Some Brief Reflections on Digital Technologies and Economic Development

Jeffrey D. Sachs

The digital revolution, including the rapid deployment of artificial intelligence (AI), is disrupting economic life, and will fundamentally alter the development pathways for today's low-income developing countries. Consider East Asia's successful development model. From the 1960s onward, rural and agrarian East Asian countries, including China and South Korea, began to industrialize rapidly via labor-intensive export sectors, such as apparel and electronics assembly operations. Workers gained skills and incomes, enabling the society to accumulate capital, including human capital, through more years of education. Export earnings from labor-intensive manufacturing financed the importation of physical capital, including infrastructure and machinery. As skills and infrastructure improved, manufacturing shifted from labor-intensive to skill-intensive sectors, and overall employment also shifted increasingly from manufacturing to services. The long-term shift from agriculture to industry to services was accompanied by the long-term shift of population from rural to urban areas.

This mode of development was christened the "flying geese" model by Japanese economists, so named because the industrial trajectory of Japan (the leading goose) was followed by the next generation of follower economies (notably Hong Kong, Singapore, South Korea, and Taiwan), and then later by a third generation (including Indonesia and Malaysia). Each new generation started up the development ladder with labor-intensive manufactures and then moved to skill-intensive manufactures and services. Around the world, low-income countries have tried to emulate this East Asian success story.

Digital Revolution: Challenges and Opportunities

The digital revolution will require a new development pathway that is not dependent on the exports of labor-intensive manufacturers. The jobs of the past that provided the path to industrialization, notably in apparel and assembly line operations, are rapidly being replaced by robots and AI systems. Already, low-income countries are no longer able to take advantage of their lower wages through the export of labor-intensive manufactured goods. Without these export earnings, these countries lack the foreign exchange to import infrastructure capital as well as to generate the domestic savings needed to invest in human capital. The flying geese pathway to development is blocked.

The challenge can be described in a more basic way. The basic economics of automation involves technologically advanced machines replacing workers in the production process. The result is a rise of output accompanied by a fall in the demand for labor. Output rises, labor productivity rises, but wages fall and income is redistributed from labor to capital. Is the society better off? Yes and no. Gross domestic product rises, but workers are left poorer. Thus, the way to ensure that everybody benefits from the technological advances brought by automation is to accompany the shift with a transfer of income from capital (the automation "winner") to workers (the automation "loser").

Economists often scoff at the job losses from automation, claiming that throughout economic history the loss of old jobs has always been matched by the creation of new ones. There is nothing to fear from automation, they claim. Yet economic history is more complex than that. Workers may indeed find new jobs, but often at lower pay. Or they may require new skills to obtain the new higher-paying jobs. In that case, those workers who can obtain the needed extra education and skill are beneficiaries, but those who cannot are left behind.

These same dynamics play out in the international economy in the interaction between developed and developing countries. During the period of East Asia's flying-geese development, the high-income countries exported capital goods to the East Asian economies, which in turn exported labor-intensive manufactured goods to the high-income countries. As noted earlier, the labor-intensive exports financed the accumulation of capital: low-wage families gained the ability to invest in human capital, and governments gained the ability to invest in infrastructure capital. To pay for the imported infrastructure capital, governments collected taxes on the growing export sectors, providing the revenues needed to fund public investments.

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Now consider the effects of automation in this scenario. Developing countries now face competition from robots in the production of their export products. One possible outcome is that they will continue to export, but with lower export prices and wages. In effect, they will suffer a terms-of-trade shock, so that their export products are no longer as valuable in world markets. More drastically, they may lose their export markets entirely. Developed countries may end up producing at home through automation the goods that they used to import from developing countries. The result could be a boost of income for developed countries and deeper impoverishment for developing countries. To put matters most simply, automation reduces the demand for low-skilled labor, the one productive factor in abundance in poor countries.

The overall effects of AI and digital technologies more generally on the development process will be more complex than this, and on the whole more beneficial. One effect will indeed be the reduced demand for unskilled labor, producing the adverse effects just noted. But the other very broad effect will be a marked increase of productivity in key sectors, which will boost overall living standards and raise the rate of economic growth in the medium term.

Across the key sectors of the economy, the broad effects of digital technologies will likely be the following:

- *Agriculture:* a rapid increase in mechanization, a rise in output from precision agriculture, and a decline in demand for low-skilled agriculture labor
- *Mining:* a rapid increase in mechanization, a rise in output, and a drastic decline in demand for low-skilled mining labor
- *Manufacturing:* a rapid increase in mechanization and AI systems, a rise in output, a decline in demand for low-skilled manufacturing labor, and a rise in demand for high-skilled manufacturing labor
- *Business services, including transportation, warehousing, and finance:* a sharp decline in demand for low-skilled labor, such as drivers and warehouse staff, and a rise in capital-intensive output and productivity based on robotics and autonomous vehicles
- *Trade:* a shift toward e-commerce and away from wholesale and retail trade, reducing the demand for workers in the retail sector
- *Healthcare:* a major expansion of access to low-cost, high-quality healthcare, including telemedicine, remote monitoring of patients, remote diagnostics,

and expert automated health systems replacing scarce doctors (for example, through machines' enhanced ability to read X-rays and other imaging)

- *Education:* a major expansion of access to low-cost, high-quality online education, including online curricula, online monitoring of student progress, online teaching training, "connected classrooms" via videoconferencing, and distance tutoring
- *Finance:* low-cost e-payments systems (such as M-Pesa in East Africa) and e-banking services for money transfers, borrowing, and lending
- *Tourism:* improvement of logistics, matching tourists with lodging, and advertising
- *Transportation:* online ride hailing, car-sharing services, and automated public transport (such as automated bus routes)
- *Governance:* major advances in e-governance, including unique biometric identification, online tax and transfer payments, e-policing and remote monitoring of public areas, e-voting, online licensing, and other public services

In short, digital technologies will enable a massive increase in productivity for a wide range of goods and services. Overall production will become more capital intensive, including three kinds of capital: human, infrastructure, and business. The demand for skilled workers will rise while the demand for unskilled workers will decline. Households with high skills and financial capital will be the big beneficiaries; households with low skills and little if any financial capital may experience a rise or fall in overall living standards depending on the balance of positive and adverse effects.

Another major effect will be the rapid shift of employment from rural to urban areas. Agriculture is likely to be substantially modernized in the coming twenty years due to the mechanization of planting, nutrient provision, and harvesting, as well as the vast benefits of precision agriculture using satellite measurements, weather forecasting, and automated infrastructure such as fertigation (irrigation plus fertilization) and other AI-guided automated machinery. Similarly, most production jobs in mining other than support services will be automated, so that mining will become a highly capital-intensive sector. As the demand for agricultural workers and miners diminishes, households (especially young people) will move from the countryside to the cities in search of work.

The rate of urbanization is likely to soar. The UN Department of Economic and Social Affairs/Population Division projects that the rate of urbanization will rise

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from 56.2 percent of the world population in 2020 to 68.4 percent in 2050.[1] This would represent an increase of 2.3 billion people—from 4.4 billion to 6.7 billion—joining the urban regions, according to the UN's medium-fertility scenario. The increase could be even greater, as the UN forecast may well be underestimating the implications of the rapid mechanization of agriculture. The reverse side of rapid urbanization is the absolute decline in the world's rural population, which the UN projects will fall by an estimated 324 million in the medium-fertility forecast.

Basic Features of Digital-Based Development Pathways

In order to reap the benefits of the digital revolution and manage rapid urbanization, the key challenge for developing countries will be to finance a rise in capital investments while simultaneously incurring a loss in labor-intensive manufacturing export earnings. The solutions will have to come along the following lines:

- Developing countries will need to create new export sectors to compensate for the reduction of labor-intensive manufacturing earnings. New viable export sectors may include capital-intensive agriculture and mining, renewable energy, tourism, information services, healthcare, education, and the arts.
- These new export sectors will generally require inflows of foreign capital and digital technology, especially in the form of foreign direct investment that combines technology, management, integration in global production systems, and finance.
- Much of the digital infrastructure itself will need to be financed through international private capital (for example, by investments in telecommunications, 5G, and other digital hardware and software) seeking to expand markets in low-income countries.
- Much of the urban infrastructure investments will need to be financed through international borrowing, with repayments based on the rise in urban land values (captured, for example, through property taxation).
- Low-income countries will need a considerable rise in official and private development assistance to ensure access to high-quality secondary, vocational, and higher education. In particular, international universities should be encouraged to open local branch campuses within low-income countries, or at least to provide joint programs and local support services (for example, through online instruction).

- Key digital software technologies for e-health, e-education, and e-governance should be made available to the low-income developing countries at zero or marginal cost rather than at patent-protected royalty and subscription prices. These would include scientific journals, satellite and other global geographic information system data, AI health systems, and other digital software and data.
- All efforts should be made to economize on capital needs; for example, by emphasizing public transport and car sharing rather than individual ownership of automobiles. In general, densely settled urban areas will allow for economies of scale for many kinds of infrastructure, including transport, electrification, broadband coverage, public service provision, and retail deliveries.

The overriding challenge for low-income developing countries, in short, will be to mobilize and economize on capital in a world economy that is becoming increasingly capital intensive. Fortunately, the world is awash in capital and savings. The question is how to attract it to low-income countries other than through the low-wage route used in the flying-geese development strategy.

Part of the answer will be to capitalize on geographic advantages through tourism, export of renewable energy (as opposed to fossil fuel energy), high-value agriculture, and high-value mining. Countries situated along international trade routes, such as the countries of Central Asia and the Caucasus, lying on the overland routes between Europe and East Asia, can benefit from transport and communications lines running through their region.

Part of the answer will be to offer "markets of the future," especially to sectors that benefit from economies of scale, such as telecoms, tech companies, healthcare companies (in search of big data), and higher education (looking for overseas campuses to provide global services for their students).

Part of the answer will be to borrow against the future by investing in urban infrastructure that will be financed through future tariffs and tolls (for example, on power, water, and transport) and through property taxation.

Part of the answer will be to export middle-tech services, such as coding and big data management. While exports of labor-intensive, low-skill exports will diminish, there will be new opportunities to export middle- and high-tech goods and services online, such as coding teams operating offshore or in time zones antipodal to the major markets.

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And inevitably, part of the answer will be to rely on sophisticated forms of development assistance from both public and private sources, including direct funding (most urgently for education) and the free or highly concessional provision of digital technologies. The poorest countries are simply unable to finance universal high-quality secondary education out of their own domestic revenues, as recently demonstrated by studies undertaken by the International Monetary Fund and the UN's Sustainable Development Solutions Network.[2]

The single most expensive investment category will be the physical infrastructure needed for sustainable cities of the future. The seven billion or so urban residents of 2050 will need affordable housing, safe water and sanitation, clean energy, sustainable transportation, and public services—including health and education. These heavy infrastructure costs will depend on the peak urban population, which in turn will depend on the pace of the demographic transition toward lower fertility rates. Countries with stable or slowly growing populations will be much better placed to afford the heavy future investments in urban infrastructure. The key to low fertility rates is, of course, the universal coverage of education at least through the secondary level for all children, especially girls.

We also should recognize that greater longevity and lower fertility will lead to population aging, which in turn will create its own specialized infrastructure needs, especially for safe and healthy housing for the aged. The median age of the world population was 23.6 years in 1950, 29.6 years as of 2015, and is projected to reach 36.1 years in 2050 (in the medium-fertility forecast of the UN).[3] Similarly, in 1950, only 5.1 percent of the global population was 65 years and older. By 2015, the proportion had reached 8.3 percent, and is forecast to be 15.8 percent as of 2050 and 22.5 percent as of 2100.[4] This greater longevity will also dramatically alter life cycle choices, including longer working years, longer retirement years, changing professional roles (with greater service sector jobs aimed at care for the elderly), and new kinds of living arrangements (especially devoted to senior citizen residences).

Next Steps on Digital-Based Development Strategies

Several developing countries are making major efforts at digital-based development strategies. China, of course, is already a world leader in AI, robotics, and the use of big data for e-commerce, e-governance, and industrial applications. India, too, is pioneering the use of digital platforms for key sectors of the

economy. Digital connectivity has soared: e-payments are being rapidly adopted, and India's online biometric ID system Aadhaar is the basis for countless applications in both public services and private business. Estonia is championing e-governance in a remarkable range of activities, including e-voting; e-services (such as licensing, registration, and birth and death records); e-health (electronic medical records and big data applications for healthcare delivery); e-finance; and e-payments. There are many more examples, with the uptake of digital hardware and software continuing at a rapid rate.

While automation could in principle lead to deepening poverty in the poorest countries if they lose out on the chance for labor-intensive stepping stone exports, the impression at this stage is that the benefits of digital technologies for the poorest countries are likely to far outweigh the costs. Most importantly, these technologies have the capacity to upgrade critical business and personal services, as well as governance, sufficiently enough to outweigh the negative effects on low-skilled work. Still, to benefit from the digital revolution, low-income countries will need a coherent capital investment strategy.

The greatest challenge will be to finance and implement this broad-based and interconnected investment agenda. Development institutions such as the IMF, multilateral development banks, UN development agencies, and key private-sector leaders should undertake concerted efforts to transfer digital skills and technologies as rapidly as possible to the low-income nations to enable them to build the digital-based industries, skills, and jobs of the future.

NOTES

[1] "World Urbanization Prospects 2018: Data Query," United Nations Department of Economic and Social Affairs/Population Division, population.un.org/wup/DataQuery/.

[2] Vitor Gaspar, David Amaglobeli, Mercedes Garcia-Escribano, Delphine Prady, and Mauricio Soto, *Fiscal Policy and Development: Human, Social, and Physical Investments for the SDGs*, SDN 19/03, International Monetary Fund, January 23, 2019, www.imf.org/en/Publications/Staff-Discussion-Notes/Issues/2019/01/18/Fiscal-Policy-and-Development-Human-Social-and-Physical-Investments-for-the-SDGs-46444; Jeffrey Sachs, Vanessa Fajans-Turner, Taylor Smith, Cara Kennedy-Cuomo, Teresa Parejo, and Siamak Sam Loni, *Closing the SDG Budget Gap*, Sustainable Development Solutions Network, December 2018, unsdsn.org/wp-content/uploads/2019/02/MOVE-HUMANITY-REPORT-WEB-V6-201218-1.pdf.

[3] "World Population Prospects 2017: Data Query," United Nations Department of Economic and Social Affairs/Population Division, population.un.org/wpp/DataQuery/.

[4] Ibid.

Abstract: Among the many disruptions caused by artificial intelligence (AI) and other digital technologies (including automation, cyberwarfare, surveillance, loss of privacy, fake news, infrastructure vulnerability), the effects on development pathways are likely to be significant and complex. AI will enable low-income countries to leapfrog in several sectors, including e-governance, e-finance, e-

health, and e-education. Yet AI will also lead to automation, reducing the demand for labor, especially unskilled labor. Labor-intensive sectors such as apparel will provide fewer jobs, and lower export earnings. Development strategies will need to adjust accordingly.