

INDUSTRIAL DEVELOPMENT REPORT 2020

BRIEF NO 1

From new technologies to industrial development... and back

Executive summary

Producing and absorbing new technologies can accelerate the achievement of inclusive and sustainable industrial development (ISID). New technologies help firms introduce new goods in the market and increase the efficiency of manufacturing production. These two mechanisms, in turn, lead to the generation of job and income opportunities both within and outside of manufacturing. New goods and greater production efficiency also contribute to increasing the economy's sustainability. At the same time, industrial development links back to the production and diffusion of new technologies. It is only by industrializing that countries, sectors and firms develop and maintain the necessary capabilities to engage in technological change.

Key findings

- » New technologies unlock product and process innovations, leading to expansion of industries, the creation of job and income opportunities, and the greening of the economy. Producing and absorbing new technologies is therefore key to achieving ISID.
- » New technologies create jobs both directly and indirectly, extending the multiplier effect of industrial development outside factory boundaries.
- » New technologies can help launch environmental goods in the market and, by increasing the efficiency of production, make manufacturing less material- and energy-intensive.



How are new technologies linked to industrial development?

A wave of new technologies is transforming the industrial landscape (Box 1). While the impact of advanced digital production (ADP) technologies remains unpredictable, history provides some clues about the impact of new technologies on industrial development. From a historical perspective, new technologies have contributed to industrialization through two key channels (Figure 1).

One channel is the creation and marketing of new products. The second channel are continuous improvements in production efficiency. Under the appropriate conditions, new technologies can also promote environmental sustainability and social inclusion—the two pillars of inclusive and sustainable industrial development (ISID), the core of UNIDO’s mandate.

The relationship between industrial development and new technologies is not unidirectional, however. A feedback loop links the process of industrialization back to new technologies: the invention, production and absorption of technology builds on scientific and industrial capabilities that countries typically develop—and maintain—through the very process of industrialization. Indeed, it is no accident that today’s technology leaders, such as the U.S., Japan, Germany or the Rep. of Korea are either yesterday’s early industrializers or economies that successfully caught up to the technology frontier.

New products lead to the emergence of new industries

There are two types of new technologies. Some aim at bringing new products to consumers. Others focus on making production more efficient. When inventors and firms successfully market new products, new industries can emerge. The most important industries today originate from product innovations that were successful and diffused widely through society. Consider, for instance, the automotive industry. It emerged from the invention of the car during the late 19th century, and its wide diffusion during the 20th century. The same dynamic applies to the electronics industry, with inventions ranging from personal computers to today’s smart devices.

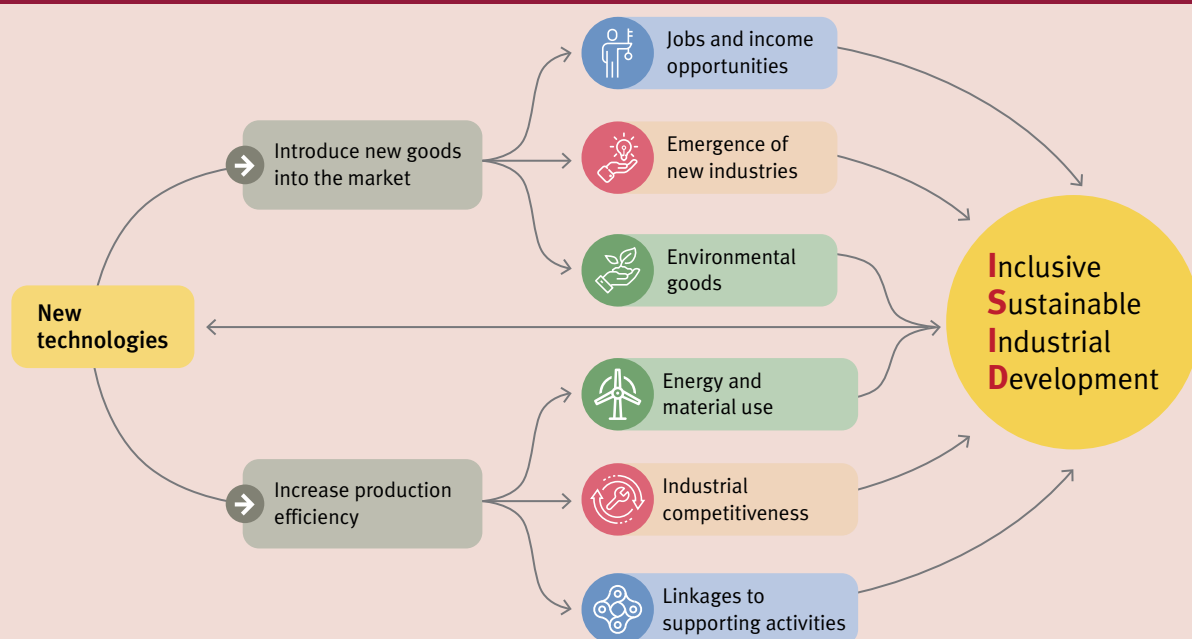
The socio-economic impact of new products cannot be overestimated. Product innovations boost economic growth by unleashing the creation of new industries. The wide diffusion of cars and personal computers, for instance, has turned the automotive and electronics industries into two of today’s industrial leaders. In the U.S. economy, transport equipment currently accounts for over 14 per cent of manufacturing value added (MVA), while computer and electronic equipment accounts for just under 13 per cent.¹ Figure 2 tracks the extraordinary rise of these two industries in the U.S economy, which, however, are also key economic industries in many other countries: as latecomer countries absorb the new technologies, production may shift and new actors may take the lead.

Box 1. What are ADP technologies?

ADP technologies combine hardware (advanced robots and 3D printers), software (big data analytics, cloud computing and artificial intelligence) and connectivity (the Internet of Things). Using state-of-the-art digital technologies in manufacturing production gives rise to smart production, also referred to as Industry 4.0—a key component of the Fourth Industrial Revolution.

Figure 1

New technologies contribute to ISID through the introduction of new goods and greater production efficiency. As countries develop industrial capabilities, their innovation potential increases as well

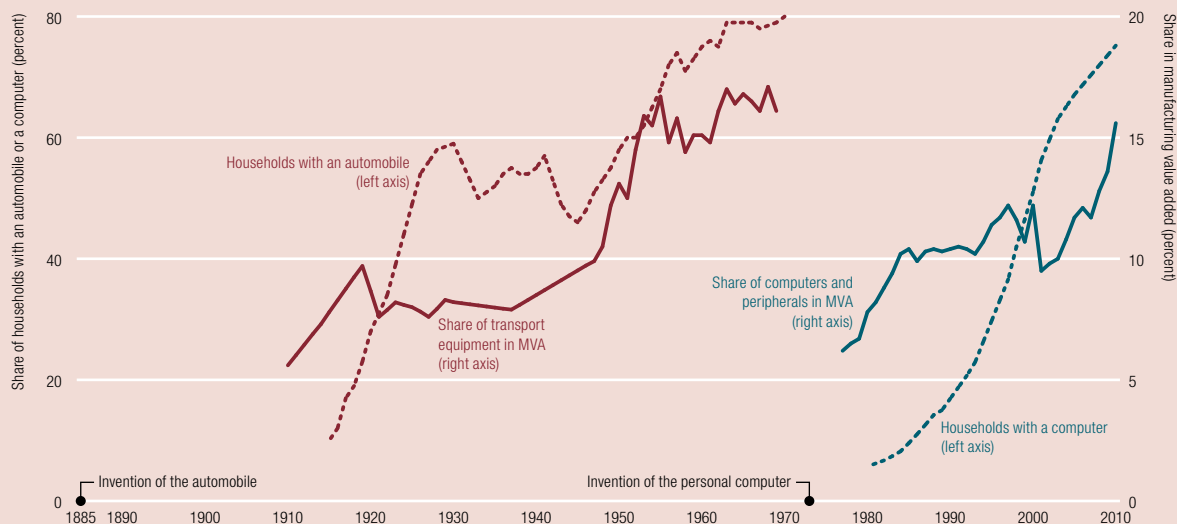


Source: UNIDO IDR 2020 Figure 1.1, page 32

¹ According to the Industry Economic Accounts Data of the U.S. Bureau of Economic Analysis (BEA).

Figure 2

The rise of the automotive and computer industries in the U.S. economy: production and consumption



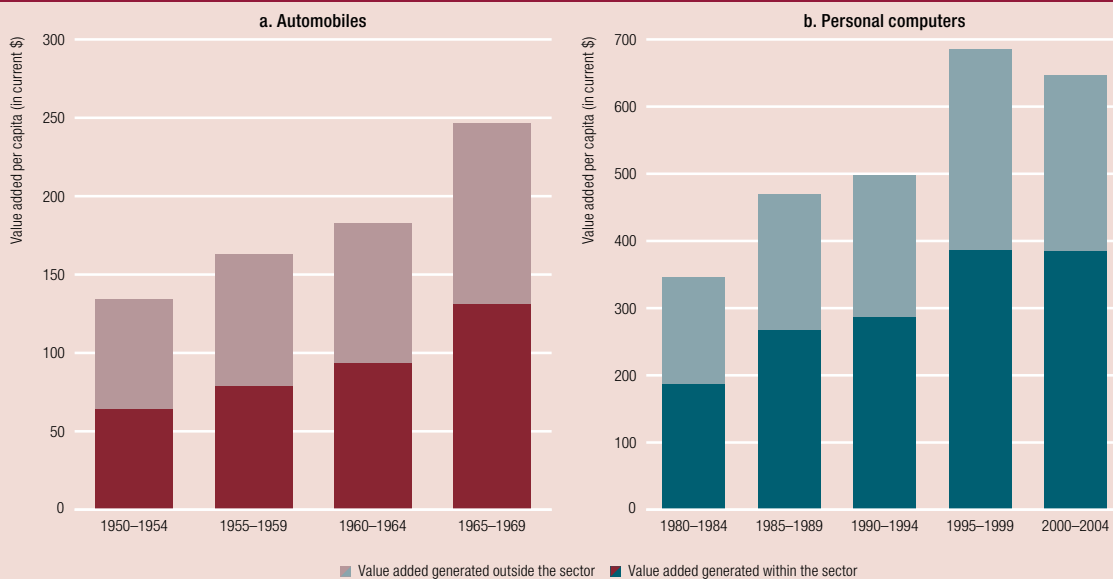
Note: MVA is manufacturing value added. The figure illustrates the impressive expansion in the consumption and production of these goods in the United States after the initial technological inventions. The dashed lines present the share of households consuming each of these goods (left axis), and the solid lines, the share of each industry in total MVA (right axis). Source: UNIDO IDR 2020 Figure 1.2, page 34

As new industries emerge, so do new job and income opportunities. Opportunities arise directly, for all those employed in the production of—to keep to our example—cars and computers. Yet income is also created indirectly, with new jobs, wages and profit in all of the activities that evolve to support the new industries (Figure 3). Think of all the ancillary activities that are necessary to supply our consumer products, ranging from the manufacturing of spare parts and the provision of logistics services, to marketing and retail. In addition, the incomes generated across the economy, either directly or indirectly, can be re-

spent or reinvested, further boosting economic growth.² This is the multiplier effect of manufacturing on other sectors. The benefits of new technologies are by no means only economic. Provided that they are designed with an eye to reducing environmental damage, they can also make industrial development more sustainable over time. New products such as electric vehicles, energy-efficient refrigerators or LED lamps are all considered environmental goods, that is, goods that contribute to the long-term sustainability of consumption and production patterns.

Figure 3

The potential of new industries to pull up the rest of the economy can double income and job creation



Note: The figure presents the income per capita generated by the production of these industries in the U.S. economy, taking productive linkages into account. Input-output techniques estimate the total value added generated by the final consumption of cars (panel a) and personal computers (panel b). Each bar presents the average income generated over a span of five years and distinguishes the share that corresponds to the same industry and that created in other industries of the economy. Source: UNIDO IDR 2020 Figure 1.3, page 35

² This is what the UNIDO IDR 2018 termed the “virtuous circle” of industrial development.

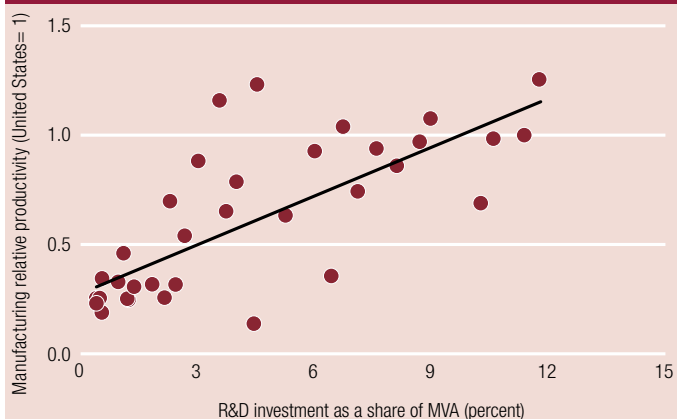
Greater production efficiency brings economic, social and environmental benefits

New technologies can also improve the efficiency of manufacturing production. Country level evidence suggests that there is a clear and positive association between investment in innovation activities and production efficiency in manufacturing (Figure 4).³

Achieving greater production efficiency is crucial, as it is key to fostering and sustaining industrial competitiveness over time (Figure 5, panel a). Moreover, it contributes to making goods more affordable for consumers, as was the case with automobiles and personal computers. What is just as important, by making it possible to produce more output with fewer resources, process innovations can also reduce pollutant emissions and the consumption of materials and energy. Indeed, economies that are closer to the world technology and productivity frontier emit fewer amounts of carbon dioxide (CO₂) per unit of value-added produced in manufacturing (Figure 5, panel c). This suggests that new technologies increase the efficiency of material and energy use, leading to more environmentally sustainable production patterns.

Economies that are closer to the frontier are not only more sustainable, they also display stronger linkages between manufacturing and other sectors, such as knowledge-intensive business services (KIBS) (Figure 5, panel b). Manufacturing industries in countries whose production

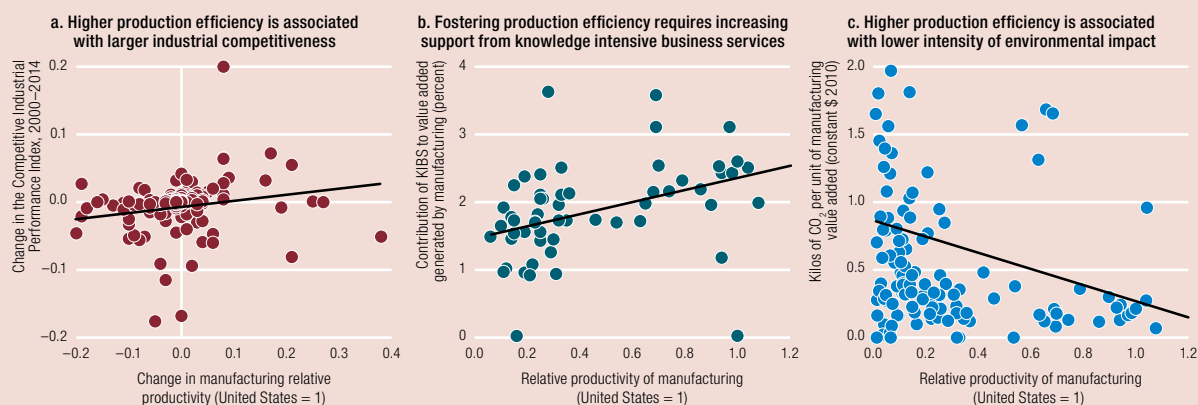
Figure 4
Countries that invest more in R&D activities tend to be closer to the world productivity frontier



Note: MVA is manufacturing value added. R&D is research and development. All values are for 2015 (or closest year). The 34 economies presented in the figure were selected due to the availability of data on R&D expenditure in manufacturing. Source: UNIDO IDR 2020 Figure 1.5, page 36

is more efficient are more closely integrated with services, suggesting that new technologies foster the creation of jobs outside of manufacturing—a leading aspect of ISID. What is more, jobs in KIBS, which include activities such as legal advisory, business consultancy and advertising, are often high paying.

Figure 5
From production efficiency to Inclusive and Sustainable Industrial Development



Note: KIBS is knowledge-intensive business services. MVA is manufacturing value added. All values are for 2015 in panels a and c and for 2000–2015 in panel b. Panel a includes data for 145 economies, panel b for 57, and panel c for 129. The 57 economies in panel b were selected based on the availability of OECD international input–output tables. Source: UNIDO IDR 2020 Figure 1.6, page 36

Conclusions

- » The relationship between ISID and new technologies is bidirectional. New technologies boost industrial development which, in turn, nurtures the industrial capabilities needed to continue innovating.
- » The creation of new products can engender the establishment of entirely new industries, generating significant income opportunities for workers and entrepreneurs alike.
- » New technologies enable gains in production efficiency, which, in turn, have significant economic, social and environmental benefits.

Bibliography and/or suggestions for further reading

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³ Production efficiency is measured here as the relative labour productivity of each country in comparison to that of the U.S., which is taken as the global frontier.