speed of their decision-making is rising. This new reality has enabled new technological giants like Facebook and Apple to become economic powerhouses. The EU's tech industry is lagging behind these Silicon Valley giants. The key factor underpinning the fourth industrial revolution is the enormous growth in computing power. Moore's Law, from 1965, states that the number of components per integrated circuit, and thus computing processing power, doubles every year. It projects that this rate of growth will continue for at least another decade. The novelty is that both the acceleration and the rate of technological change are increasing. The precondition for technological change is humanity's ability to adapt its systems. In this way technology has made humans richer and more confident about finding appropriate solutions. However, we have to be prepared to accept that humanity will not be able to keep up with the pace of change. Humans are becoming 'dislocated' not only technologically but also in economic and societal terms.

The fourth industrial revolution is markedly different from its predecessors because of the combination of factors: (a) integrated circuits on microchips, (b) memory units to store information, (c) networks that help to enhance communication, (d) software applications that provide a direct link to consumers' needs and (e) sensor capacity that allows artificial intelligence to analyse most things which were previously only accessible to the human mind (see Friedman 2016).

In light of these considerations, this article proposes that the EU should set a technology policy, applicable to all member states, which establishes a vibrant environment that is open to new technologies. The article first describes the historical development of technology policy and then gives a short overview of the lessons that can be learned from countries with different policies. Finally, it offers concrete ideas for EU policies.

EU technology policy

The European Commission started addressing technology policy in the early 1980s with the goal of supporting expenditure in Research and Development (R&D) (Vonortas

2000). The resulting framework programme focused on the supply of technologies rather than on creating demand among those that bought and used them, that is, consumers and the state. With the 1992 Maastricht Treaty, the European Commission made industrial innovation the focus for technology policy. The biggest challenge for an EU-wide technology strategy was posed by the differences in economic and industrial structure among the member states. These differences were reflected in their individual national science and technology policy systems.

When compared with the US, which is a global leader in technology, the EU had several shortcomings. First, the EU's total R&D expenditure was significantly lower than that in the US. Second, R&D expenditure in the US was made at the federal level, whereas in the EU the largest share of R&D expenditure was made by the member states. Third, while spending on defence and security accounted for almost half of R&D in the US, non-military spending dominated the EU budgets. After the end of the Cold War, technology policy lost some of its relevance. The public sector reduced its role in technology policy by cutting public R&D expenditure, which had a special impact on the defence sector. The corporate sector now became the dominant provider and user of (new) technologies. This created new high-technology sectors, brought about productivity gains, accelerated technological change and increased the knowledge intensity of industry. It helped to lead the fourth industrial revolution in its early stages. Thus, with the private sector taking on more responsibility, the public sector's capacity to formulate and to implement a technology strategy was reduced.

Political debate in the late 1990s and early 2000s established a narrative of an EU which had failed to keep pace with the high growth rates of other regions, especially the US and East Asia. The question arose as to whether the EU should increase its role in R&D and technology policies. The Lisbon Agenda, adopted in 2000, called for the Union to become 'the most competitive and dynamic knowledge-based economy in the world capable of sustainable economic growth with more and better jobs and greater social cohesion' (European Council 2000). It gave new impulse to the EU's technology policies.

Leading the fourth industrial revolution

EU policies focus on investing in digital infrastructure and strengthening the single market by reducing barriers to the trade in goods, services and applications and by implementing better policies in education, such as schemes for lifelong learning. However, EU policy should foster the demand side of European technology policy, an area that policymakers have hitherto undervalued. This means establishing a policy that creates a market network in which the use of new technologies (hardware/devices and software/applications) is part of what the state organises or finances. Technology policy must be linked to economic policy (Branscomb and Florida 1998). This approach requires that the public sector explicitly stresses its own role as a customer and user of technology. The public sector not only reinforces the 'supply side' of new technologies but also acts as a 'buyer' of these applications. This is especially important where the purchase and use of

technology by the public sector leads to benefits for the private sector. For example, public expenditure for R&D in defence or security might lead to the invention of technologies which private companies go on to use to compete more successfully on global markets. Strengthening the demand side of EU technology policy would enhance market outcomes.

The approach that still dominates technology policy focuses on relatively immobile resources such as infrastructure, the workforce and the quality of education. While this has predictable positive effects for the growth potential of a domestic economy, these advantages go together with problems. The concrete outcomes of such technology policies are diverse and dispersed. And the fuzzier policy targets are, the better they go together with politics that favour the vested interests of special groups, rather than with broad technological progress. And yet it is this progress that results in technological innovation, new products and services, productivity gains, better-paid jobs and higher living standards for all. This situation creates a dilemma about the direction of new technology policy (Sharp and Peterson 1998).

This dilemma involves three main issues. The first of these concerns the coherence or complexity of the policy goals and structures. The question is whether the objectives of competitiveness, strengthening the scientific base and enhancing social cohesion can be achieved together. Consider, for example, the potential conflict between research excellence and territorial cohesion within the EU. The second issue concerns the risk of unrealistic expectations about what technology programmes can achieve. Centralised planning is necessary because technology policies and resources differ among the member states. However, centralisation is in conflict with the principle of subsidiarity, according to which actions should be taken at the EU level only when necessary. The third issue is how to reconcile an open-market and consumer-friendly policy with the established path-dependent, technocratic, closed style of policymaking on research matters that prevails in the EU. The more open to innovation the approaches are, the more the EU has to make room for a policy which ensures that it is not merely small and special groups, but the economy as a whole that benefits from the fruits of innovation in the form of new products and services. Thus far this has not been a significant approach in the EU.

The public sector

EU policy on the fourth industrial revolution should focus on strengthening member states' capacity to improve the potential for innovation in the private sector, and not on picking winners and creating EU champions of industry. The private sector creates technologies that serve the needs of customers efficiently and effectively. The role for governments should be to support a broad range of technological applications in different industries. Governments should be reluctant to support technology in which investments can be made more appropriately by companies. Removing all obstacles in the way of cooperation between government and the private sector would support this approach. Universities would play a crucial role. They would carry over the fruits of pure science

to applied science. And they would also provide labs and workspaces with the aim of developing entrepreneurial skills and fostering the demand for new products, services and applications.

There are many ways to explain the success of Silicon Valley and its technological giants. One factor is the collaboration among and between companies, universities and government laboratories. This cooperation started in the 1980s, when Congress exempted smaller companies from antitrust laws, thus making it possible for them to participate in research consortia. This contributed to a variety of initiatives such as the Computer Technology Corporation, a consortium of computer companies engaged in research on software development tools and computer architecture. Another early venture was the Open Software Foundation, which emerged through the collaborative efforts of computer manufacturers and software companies to develop standard interfaces so that customers could easily connect with products made by all members of the organisation (Branscomb 1992).

Drawing on the last-mentioned example, the EU could mobilise its market power under clear, simple and common standards, established together with the private sector. These standards would lead to better quality and increase productivity. In this manner open data would spur innovation and provide access to public data while respecting data privacy. Take as an example the basic findings of technologies that help to analyse and characterise materials for clothing. These findings could help to invent new ways of manufacturing long-lasting clothing or clothing that meets the individual needs of customers with allergies. Since these innovations are often small and incremental, they do not receive much attention from politicians. But they create enormous added value in terms of market visibility, because they result in new useable products. And it only makes sense to speak about innovation when the changes involved result in new products and services that consumers buy and use. Market success is nothing other than the translation of such a 'generic' technology policy that accelerates commercialisation by creating demand for the application of new technologies. Another way to foster public–private cooperation is through government-supported activity that pays off commercially in technical assistance. Examples of this are combinatorical analytics or pattern recognition driven by artificial intelligence, computer-aided design, computer-controlled machine and blended learning, and electronic data analytics.

The next major step in the EU's response to the fourth industrial revolution should be to develop a strategy similar to the White House's *Artificial Intelligence Strategy* (US Government 2016). Implementing such a strategy would create an industrial policy which is strongly oriented towards demand and does not assign to governments and their institutions the role of picking winners. Instead, governments create a playing field for market forces and indirectly support innovation through market procedures in a Schumpeterian sense. An EU technology strategy should shift away from merely financing R&D. Instead, it should encourage the transfer of technology to established corporations as well as to new enterprises and start-ups.

In this context collaboration with local universities would be a good way of developing feasible innovation based on the results of basic research. Patents are the result of pure science, but they are seldom used for practical purposes. Universities should develop incentives so that these patents are developed into commercially viable products and services. Within the EU, established and well-working academic and research networks could be further developed into regional, often cross-border, technology hubs and ecosystems for small and mid-sized manufacturers. Such hubs could develop new products and services and raise the overall technology-driven productivity of our economies and thereby our living standards.

Another way to strengthen public support for technologies that have path-breaking capacities lies in the endeavour to develop a common EU defence policy (European Commission 2016). Efficient spending on joint defence capabilities and on strengthening citizens' security is directly linked to a technology policy that helps to foster the common competitive and innovative base for manufacturing and industrial wealth creation which lies at the core of the single market. The role model for such a policy is the Defense Advanced Research Projects Agency (DARPA). Founded in 1957, this US agency is linked to the Ministry of Defense. Its purpose is to invent technologies that are transformational rather than incremental (Defense Advanced Research Projects Agency n.d.). It has a remarkable record in strategic investment in technologies that lead to corporate sector profits. What makes DARPA relevant is its capacity to include the use of technologies in both the military and the commercial sectors. The new EU defence policy could invite corporate industries, start-up ecosystems, research clusters and academic hubs to cooperate which would be of great benefit for the Union's technology policy.

Furthermore, an EU-wide technology policy must address not only technological factors but also issues related to budgeting, market and industry structure, and trade policy. Because the effects of technology-driven automation will likely be felt across the whole economy and the consequences are difficult to predict, policy responses must be targeted at the entire economy and not only at certain sectors. In addition, the economic effects of the fourth industrial revolution will not be separable from those of other factors such as globalisation, demographic change, migration, and decreases in market competition and in worker bargaining power. Even if it is not possible to determine the extent to which each of these factors has contributed to the current transformation, it is clear that the current challenges require a broad response. Therefore, a technological policy for the EU has to find a diverse approach that encompasses existing policies, including competition policy, the reduction of market entry barriers for young entrepreneurs and the promotion of digital and technological skills in school and higher professional education.

Moreover, while Europeans are optimistic about the future, this optimism is tempered by real concerns about the drawbacks of scientific and technological innovations (European Commission 2015). EU citizens are more wary of technological openness than are the citizens of non-EU countries. They are concerned about, inter alia, privacy and data storage, and the ethical dimension of self-deciding machines and human–machine interaction. These concerns represent inherent barriers to technological

change and to any attempt to successfully provide leadership in the context of the fourth industrial revolution. To fight for public support of technology policy and to help citizens understand the competitive advantages of the current changes, all stakeholders have to find ways to make their points of view clearly heard. Taking publicly debated critical technologies seriously should be tied to efforts to solve key business and social problems, for example, better health care and medical services. The role of social entrepreneurs that provide profits for shareholders as well as social benefits for stakeholders and societies should be taken into account when formulating a Europe-wide technology agenda.

Conclusion

The fourth industrial revolution will be different from the previous ones. Technology will play a much larger role in wealth creation and socio-political stability. The EU is advised to complement its current policy mix of open markets, competition, entrepreneurship and education. It should direct its R&D strategy through a coordinated technology policy that applies to all member states. The crucial thing is that technology policy should play an active role in an EU-wide promotion and concentration of the efforts to create an innovation ecosystem that includes academic, corporate and governmental partners. This would result in public spending becoming more relevant and lead to breakthrough innovations that prevail on the market. The ultimate aim is to improve living standards and job opportunities for EU citizens.

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