Executive summary

The next production revolution will occur because of a confluence of technologies. These range from a variety of digital technologies (e.g. 3D printing, the Internet of Things, advanced robotics) and new materials (e.g. bio- or nano-based) to new processes (e.g. data-driven production, artificial intelligence, synthetic biology). This report examines the economic and policy ramifications of a set of technologies likely to be important for production over the near term (to around 2030). As these technologies transform production, they will have far-reaching consequences for productivity, employment, skills, income distribution, trade, well-being and the environment.

Productivity and labour market changes

New production technologies will play important roles in determining the availability and nature of work. Part of a strategy for coping with rising shares of high- and low-wage jobs must involve the growth of technology-intensive production work. Technological development will inevitably disrupt today's industries, and incumbent firms will be challenged as new technologies redefine the terms of competitive success. The precise pace and scale of future adjustments are unknown. But resilience and prosperity will be more likely in countries with forward-looking policies, better functioning institutions, better educated and informed citizens, and critical technological capabilities in a number of sectors.

Command over new production technologies also promises greener production, safer jobs (with some hazardous work performed by robots), new and more customised goods and services, and faster productivity growth. Indeed, the technologies considered in this report, from information and communication technologies and robots to new materials, have more to contribute to productivity than they currently do. Often, their use is predominantly in larger firms. And even in those firms, many potential applications are underused.

Compared to earlier industrial revolutions, induced by steam and electrification, the creation and international spread of inventions that can transform production will occur quickly. But it could take considerable time for new technologies, once invented, to diffuse throughout the economy and for their productivity effects to be fully realised. The past has seen unrealistic enthusiasm regarding timelines for the delivery of important production technologies.

While new technologies will create jobs through a number of channels, and productivity-raising technologies will benefit the economy overall, the associated adjustments could be significant. Hardship could affect many if labour displacement were to occur in a major sector, or in many sectors simultaneously. Policy makers need to monitor and actively manage the adjustments, e.g. through forward-looking policies on skills, labour mobility and regional development.

Knowledge, technology and skills diffusion

Diffusion of the technologies must include not only the hardware, but also the complementary intangible investments and know-how needed to fully exploit technologies, ranging from skills to new forms of business organisation. Here, among other things, the efficient deployment and reallocation of human and financial resources is essential. Aligning framework policies that promote product market competition, reduce rigidities in labour markets, remove disincentives for firm exit and facilitate growth for successful firms is critical. New firms will introduce many of the new production technologies.

Effective institutions dedicated to technology diffusion can help. Especially among small and medium-sized enterprises (SMEs), a major challenge will be the digital transformation of firms which were not born digital. Institutions with specific remits to aid diffusion, such as technical extension services (which provide information and outreach, especially for SMEs), tend to receive low priority in innovation policy overall. But such institutions can be effective if properly designed, incentivised and resourced.

Rapid technological change will challenge the adequacy of skills and training systems. Some new production technologies raise the importance of interdisciplinary education and research. Greater interaction between industry and education and training institutions is often required, and this need may grow as the knowledge content of production rises. Effective systems for life-long learning and workplace training are essential, so that skills upgrading matches the pace of technological change and retraining can be accessed when needed. Digital skills, and skills which complement machines, are vital. Also important is to ensure strong generic skills – such as literacy, numeracy and problem solving – throughout the population, in part because generic skills are a basis for learning fast-changing specific skills.

Investments in data and science

Data will be central to 21st-century production. Policy should encourage investments in data that have positive spillovers within and across industries. Obstacles to the reuse and sharing of data, including public data, should be examined. And data governance frameworks are needed that address privacy and digital security considerations. The quality of digital infrastructure, including access to high-powered computing, will be critical for firms in many sectors.

Sound science and R&D policies are important. The technologies addressed in this report have arisen because of advances in scientific knowledge and instrumentation emanating from both the public and private sectors. The complexity of many emerging production technologies exceeds the research capacities of even the largest individual firms, necessitating a spectrum of public-private research partnerships. Many of the research challenges critical to the next production revolution are also multidisciplinary. Evaluation metrics for research programmes need to properly incentivise multidisciplinary research, research scale-up and linkages across stakeholders.

Trust and long-term thinking

Public understanding and acceptance of new production technologies also matter. A close connection exists between public resistance to new technologies and the disruption of trust in scientific and regulatory authorities. Policy makers and institutions should voice realistic expectations about technologies and duly acknowledge uncertainties. Science

advice should be seen to be unbiased and trustworthy. Public deliberation can also help to build understanding between scientific communities and the public.

Foresight processes, if applied appropriately, can support policy making during times of technological and socio-economic change. With participatory methods, stakeholders can be mobilised to develop shared views about the future, and negotiate and agree on joint actions. Foresight processes can bring benefits in themselves, such as strengthened stakeholder networks and improved co-ordination across policy domains.

Finally, long-term thinking is essential. In addition to addressing short-term challenges, leaders in business, education, unions and government must be ready to frame policies and prepare for developments beyond typical election cycles. Reflection is required on a variety of new risks and challenges that emerging technologies create, and how policy priorities might need to evolve, in fields as diverse as the intellectual property system, competition and trade policies, and the distributional implications of future production.