

H HEURISTICS

Navigating a Changing World

From the West to the World

Western Innovations That Have Already Diffused

Across the Globe, and What the Record Teaches

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Abstract

Policy debate about technology and development is usually conducted in the future tense: what emerging economies might adopt, what they could leapfrog, what must be transferred. This report looks instead at what has already happened. It asks which innovations that first took scalable form in the Western world have diffused to the rest of it, how completely, and what the record shows about how diffusion works. By the mid-2020s about 92 per cent of people had electricity, 74 per cent were online, 79 per cent of adults held an account, 88 per cent of adults could read, and 85 per cent of infants received three doses of the DTP vaccine; the sovereign nation-state, which numbered 51 in the United Nations in 1945, numbered 193.

Applying four tests, reach, spread, local anchoring and persistence, to eight domains (health, energy and industry, food, transport and trade, information and communication, the state, law and education, finance and standards, and language, sport and culture), the report finds three clusters. Three of eleven indicators are near-complete at 85 per cent or more, six are substantial at 70 to 85 per cent, and two remain partial: safely managed sanitation at 58 per cent and democratic government in 49 per cent of countries. Diffusion follows the structure of an innovation more than its age. Household- and individual-scale technologies such as phones and vaccines spread fastest; network goods that need public capital, such as sewers and grids, spread slowest; and institutional forms spread more completely than the practices that give them substance.

The record also shows that arrival has become faster than depth. Radio took about six years to move from 10 to 50 per cent of US households and the internet nine, against 43 for the landline; yet gaps in intensity of use persist, with a typical high-income mobile user generating nearly eight times the data of a low-income one. The remaining gaps are concentrated: sub-Saharan Africa has electricity access of 55 per cent against 92 per cent worldwide. Finally, diffusion has erased the originator's monopoly. Residents of China now file roughly half of the world's patent applications, mobile money and real-time payments originate in Kenya and India, and, by the IEA's 2022 count, China held more than 80 per cent of every stage of solar-panel manufacturing, a technology first demonstrated at Bell Laboratories. Early evidence on generative AI suggests the same pattern at higher speed: a leader-to-laggard gap of about 1.8 to one, against 53 to one for the internet in 2005, but with the hard capabilities still concentrated.

Keywords: technology diffusion; innovation; adoption lags; development; globalisation; institutions; health; digital infrastructure; artificial intelligence

JEL classification: O33, O30, O19, O57, F63; technological change and diffusion; innovation; international linkages to development; comparative studies of countries; economic development

Data and method: This report synthesises institutional and peer-reviewed research, drawing mainly on World Bank, UN, ITU, WHO, UNICEF, FAO, WIPO, IEA and Our World in Data publications and datasets available to October 2026. All charts are built from public series downloaded for this report; the source of each is stated beneath it. Some 2025 and 2026 figures are preliminary or modelled and may be revised. Attribution of origin is conventional and sometimes contested. Figure 2 is a stylised illustration, not data, and the figures on generative AI come from a single company's estimates.

Contents

1. Introduction: An Invention Is Not a Neighbourhood	5
1.1 What “Western” and “diffused” mean here	5
1.2 The headline result	6
1.3 Evidence, limits and cautions	7
1.4 Structure of the report	7
2. How Innovations Diffuse: Lags, Curves and Channels	8
2.1 The S-curve and the lag	8
2.2 Faster curves for newer technologies	9
2.3 Four channels of transmission	9
3. Health and Medicine: The Fastest Gains in Human History	11
3.1 From Jenner to eradication	11
3.2 What the data show	11
3.3 Where the story is incomplete and what it did not owe to the West	13
4. Energy and Industry: Electricity, Engines and the Factory	14
4.1 The machinery of the first and second industrial revolutions	14
4.2 Electricity: near-universal, with one stubborn exception	14
5. Food and Agriculture: Fertiliser, Seeds and the Yield Revolution	16
5.1 Nitrogen and the Green Revolution	16
5.2 What the data show	16
6. Transport and Trade: Rails, Wings and the Standard Box	18
6.1 Railways, motor roads and aircraft	18
6.2 The container and the age of standard boxes	18
7. Information and Communication: From Print to the Smartphone	20
7.1 A sequence of networks	20
7.2 What the data show	20
8. The State, the Law and the School: Institutions That Travelled	22
8.1 The nation-state and the written constitution	22
8.2 Democracy: form spread faster than substance	22
8.3 The school and the university	23
9. Finance, Commerce and Standards: The Plumbing of the Global Economy	25
9.1 Corporate, financial and accounting institutions	25
9.2 The systems that run commerce	25
9.3 Financial inclusion: arrival and depth again	25
10. Language, Sport and Everyday Culture	27
10.1 English and the Latin alphabet	27
10.2 Sport as institutional export	27
11. Beyond the West: Debts, Counter-Flows and a Shifting Centre of Invention	28
11.1 The debts	28
11.2 Reverse flows today	28
11.3 The geography of invention	29
11.4 What the reversal teaches	30
12. Where Diffusion Is Incomplete	31

12.1 The unfinished inventory	31
12.2 Why some innovations stall	31
12.3 Closing the gaps: bypass and its limits	32
13. Lessons and the Next Test: What Diffusion Teaches About What Comes Next	33
13.1 Five lessons from what has already spread	33
13.2 What follows for decision-makers.....	33
13.3 The next test: artificial intelligence	33
13.4 Summary scorecard	35
13.5 Conclusion.....	35
References and Further Reading	36
Appendix A. Data Notes and Reproducibility	38

1. Introduction: An Invention Is Not a Neighbourhood

By the mid-2020s about 92 per cent of humanity had electricity, three-quarters were online, four in five adults held an account of some kind, and nearly nine in ten people over fifteen could read. Very little of that infrastructure was invented in the places where most of those people live. This report asks which innovations that first took commercial or institutional shape in the Western world have already spread to the rest of it, how completely, and what the record says about how diffusion works.

The question matters because the standard story of technology and development is told in the future tense. Policy documents speak of what emerging economies might adopt, what they could leapfrog, and what must be transferred. That framing hides a large fact: a great deal has already been transferred. The decisive question for most of the technologies that shaped the twentieth century is no longer whether they will reach the world, but how deeply they have, what remains unfinished, and what sort of innovation travelled easily and what sort did not. Answering it from evidence, rather than from slogans about the “Western model” in either direction, is the purpose of this report.

The record is larger than most summaries suggest. The World Health Organization (WHO) [declared smallpox eradicated in 1980](#), ending a disease that a Gloucestershire doctor, Edward Jenner, had learned to prevent in 1796. The International Telecommunication Union (ITU) [estimates that about six billion people were online in 2025](#). Nature Geoscience’s widely cited reassessment of the Haber–Bosch process, patented in Germany before the First World War, [concluded that synthetic fertiliser supports almost half the world’s population](#). A shipping container first sailed from Newark in 1956; world container ports now handle [more than 900 million twenty-foot-equivalent units a year](#). None of these needs a Western presence to keep operating.

1.1 What “Western” and “diffused” mean here

Both words need disciplined definitions. By **Western** this report means Europe and the societies that European settlement created, chiefly North America and Australasia. An innovation is attributed to the West when it first took the form in which it later scaled there: the steam engine as a commercial machine, not the earlier history of pumps; the university as a chartered corporation; the joint-stock company as a tradable security. This is a convention about where an idea became an organised, scalable thing, not a claim that Western peoples produced it from nothing. Section 11 returns to the large debt that “Western” innovations owe to elsewhere, and to the growing flow in the opposite direction.

An innovation counts as **diffused** only if it passes four tests, summarised in Table 1. Reach asks how much of the world’s population, or how many of its countries, now use it. Spread asks whether use extends across income groups and regions or stays concentrated in rich countries. Local anchoring asks whether the innovation is now produced, regulated, repaired or taught locally, so that it no longer depends on its originators. Persistence asks whether it survives without the political and commercial structures that first carried it. Few innovations pass all four completely. The report reports the degree to which each does, and where data exist it reports both arrival and depth.

Table 1. Four tests for “already diffused”

Test	Question asked	Typical evidence used here
Reach	How large a share of humanity, or of countries, uses it?	Population coverage rates from the World Bank, ITU, WHO, UNICEF and UN agencies
Spread	Does use extend beyond rich countries and cities?	Breakdowns by income group and region; urban–rural gaps
Local anchoring	Is it produced, regulated, serviced or taught locally?	Manufacturing, patent and standards data; local institutions
Persistence	Does it endure without its originators’ backing?	Continuity through decolonisation, aid cycles and political change

Thresholds are indicative. The report uses roughly 70 per cent of the relevant world population as the boundary of “substantial” reach and 85 per cent as “near-complete”.

1.2 The headline result

Figure 1 sets eleven measures side by side. They fall into three clusters. Three innovations are close to complete: electricity, basic drinking-water service and adult literacy all reach roughly 88 to 92 per cent of the relevant population. Six are substantial, between 70 and 85 per cent: routine childhood vaccination, bank or mobile-money accounts, secondary schooling, clean cooking, safely managed drinking water and the internet. Two remain partial: safely managed sanitation, at 58 per cent, and democratic government, which under the classification used by the [Our World in Data regimes series](#) describes about 49 per cent of countries. One further form has become universal: the sovereign nation-state, whose membership roll at the United Nations has [grown from 51 states in 1945 to 193](#).

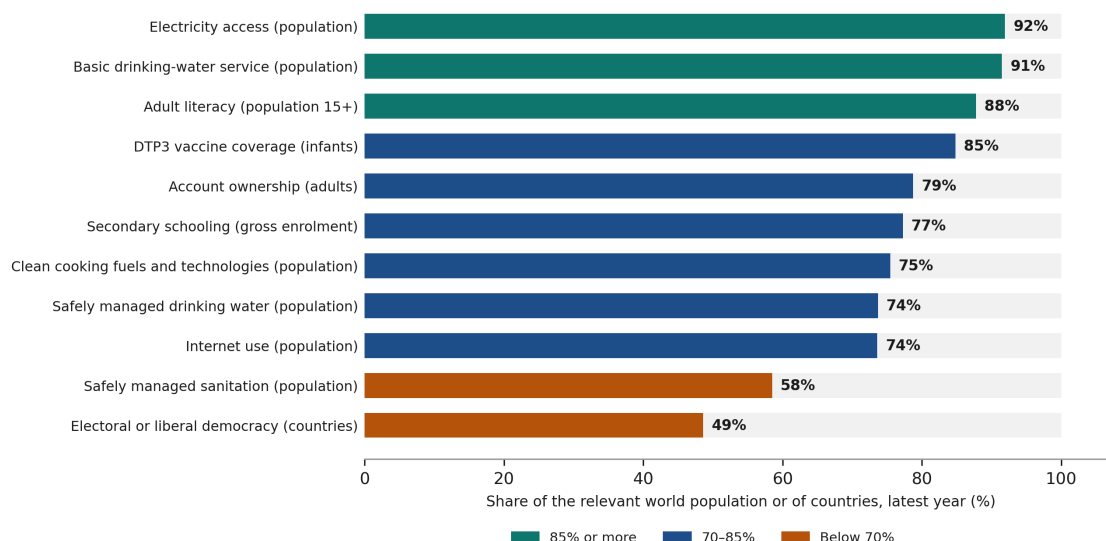


Figure 1. How far selected Western-origin innovations have reached, latest year.

Source: World Bank World Development Indicators (electricity, water, sanitation, literacy, DTP3, accounts, schooling, cooking, internet); Our World in Data, Regimes of the World classification (V-Dem) for democracy. Latest years are 2024 for most series and 2025 for internet use. Schooling is a gross enrolment ratio capped at 100 per cent. H Heuristics analysis.

Two features of this picture are worth stating at once. First, the least complete innovations are not the newest ones. Sanitation systems date from the nineteenth century and are the laggard; the internet, a product of the 1990s, has reached three-quarters of humanity. The pattern is that diffusion follows the structure of an innovation more than its age. Items that individuals or households can adopt on their own, such as a phone or a vaccine dose, spread faster than items that require dense public capital, such as sewers and grids. Second, headline reach conceals depth. The ITU's figures show that a typical user in a high-income country generates nearly eight times as much mobile data as one in a low-income country, and that online use is 85 per cent in urban areas against 58 per cent in rural ones. Arrival and use are different things.

1.3 Evidence, limits and cautions

This is a synthesis report. It draws on institutional and peer-reviewed sources, principally the World Bank, UN agencies, the ITU, WHO, UNICEF, the Food and Agriculture Organization (FAO), the World Intellectual Property Organization (WIPO) and Our World in Data, with data available to October 2026. Charts are built from public series downloaded for this report, and each figure states its source. Some 2025 and 2026 figures are preliminary or modelled. The report makes three cautions explicit. First, attribution of origin is contested and often arbitrary, because most innovations are recombinations. Second, the report is about diffusion, not desirability: some Western exports, from industrial pollution to cigarettes, diffused as thoroughly as vaccines. Third, a focus on what spread inevitably under-weights what did not; the many Western ideas that failed to travel appear here only as the foil to those that did.

1.4 Structure of the report

Section 2 sets out how diffusion works, using the empirical literature on adoption lags. Sections 3 to 10 take eight domains in turn: health, energy and industry, food, transport and trade, information and communication, the state, law and education, finance and standards, and language, sport and culture. Section 11 reverses the lens and examines non-Western origins and the changing geography of invention. Section 12 asks where diffusion remains incomplete. Section 13 draws lessons and applies them to the current wave, artificial intelligence.

2. How Innovations Diffuse: Lags, Curves and Channels

Diffusion has regularities. Adoption follows an S-shaped curve; the delay between invention and adoption in poorer countries is shrinking; and speed depends on whether an innovation can ride existing networks. The evidence suggests that arrival has become faster but depth has not necessarily followed.

2.1 The S-curve and the lag

The sociologist Everett Rogers gave the field its enduring vocabulary in [Diffusion of Innovations](#), first published in 1962. Adoption starts slowly among a few early adopters, accelerates as networks of imitation form, and levels off as the population saturates. The S-shaped logistic curve fits an enormous range of technologies, from hybrid corn in Iowa to mobile phones in Lagos.

Economists added a cross-country dimension. Diego Comin and Bart Hobijn's [An Exploration of Technology Diffusion](#) estimated adoption for 15 technologies in 166 countries across two centuries. They found that, on average, countries adopted a technology about 45 years after its invention, with wide variation across technologies and countries, and that newer technologies were adopted faster than old ones. Earlier work by [Comin and Hobijn](#) found that the pace of adoption depends on human capital, openness to trade, the form of government and prior adoption of predecessor technologies, and that rising similarity in these variables after the Second World War helped raise the overall rate of diffusion.

A refinement matters for the rest of this report. Comin and Mestieri's article [If Technology Has Arrived Everywhere, Why Has Income Diverged?](#) argues that adoption lags between rich and poor countries have converged, while the intensity with which adopted technologies are used has diverged. Arrival is not the same as use. This is the logic of the stylised comparison in Figure 2: an old technology shows a long lag but eventually a similar ceiling, while a newer one shows a short lag but a lower ceiling in late-adopting economies.

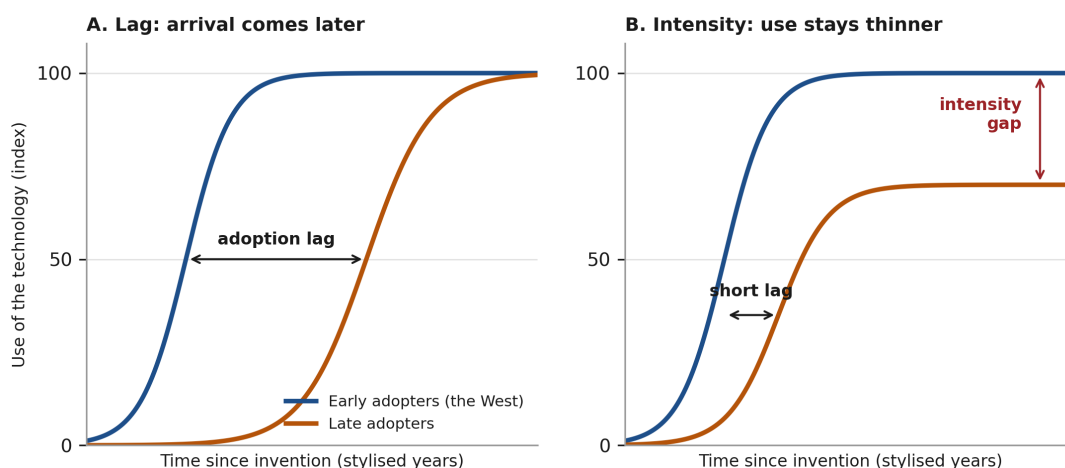


Figure 2. Lag and intensity: two ways a technology can be “diffused” yet unevenly used.

Source: H Heuristics stylised illustration based on the logic of Comin and Mestieri (2018). The curves are schematic and are not drawn from data.

2.2 Faster curves for newer technologies

US household data, assembled by Comin and Hobijn and republished by [Our World in Data](#), show the acceleration at the leading edge. Aligning each technology at the year it reached 10 per cent of households, Figure 3 shows that radio took about six years to reach 50 per cent, mobile phones eight, the internet nine, the automobile eleven, electric power seventeen and the landline telephone forty-three. Each additional unit of adoption became cheaper to achieve as technologies began to ride existing networks: the internet travelled over telephone lines and then cellular networks; mobile phones used standards already settled for earlier systems; social media sat on top of the internet.

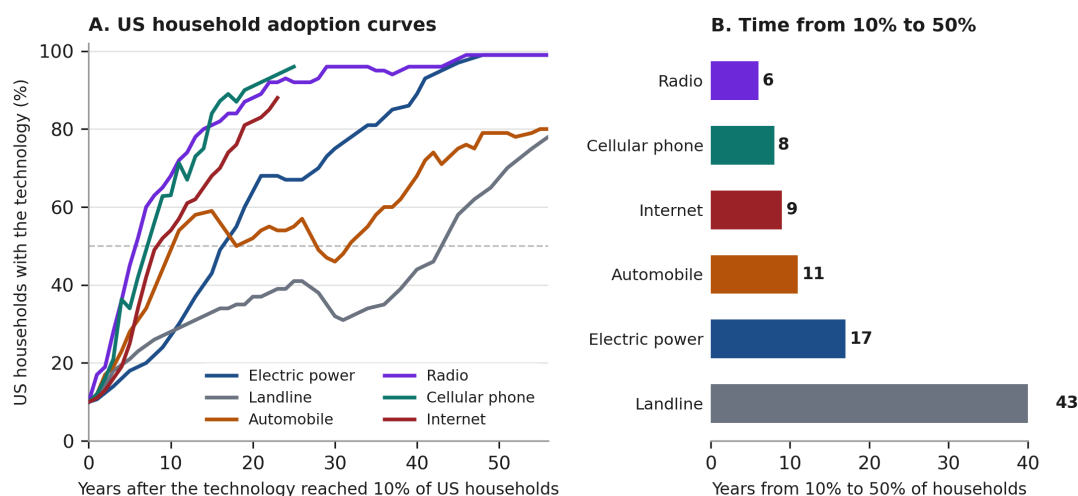


Figure 3. Years from 10 to 50 per cent of US households: newer technologies diffuse faster.

Source: Comin and Hobijn (2004) and others, via Our World in Data, “Technology adoption by households in the United States”. Series are aligned at the year each first reached 10 per cent of households. These are US data; they show the rate at which technologies spread in the leading economy, not in the world.

The same logic operates at the global scale. When the lead economy’s curve steepens, so does everyone else’s: later adopters import not only the device but also the standards, supply chains and business models that cut the cost of adoption.

2.3 Four channels of transmission

Four channels carried Western innovations to the rest of the world, and each left a different mark. **Trade and investment** moved goods, machines and factories: railways, power plants and containers arrived through commerce and finance. **Empire and coercion** transferred institutions and infrastructure on terms that frequently served extraction. Railways, telegraph lines and schools in colonial territories were built for the imperial power’s purposes, and their later adaptation to national development is a separate story from their origin. Honest accounting requires holding both facts together. **Deliberate institutional transfer** worked through international organisations, aid agencies and standard-setting bodies: the WHO’s eradication and immunisation programmes, the World Bank’s lending and the Bureau International des Poids et Mesures all fit here. **Imitation and learning** worked through students abroad, returning migrants, multinational firms and policy copying; Japan’s nineteenth-century missions to Europe and South Korea’s twentieth-century study of Japan are the textbook cases.

These channels explain why diffusion is uneven. Trade carries what has a market; coercion carries what an empire wanted; institutions carry what a convention can codify; imitation carries what a learner can observe and copy. Innovations that match several channels at once, such as the mobile phone, travel fastest. Those that match none, such as a locally financed sewer network, travel slowest.

3. Health and Medicine: The Fastest Gains in Human History

Life expectancy in low-income countries today is higher than it was in Europe in 1950. Much of that gain comes from tools first developed in Western laboratories and public-health systems, carried worldwide by vaccination campaigns, antibiotics and sanitation.

3.1 From Jenner to eradication

The modern history of disease control begins with Edward Jenner's [smallpox vaccination in 1796](#) and with [Louis Pasteur's](#) work on germs and vaccines in the nineteenth century. The twentieth century added antibiotics, with [Alexander Fleming's observation of penicillin in 1928](#) and its industrial scale-up in the 1940s, and hormone therapy, with the discovery of [insulin at Toronto in 1921–22](#). Each travelled quickly by the standards of its time because each was a product, a dose or a protocol that a health system could deliver.

Smallpox shows the full arc. A global campaign led by the WHO and supported by many governments, including the United States and the Soviet Union, vaccinated at scale and tracked cases until the last natural infection, in Somalia in 1977. The World Health Assembly [formally declared the disease eradicated on 8 May 1980](#). It remains the only human disease ever eradicated, and its eradication required a Western invention, a global institution and the labour of health workers in almost every country, including many that had no health system to speak of.

Routine childhood immunisation turned a one-off campaign into a permanent service. The WHO's Expanded Programme on Immunization began in 1974, when fewer than 5 per cent of infants had access to routine vaccines. A 2024 modelling study in *The Lancet*, [summarised by UNICEF](#), estimated that vaccination against 14 pathogens saved about 154 million lives over fifty years, 101 million of them infants, with measles vaccination accounting for roughly 60 per cent of the total. By 2024, according to the [WHO and UNICEF's coverage estimates](#), 85 per cent of infants worldwide received three doses of diphtheria–tetanus–pertussis (DTP3) vaccine, and 111 of 194 countries met the 90 per cent target.

3.2 What the data show

Figure 4 charts life expectancy at birth since 1950 using United Nations estimates. The world average rose from about 46 years in 1950 to 73 years in 2023, a gain of 27 years in under three generations. Africa gained 27 years, from 37 to 64; Asia gained 33 years, from 42 to 75. Europe and North America gained too, but by less, about 17 and 12 years, so that the gap between the leaders and the rest narrowed sharply. The striking comparison is that low-income countries, at about 65 years in 2023, now have a life expectancy above Europe's in 1950, at about 62.

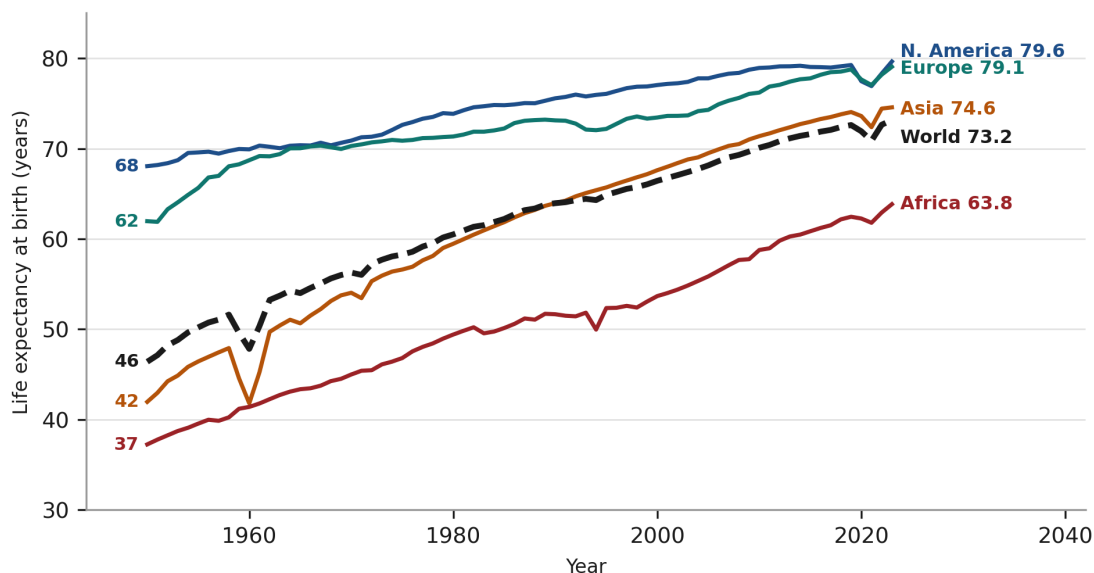


Figure 4. Life expectancy at birth by region, 1950–2023.

Source: United Nations, World Population Prospects 2024, via Our World in Data. The dip around 1960 in Asia reflects the Great Chinese Famine; the dip around 2020 reflects COVID-19. H Heuristics analysis.

Figure 5 shows two of the mechanisms. Panel A follows under-five mortality from the early nineteenth century. In 1800 about 43 per cent of children worldwide died before their fifth birthday; in 2024 about 3.7 per cent did, according to [Our World in Data’s compilation](#) of UN and historical estimates. The [UN Inter-agency Group for Child Mortality Estimation](#) estimates that the under-five death rate in low-income countries fell from about 180 per thousand in 1990 to about 69 in 2024. Panel B shows routine immunisation: world DTP3 coverage climbed from 17 per cent in 1980 to 85 per cent in 2024, and from 5 per cent to 70 per cent in low-income countries.

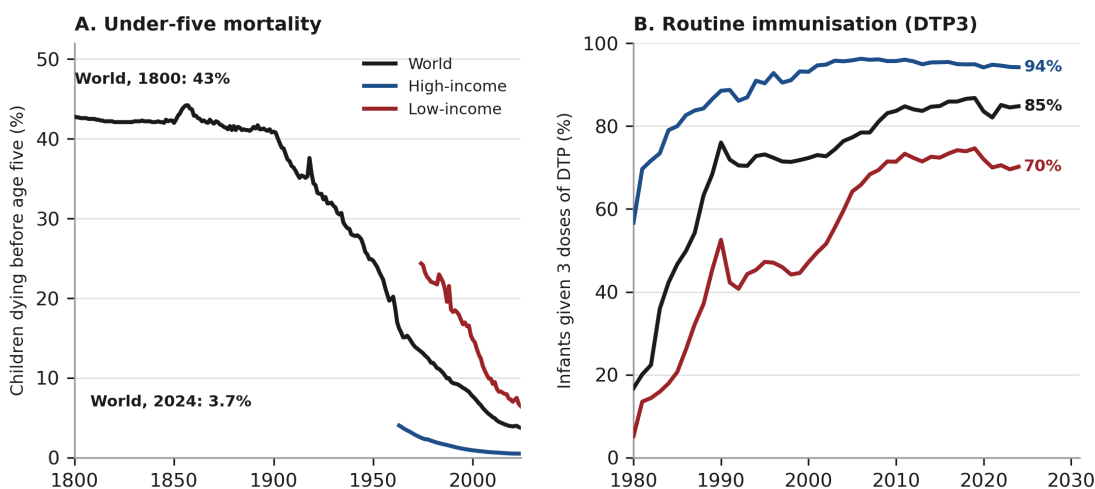


Figure 5. Child survival and routine immunisation.

Source: Our World in Data (under-five mortality; UN IGME and historical series); World Bank World Development Indicators, SH.IMM.IDPT (DTP3, share of children aged 12–23 months). Income-group series for child mortality begin after 1950. H Heuristics analysis.

Table 2. Selected health innovations and their diffusion

Innovation	Origin	Diffusion marker
Smallpox vaccination	Edward Jenner, England, 1796	Disease eradicated worldwide; declared by the WHO in 1980
Antibiotics (penicillin)	Fleming, UK, 1928; mass production in the UK and US in the 1940s	Nobel Prize 1945 ; now a staple of health systems worldwide, with resistance a global concern
Insulin therapy	Toronto, Canada, 1921–22	Nobel Prize 1923 ; standard diabetes care worldwide
Routine childhood immunisation	WHO Expanded Programme, 1974, built on Western-developed vaccines	DTP3 coverage 85% in 2024; 14.3 million zero-dose children
Germ theory and sanitation	Pasteur, Koch and public-health reformers, nineteenth century	91% basic drinking-water service, 58% safely managed sanitation (2024)

Dates and places refer to the form in which each innovation first took scalable shape.

3.3 Where the story is incomplete and what it did not owe to the West

Three qualifications temper this success. First, diffusion has stalled recently. WHO and UNICEF report that 14.3 million children received no vaccine at all in 2024, up from 12.9 million in 2019, and that only 111 countries reached the 90 per cent DTP3 target against 125 in 2019. Coverage in West and Central Africa is the lowest, at 72 per cent. Second, the gains owed much to forces other than medical technology: rising incomes, nutrition, female education and clean water all lowered mortality, and several of these were driven locally. Third, diffusion was not simple transmission. Oral rehydration therapy was field-tested in South Asia in the 1960s and 1970s, and much of the world’s vaccine manufacturing capacity is now in India and China. Section 11 takes up that reversal.

4. Energy and Industry: Electricity, Engines and the Factory

The industrial revolution's core technologies, from steam and the factory to the electric grid and the internal combustion engine, have become the default infrastructure of every large economy. Their reach is high, with one notable exception: the last 8 per cent without electricity are concentrated in one region.

4.1 The machinery of the first and second industrial revolutions

The [Industrial Revolution](#) in Britain combined a power source, the [steam engine](#) from Newcomen's atmospheric engine of 1712 to Watt's separate condenser of the 1760s and 1770s, with an organisational form, the factory, and a transport network, the railway, which opened commercially in England in the 1820s and 1830s. The second wave added electricity and chemicals. [Thomas Edison's Pearl Street Station](#) in New York began supplying power in 1882; Karl Benz built a practical petrol-engined [motor car](#) in Germany in 1885–86.

Each travelled by a different route. Railways were exported by British and later European capital, and by imperial governments, to India, South America, Africa and China. Electricity spread by utility franchises and then by state planning. Motor vehicles spread through trade and licensed local manufacture. The industry's trade association, OICA, [reports](#) that more than 1.2 billion vehicles were in use worldwide in 2015, a figure that has grown since; a majority of the world's cars are now assembled outside Europe and North America.

4.2 Electricity: near-universal, with one stubborn exception

Electrification is the cleanest test of reach, because the World Bank and partner agencies have tracked it for decades. Figure 6 shows that the world's population with electricity access rose from about 78 per cent in 2000 to about 92 per cent in 2024. The change is dramatic in South Asia, where access rose from 47 per cent in 1993 to almost 100 per cent in 2024, and in East Asia and the Pacific, which is now at 99 per cent. It has been slow in sub-Saharan Africa, where access reached 55 per cent in 2024, and in the group of low-income countries, at 49 per cent. The multi-agency [Tracking SDG7](#) report for 2025 puts the number of people without electricity at about 666 million in 2023, most of them in sub-Saharan Africa.

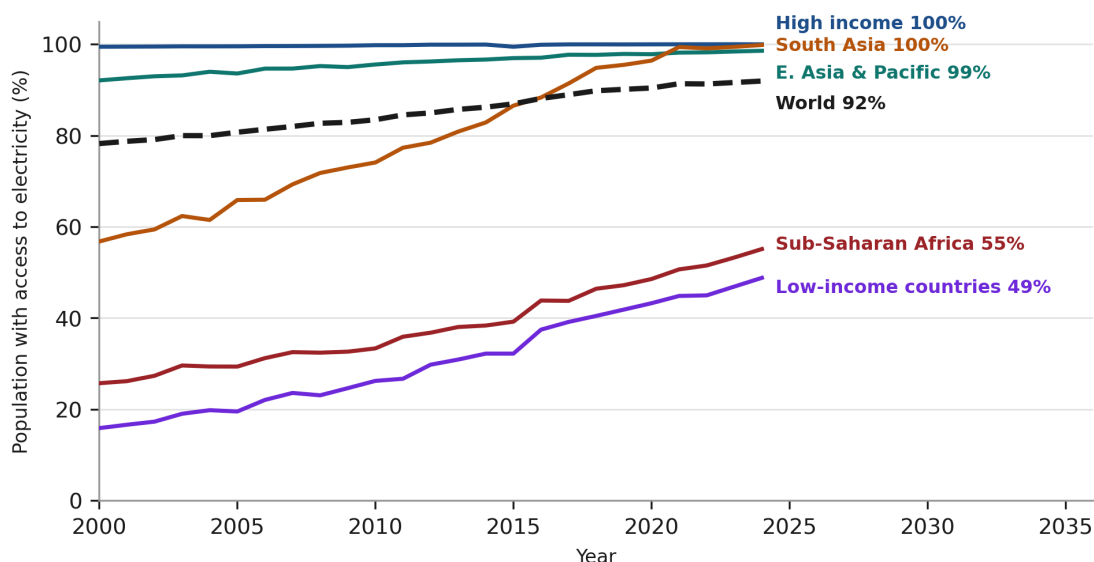


Figure 6. Population with access to electricity, by region and income group, 2000–2024.

Source: World Bank, World Development Indicators, EG.ELC.ACCS.ZS (Sustainable Energy for All and partner agencies). Series for South Asia and sub-Saharan Africa start earlier than 2000 but are shown from 2000 for comparability. H Heuristics analysis.

That South Asia could move from half to nearly all of its population in thirty years shows that the electric grid is not a rich-country technology in any deep sense; it is a technology that diffuses where a state or utility can finance the network. Sub-Saharan Africa’s slower progress reflects population growth outpacing connections, limited fiscal capacity, and low densities that raise the unit cost of grids. The same technology is now arriving by a different route in those places: off-grid and distributed solar, itself an invention with a Western origin whose manufacturing has since moved east (Section 11).

Table 3. Selected energy and industrial innovations and their diffusion

Innovation	Origin	Diffusion marker
Steam power and the factory	Britain, 1712–1780s	Manufacturing now located largely in Asia; Industrial Revolution as the template for national industrialisation
Railways	England, 1820s–1830s	Built on every inhabited continent; the commercial model of the railroad is universal
Public electricity supply	New York, 1882 (Edison)	92% of the world’s population with access in 2024 ; 666 million without (2023)
Motor vehicle	Germany, 1885–86 (Benz)	More than 1.2 billion vehicles in use in 2015 (OICA)

Dates give the first commercially scalable form in the West.

5. Food and Agriculture: Fertiliser, Seeds and the Yield Revolution

Two Western innovations, synthetic nitrogen and high-yielding crop varieties, changed what the world could eat. Their reach is global, but their intensity differs sharply: cereal yields in Africa are still less than half the world average.

5.1 Nitrogen and the Green Revolution

Before the twentieth century, farm yields depended on organic nitrogen from manure, legumes and guano. Fritz Haber's laboratory synthesis of ammonia in 1909 and Carl Bosch's industrial scale-up at BASF in 1913 broke that constraint; Haber received the [Nobel Prize in Chemistry in 1918](#). The review by Erisman and colleagues, [How a century of ammonia synthesis changed the world](#), concludes that large-scale fertiliser production supports almost half of the world's population. [Hannah Ritchie's review](#) for Our World in Data surveys the competing estimates and the assumptions behind them.

The Green Revolution carried the second innovation, the semi-dwarf, fertiliser-responsive grain variety. Its institutional vehicles were philanthropic: the Rockefeller and Ford foundations funded the [International Rice Research Institute](#), founded in the Philippines in 1960, and the maize and wheat centre that became CIMMYT in Mexico. The work of the American agronomist [Norman Borlaug](#), who received the Nobel Peace Prize in 1970, on semi-dwarf wheat is the best-known part of it. Evenson and Gollin's assessment in *Science*, [Assessing the Impact of the Green Revolution, 1960 to 2000](#), found that international crop-improvement research raised yields across a wide range of crops and regions of the developing world, though unevenly.

5.2 What the data show

Figure 7 charts cereal yields since 1961. World cereal yields rose from 1.35 tonnes per hectare to 4.21, a threefold increase. Asia, which began at 1.21 tonnes, now matches Europe at about 4.4–4.5; North America, at 6.9, remains the frontier. Fertiliser intensity tells the same story: world use per hectare of arable land rose from about 43 kilograms in 1966 to about 136 kilograms in 2023. Asia's yield gains are among the clearest cases of a technology package, seed, fertiliser, irrigation and credit, moving from one part of the world to another and then being sustained locally.

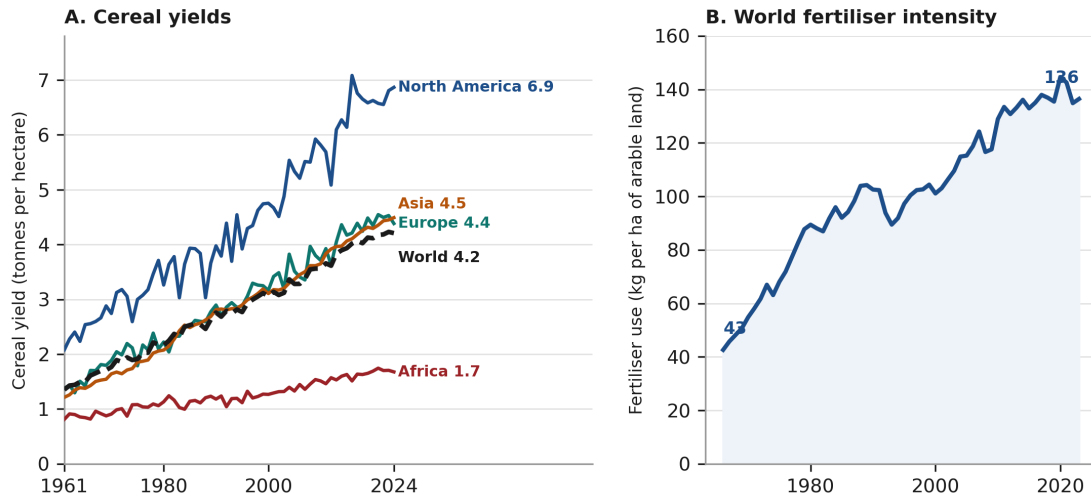


Figure 7. Cereal yields and fertiliser intensity.

Source: FAO via Our World in Data (cereal yield, tonnes per hectare, 1961–2024); World Bank World Development Indicators, AG.CON.FERT.ZS (fertiliser consumption in kilograms per hectare of arable land, 1966–2023). H Heuristics analysis.

Africa shows the limit of the package. Its cereal yield rose from 0.8 to 1.7 tonnes per hectare, less than half the world average of 4.2. The causes are agronomic and institutional: rain-fed farming, soils low in nutrients, thin input markets and credit, and smaller public investment in research and extension. The FAO's *State of Food Security and Nutrition in the World 2025* estimates that 8.2 per cent of the world's people, about 673 million, faced hunger in 2024, and that the share in Africa exceeded 20 per cent. The Green Revolution diffused in the places where its complements were in place and has barely begun where they are not.

There is a second caveat: costs travelled with the technology. Intensive nitrogen use has contributed to water pollution and greenhouse-gas emissions, and the dependence of modern agriculture on fossil-fuel-derived ammonia exposes importers to energy-price shocks. Diffusion carried the solution and the problem together, which is typical of general-purpose technologies.

6. Transport and Trade: Rails, Wings and the Standard Box

The systems that move people and goods around the planet, railways, motor roads, aircraft and containers, were all first assembled in Europe and North America. They have since become so thoroughly global that their busiest hubs now lie mostly in Asia.

6.1 Railways, motor roads and aircraft

The railway was the first transport system to be exported as a complete package of track, locomotives, signalling, timetables and finance. After the Stockton and Darlington Railway opened in 1825 and the Liverpool and Manchester Railway in 1830, British engineers and capital built lines across Europe, India, Latin America and Africa. The pattern of coercion noted in Section 2 applies: many colonial railways ran from mines and plantations to ports and were laid out to extract rather than to connect. Their later reuse by independent states is nonetheless a clear case of persistence, since the same lines, gauges and rail engineering practices now serve national economies.

Powered flight followed the same logic at faster speed. The [Wright brothers' flights at Kitty Hawk in 1903](#) were followed within two decades by commercial airlines and within a half-century by the jet airliner. The 1944 Chicago Convention created the International Civil Aviation Organization, whose [membership today covers 193 states](#), and its technical standards, from air-traffic procedures to pilot licensing, are what allow an aircraft built in Toulouse or Seattle to land safely in Nairobi or Jakarta.

6.2 The container and the age of standard boxes

The container is a distinctive case because its invention was organisational rather than technical. Malcolm McLean, an American trucker, [sent the converted tanker *Ideal X* from Newark on 26 April 1956 with 58 containers](#); his estimate was that loading cost would fall from about US\$5.83 a ton to under US\$0.16. [Guinness World Records recognises it as the first modern containership](#). The innovation became global only when international standards for container dimensions and fittings were agreed in the 1960s, so that a box could move between ship, rail and truck anywhere.

The scale today is large. [UNCTAD's Review of Maritime Transport 2025](#) reports that maritime trade volume reached 12,720 million tonnes in 2024, and the World Bank records [container port throughput](#) of about 913 million twenty-foot-equivalent units in 2024, up from about 547 million in 2010. Figure 8 shows these series alongside world air-passenger traffic, which has risen from roughly 0.3 billion passengers in 1970 to about 4.3 billion in 2023 according to the [World Bank's air-transport series](#), with a sharp fall in 2020 and a full recovery by 2023.

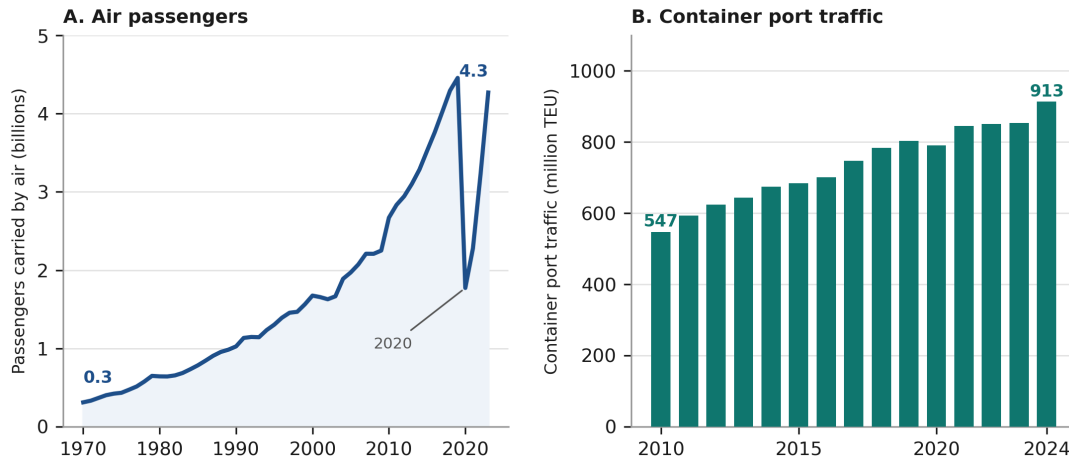


Figure 8. Air travel and container shipping: two Western-origin systems at world scale.

Source: World Bank World Development Indicators, IS.AIR.PSGR (air passengers carried, registered carriers worldwide, 1970–2023) and IS.SHP.GOOD.TU (container port traffic, TEU, 2010–2024). Container series available from 2010 only. H Heuristics analysis.

The distribution of activity tells its own story about diffusion. The world’s busiest container ports are now overwhelmingly in Asia, with Shanghai first, and a large part of the world’s shipbuilding, port equipment and container manufacturing capacity sits in East Asia. A system started by an American trucking company became, within two generations, an infrastructure whose hubs, shipyards and box manufacturers are mostly in Asia, even though the largest shipping lines remain European. That is not failure; it is what a fully diffused technology looks like.

Table 4. Selected transport and trade innovations and their diffusion

Innovation	Origin	Diffusion marker
Public steam railway	England, 1825–1830	Built on every inhabited continent (railroad history)
Powered flight and airliners	United States, 1903 (Wright brothers)	About 4.3 billion air passengers in 2023; 193 ICAO member states
Container shipping	United States, 1956 (Ideal X)	913 million TEU handled by ports in 2024

Dates give the first commercially scalable form in the West.

7. Information and Communication: From Print to the Smartphone

Information technologies show the fastest diffusion in this report and the clearest gap between arrival and use. Mobile subscriptions now exceed one per person worldwide; internet use has reached three-quarters of humanity; and the remaining gaps look more like gaps in quality than in access.

7.1 A sequence of networks

The modern information stack was built in layers over six centuries. [Johannes Gutenberg's printing press](#) of about 1450 made written text cheap to copy in Europe, though movable type had existed earlier in China and Korea (Section 11). The [electric telegraph](#) of the 1830s and 1840s and the [telephone patented by Alexander Graham Bell](#) in 1876 turned communication into a networked service. [Marconi's wireless](#) in the 1890s led to radio and television. The twentieth century then added the digital computer ([ENIAC](#), 1945), the [transistor](#) (1947), the [integrated circuit](#) (late 1950s) and the [ARPANET](#), the American research network of 1969 that became the internet. [Tim Berners-Lee](#) proposed the World Wide Web at CERN in 1989, and Apple's [iPhone](#) in 2007 put a networked computer in a pocket.

Each layer reused the one below it. Cellular telephony, from the [first handheld mobile phone](#) in the 1970s, built on the telephone network. Europe's GSM standard, launched in 1991, became the dominant global specification for second-generation networks, which is one reason handsets could roam and be mass-produced for the whole world.

7.2 What the data show

Figure 9 shows both arrival and gap. Mobile-cellular subscriptions per 100 people were about 2 worldwide in 1995, 96 in 2015 and 112 in 2025, according to the [World Bank's ITU-based series](#). High-income countries now have 142 per 100 people, but low-income countries have 69, up from 53 a decade earlier. Internet use, [measured by the World Bank from ITU data](#), rose worldwide from about 16 per cent in 2005 to about 74 per cent in 2025. In high-income countries it moved from 53 to 94 per cent; in upper-middle-income countries from 10 to 89 per cent; in lower-middle-income countries from 4 to 63 per cent; and in low-income countries from 1 to 23 per cent.

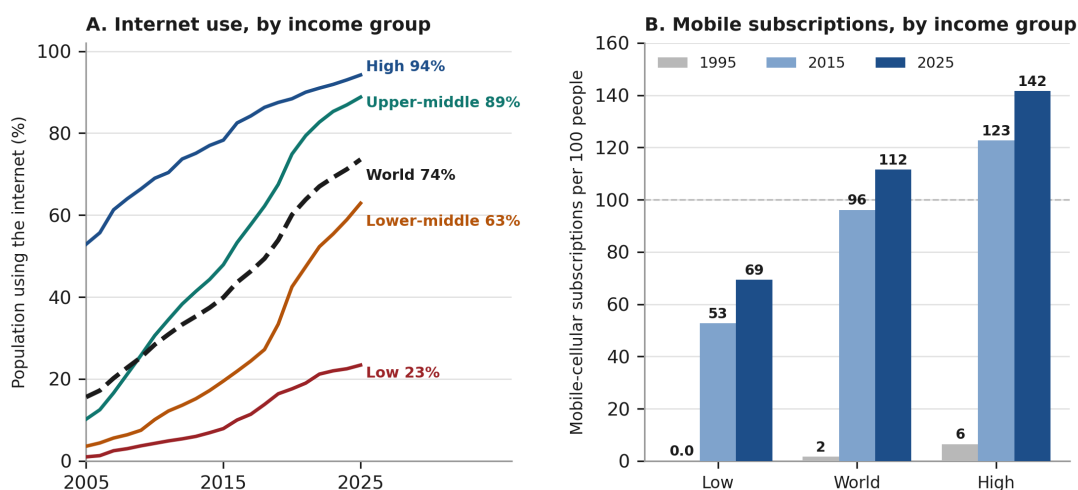


Figure 9. Internet use and mobile subscriptions.

Source: World Bank World Development Indicators, IT.NET.USER.ZS (individuals using the internet, % of population, 2005–2025) and IT.CEL.SETS.P2 (mobile-cellular subscriptions per 100 people; panel B shows years with complete data for all three groups). Subscriptions can exceed 100 per 100 people because individuals hold several. H Heuristics analysis.

Two further results from the [ITU's Facts and Figures 2025](#) qualify the optimistic reading. Six billion people were online in 2025 and 2.2 billion were not, of whom 96 per cent live in low- and middle-income countries. And affordability remains a barrier in about 60 per cent of low- and middle-income countries, even as the median price of data fell. The gap has shifted from whether a network is present to whether it is useful, fast and affordable: the intensity point from Section 2.

The mobile phone also shows how diffusion can bypass an earlier stage. Fixed landlines took 43 years to move from 10 to 50 per cent of US households (Figure 3). In much of Africa and South Asia, mobile phones became the main route onto a network without a mature fixed-line system ever being built. The pattern, in which a later technology reaches latecomers faster because it does not require the earlier infrastructure, recurs in mobile money (Section 11), and it is the pattern that the final section examines for artificial intelligence.

Table 5. Selected information and communication innovations and their diffusion

Innovation	Origin	Diffusion marker
Printing with movable type	Mainz, Germany, c.1450 (Gutenberg); earlier forms in East Asia	Adult literacy 88% worldwide
Telephone	United States, 1876 (Bell)	Basis of the mobile networks now at 112 subscriptions per 100 people
Programmable computer and transistor	UK and US, 1936–1947 (ENIAC , transistor)	Embedded in nearly all manufacturing, finance and communication
Internet and the Web	United States, 1969 (ARPANET); Switzerland, 1989 (Berners-Lee)	About 6 billion users in 2025 , 74% of the population

Dates give the first commercially scalable form in the West.

8. The State, the Law and the School: Institutions That Travelled

Institutions diffused as completely as machines in form and less completely in substance. Every country now has a flag, a seat at the United Nations and a written constitution; far fewer have the continuity of rule of law and open political competition that those forms were meant to carry.

8.1 The nation-state and the written constitution

The idea that the world is divided into sovereign, territorially bounded states, conventionally dated to the [Peace of Westphalia in 1648](#), became a global fact in the twentieth century. The League of Nations and then the United Nations offered a template: the UN began with 51 members in 1945 and now has 193, most of the growth coming from decolonisation in the 1950s and 1960s and from the dissolution of the Soviet Union and Yugoslavia after 1989. Figure 10A shows the trajectory. The state form, with defined borders, a national legislature, a civil service and a standing army, is now so universal that it is hard to see it as an export.

The written constitution travelled with it. Since the American Constitution of 1787 and the French constitution of 1791, drafting a founding charter has been treated as a mark of sovereignty. The [Constitute project](#) archives the texts of the constitutions of almost every sovereign state in the world. Metrology followed a similar path. The French Republic created the metric system in the 1790s, and sixteen other states joined France in signing the [Metre Convention on 20 May 1875](#). Today the metric system is the legal basis of measurement almost everywhere; the United States remains the principal holdout for everyday use, although even there the [National Institute of Standards and Technology](#) defines customary units by reference to metric ones.

8.2 Democracy: form spread faster than substance

Electoral democracy is the most contested example of institutional diffusion. Using the Regimes of the World classification, which is produced by the V-Dem Institute and republished by [Our World in Data](#), only five of about 145 countries in 1900 were electoral or liberal democracies; by 2000 the figure was 84 of 178; and in 2024 it was 86 of 179. Figure 10B shows the pattern. The expansion came in waves, after 1945 and again from the mid-1970s, with a surge after 1989; it has since stalled and partly reversed.

The most recent [V-Dem Democracy Report 2026](#) counts 87 democracies and 92 autocracies at the end of 2025 and estimates that about 74 per cent of the world's people live in autocracies. It also finds that the average level of democracy in the world has fallen back to the level of the late 1970s. The point for a study of diffusion is not that democracy is failing. It is that diffusion of a form such as multiparty elections is distinct from diffusion of the conditions that give it substance, including independent courts, free media and a norm of peaceful transfer of power. Constitutions, flags and parliaments spread easily because they are cheap to adopt; the habits that make them work spread slowly, if at all.

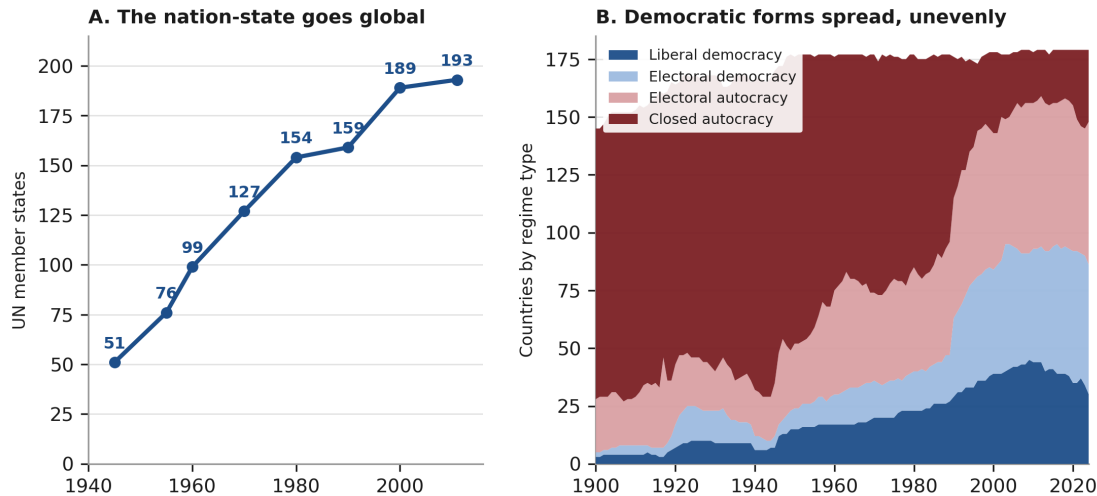


Figure 10. *The nation-state goes global, and democratic forms spread unevenly.*

Source: UN membership data from the United Nations (selected years, 1945–2011); regime classification from V-Dem’s Regimes of the World via Our World in Data (1900–2024, number of countries in each category; the number of countries covered grows over time as new states appear). H Heuristics analysis.

8.3 The school and the university

Mass schooling is one of the clearest cases of institutional diffusion. The university began in medieval Europe, with [Bologna](#) conventionally dated to 1088 and Paris and Oxford soon after. Compulsory state schooling was pioneered in the German states, notably Prussia in the eighteenth century, and became the template for national education systems across the world. By the twentieth century nearly every state had a ministry of education, and by the twenty-first the curriculum, school calendar and credential structure were recognisably similar from Brazil to Indonesia.

The result is visible in literacy. Our World in Data’s long-run series, built from historical estimates and, from the 1970s, [UNESCO and World Bank data](#), puts the world’s literate share at about 12 per cent in 1820 and about 88 per cent in 2024 (Figure 11A). The World Bank’s gross secondary enrolment ratio rose from 49 per cent in 1970 to 77 per cent in 2024. Upper-middle-income countries went from 37 per cent to 96 per cent, almost matching high-income countries; low-income countries went from 18 per cent to 41 per cent.

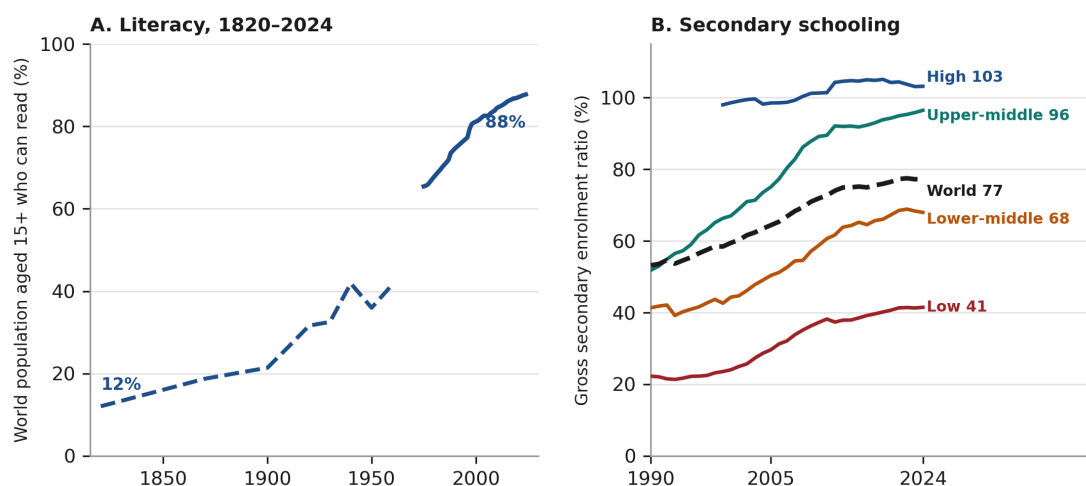


Figure 11. Literacy and secondary schooling.

Source: Our World in Data (long-run literacy; the series changes source between 1960 and 1975, shown as a break between dashed and solid lines); World Bank World Development Indicators, SE.SEC.ENRR (gross secondary enrolment ratio, 1990–2024). Gross ratios can exceed 100 per cent. H Heuristics analysis.

Enrolment is a measure of arrival; learning is a measure of depth, and here the record is weaker. The World Bank’s [World Development Report 2018](#) documented a “learning crisis” in which many children complete primary school without mastering basic reading. The same diffusion-versus-intensity distinction applies: the school has reached almost everyone, while the quality of what it delivers still differs widely. The [Our World in Data education overview](#) gathers the evidence.

Table 6. Selected institutional innovations and their diffusion

Innovation	Origin	Diffusion marker
Sovereign nation-state	Europe, conventionally dated to 1648	193 UN member states , from 51 in 1945
Written constitution	United States, 1787; France, 1791	Texts archived for almost every sovereign state
Metric system	France, 1790s; Metre Convention , 1875	Legal basis of measurement in almost all countries
Mass schooling and the university	Medieval Bologna ; Prussia, eighteenth century	Adult literacy 88%; secondary enrolment 77% (World Bank)
Electoral democracy	United States and France, late eighteenth century	86 of 179 countries in 2024; 74% of people live in autocracies

Dates and places give the conventional origin of each institutional form in the West.

9. Finance, Commerce and Standards: The Plumbing of the Global Economy

Accounting, corporate law, banking and technical standards rarely appear in lists of great inventions, yet they are among the most thoroughly diffused. They are the plumbing through which the rest of the world's transactions flow.

9.1 Corporate, financial and accounting institutions

Much of the world's commercial architecture was assembled in Italy and northern Europe between the fourteenth and eighteenth centuries. Double-entry bookkeeping was codified for a general audience by [Luca Pacioli](#) in 1494. The [Dutch East India Company](#), founded in 1602, was the first company to issue tradable shares to the public on a permanent basis. Sweden's Riksbank (1668) and the [Bank of England](#) (1694) set the pattern for the central bank, and [Lloyd's of London](#), which emerged from a coffeehouse in the late seventeenth century, shaped modern marine insurance.

These forms have been adopted worldwide, usually by statute. Every large economy now has a corporate code allowing limited-liability companies, a central bank, a stock exchange and commercial banks, even though ownership patterns and regulatory cultures differ. Accounting standards offer a measurable case. The IFRS Foundation, based in London, maintains [profiles for 170 jurisdictions](#), most of which require or permit its standards for domestic public companies. The International Organization for Standardization, founded in 1947 and headquartered in Geneva, publishes the technical standards, from [container dimensions](#) to [quality management](#), that make goods interchangeable.

9.2 The systems that run commerce

Several commercial systems of the late twentieth century now operate globally. [SWIFT](#), the messaging cooperative founded in Brussels in 1973, connects more than 11,500 institutions in over 200 countries and territories. The barcode was first scanned at a supermarket in Ohio on 26 June 1974; [GS1 reports that more than six billion barcodes are scanned every day](#). Payment cards, automated teller machines and electronic funds transfer spread through similar cooperative networks.

9.3 Financial inclusion: arrival and depth again

The best long-run measure of the reach of formal finance is the [World Bank's Global Findex](#), which has surveyed adults every three years since 2011. Its 2025 edition found that [79 per cent of adults worldwide held an account at a financial institution or through a mobile-money provider in 2024](#), up from 51 per cent in 2011. In low- and middle-income economies the share rose from 42 to 75 per cent, a catch-up that cut the gap with high-income economies, at 95 per cent, from about 46 percentage points to about 20. In low- and middle-income economies, 61 per cent of adults made or received a digital payment. About 1.3 billion adults remained without an account.

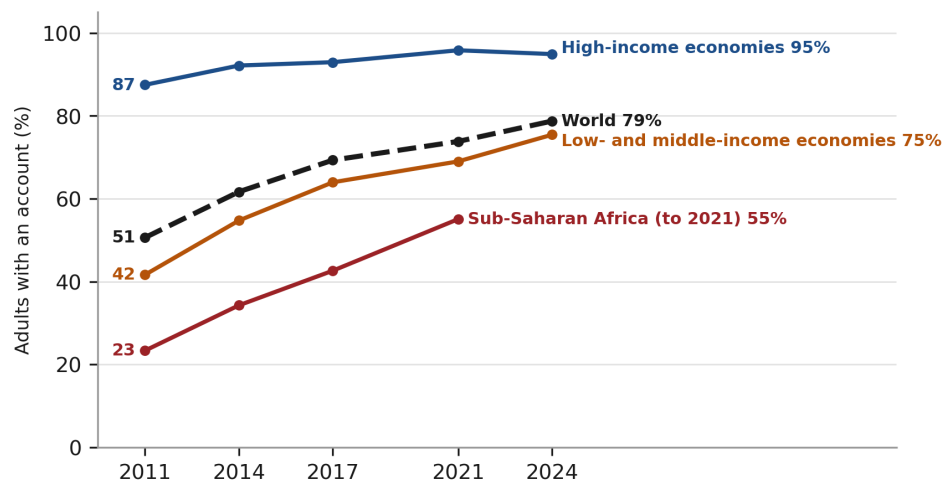


Figure 12. Adults with an account at a financial institution or mobile-money provider.

Source: World Bank, Global Findex Database, FX.OWN.TOTL.ZS (survey years 2011, 2014, 2017, 2021 and 2024; Sub-Saharan Africa series ends in 2021 in the data used). Aggregate group estimates are as published by the World Bank. H Heuristics analysis.

Financial inclusion illustrates a theme of this report: the bank account is a Western-origin institution, but much of its recent diffusion has been carried by a non-Western innovation, mobile money, which began with Safaricom’s M-Pesa in Kenya in 2007 (Section 11). The Western institution provided the template; local innovation delivered it at scale.

Table 7. Selected finance, commerce and standards innovations and their diffusion

Innovation	Origin	Diffusion marker
Double-entry bookkeeping	Italian city-states; codified by Pacioli , 1494	Basis of all modern financial accounting
Joint-stock company	Dutch East India Company , 1602	Universal corporate form; IFRS profiles for 170 jurisdictions
Central bank	Sweden, 1668; England, 1694	Present in virtually every economy
Barcode	United States, first scanned 1974	More than 6 billion scans a day
Interbank messaging	Belgium, 1973 (SWIFT)	More than 11,500 institutions in over 200 countries and territories
Bank account	Europe, centuries of evolution	79% of adults with an account in 2024

Dates give the first scalable form in the West.

10. Language, Sport and Everyday Culture

Some of the most visible diffusions are not technologies at all. English is the world's most widely spoken language by total speakers, association football is played in nearly every country, and the Olympic Games have grown from thirteen countries to 206 national committees.

10.1 English and the Latin alphabet

Language diffuses differently from machines because it spreads through speakers, not products. English began as the language of a few million people on one island; through colonisation, trade, American cultural and economic power and the internet, it became a lingua franca. [Ethnologue's 2025 estimate](#) is that English has about 1.5 billion speakers, ahead of Mandarin Chinese with about 1.2 billion, but roughly three in four of English's speakers use it as an additional language. It is the language of air-traffic control, of most scientific publishing, and of a large share of the internet's content. The Latin alphabet, itself derived from Greek and Phoenician antecedents, is the writing system for most European languages and, through adoption or romanisation, for languages from Turkish and Vietnamese to Indonesian and Swahili.

What diffused here is mostly the second-language form. English in India, Nigeria or Singapore is a local variety with its own idioms, and the largest populations of English speakers by country include India alongside the United States. That is characteristic of cultural diffusion: it works by adaptation, and the original form is only one of its descendants.

10.2 Sport as institutional export

Modern organised sport is a Western institutional invention. The English Football Association [adopted a codified set of rules in 1863](#); FIFA was founded in Paris in 1904 and now has [211 member associations](#), more than the UN has members. James Naismith [invented basketball in Massachusetts in 1891](#). The revival of the Olympic Games, led by [Pierre de Coubertin](#), produced the first modern Games in Athens in 1896, with, by [Olympedia's count](#), 176 participants from 13 countries. The IOC now [recognises 206 National Olympic Committees](#).

The common feature is portability: a set of rules, a governing federation, a competition calendar and a ready symbolic apparatus, all of which any society can adopt at low cost. Sport is also a case where local anchoring is complete. Football's tactical innovations, players and fan cultures now flow in every direction, and the Western originators have no special claim on the sport's future.

Table 8. Selected language, sport and cultural innovations and their diffusion

Innovation	Origin	Diffusion marker
English as a global language	England; spread through empire and the United States	About 1.5 billion speakers , three in four non-native
Association football	England, rules codified 1863	211 FIFA member associations
Basketball	United States, 1891	Played in nearly every country
Modern Olympic Games	Athens, 1896, led by Coubertin	206 National Olympic Committees , from 13 countries in 1896

Speaker figures are estimates; counts of associations and committees are as published by the relevant bodies.

11. Beyond the West: Debts, Counter-Flows and a Shifting Centre of Invention

The story of Western innovation is itself a story of diffusion into the West, and the flows now run both ways. The strongest evidence that Western innovations have diffused is that the rest of the world has begun to invent in return, and in some fields to lead.

11.1 The debts

The label “Western innovation” compresses a long chain of borrowings. Paper, traditionally credited to [Cai Lun](#) at the Han court around 105 CE, reached Europe through the Islamic world in the early medieval period. Movable-type printing existed in China and Korea centuries before Gutenberg’s press. The positional decimal system that Europeans call Arabic numerals originated in India, and the [Hindu–Arabic numerals](#) reached Europe through Arabic mathematical texts. Gunpowder and the magnetic compass came from China. The very idea of the university has parallels in the madrasa and earlier institutions of learning in Asia and the Islamic world. None of this reduces the real achievements of the European and American scientific, industrial and organisational systems that scaled these ideas. It does mean that “diffusion from the West” is better understood as one stage in a longer relay.

11.2 Reverse flows today

Contemporary counter-flows are easier to document, because they are recent. Four stand out.

- **Mobile money.** Safaricom’s M-Pesa launched in Kenya in 2007 and showed that a phone could replace a bank branch for millions of people. The GSMA’s [State of the Industry reports](#) count more than two billion registered mobile-money accounts, concentrated in sub-Saharan Africa and South Asia. Its design is now studied and licensed by firms in rich economies.
- **Unified Payments Interface.** India’s UPI, launched in 2016, lets any bank account pay any other by phone. [National Payments Corporation of India statistics](#) show monthly transactions in the tens of billions, and several other countries have linked their payment systems to it. It is a public-infrastructure design that Western countries have been slower to match.
- **Lean production and the QR code.** Toyota’s [production system](#), developed from the 1950s, reshaped manufacturing worldwide, including in the plants of the American firms that had pioneered the assembly line. The two-dimensional QR code, [created by Denso Wave of Japan in 1994](#) to track car parts, became the dominant way of linking printed objects to digital services.
- **Solar photovoltaics.** The silicon solar cell was demonstrated at Bell Laboratories in the United States in 1954. Seven decades later, the International Energy Agency finds that [China’s share of every stage of solar-panel manufacturing exceeds 80 per cent](#), a result of scale, industrial policy and learning-by-doing.

Table 9. Selected innovations with non-Western origins that shaped the world

Innovation	Origin	Diffusion marker
Paper	Han China, c.105 CE (Cai Lun)	Universal medium of writing and packaging
Positional decimal numerals	India; transmitted through the Arab world (Hindu–Arabic numerals)	The numeral system of nearly the whole world
Mobile money	Kenya, 2007 (M-Pesa)	More than two billion registered accounts
Unified Payments Interface	India, 2016	Tens of billions of monthly transactions
QR code	Japan, 1994 (Denso Wave)	Standard interface between print and digital services
Lean production	Japan, 1950s (Toyota)	Adopted by manufacturers on every continent

Dates are conventional. Many of these innovations have complex, multi-region histories.

11.3 The geography of invention

The cleanest quantitative evidence of the shift is in patenting. WIPO’s [World Intellectual Property Indicators 2025](#) reports a record 3.7 million patent applications worldwide in 2024. [Residents of China filed 1.8 million, roughly half the world total](#), against 501,831 from the United States, 419,132 from Japan, 295,722 from the Republic of Korea and 133,485 from Germany. In the WIPO [Global Innovation Index 2025](#), China entered the top ten for the first time, at tenth place behind Switzerland, Sweden, the United States, the Republic of Korea, Singapore, the United Kingdom, Finland, the Netherlands and Denmark.

Figure 13 uses the World Bank’s series of resident patent filings at national offices to show the long-run change. Between 1995 and 2024 the share of world resident filings made by residents of China rose from 1.4 per cent to 61.9 per cent. Over the same period the United States’ share fell from 17.6 to 10.0 per cent, that of eight large European offices from 11.4 to 2.9 per cent, and Japan’s from 47.6 to 8.8 per cent. India, though still small, rose from 0.2 to 2.3 per cent.

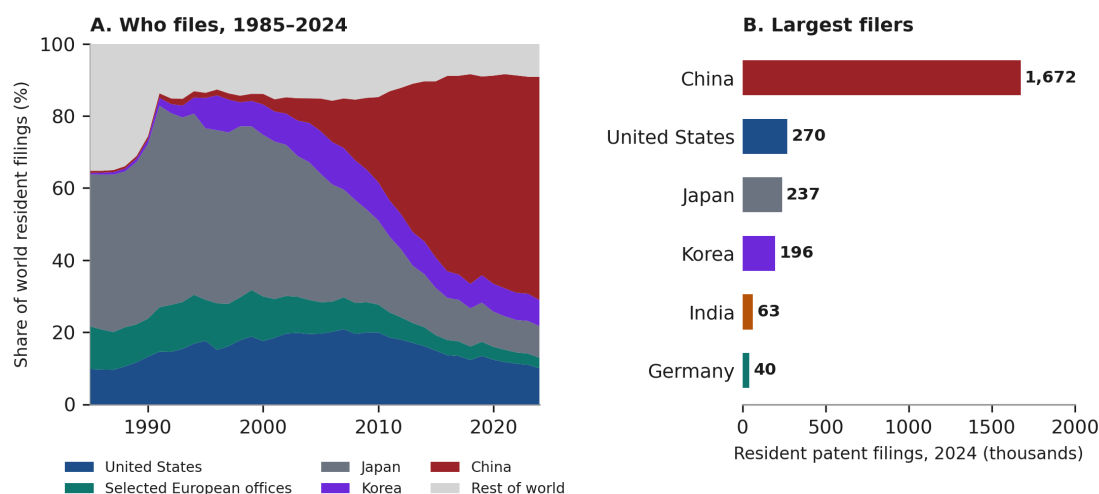


Figure 13. Resident patent filings: a changing geography of invention.

Source: World Bank World Development Indicators, IP.PAT.RESD (patent applications by residents filed at national offices; WIPO data). Selected European offices are Germany, France, the United Kingdom, Italy, the Netherlands, Sweden, Switzerland and Spain. Coverage before about 1990 is incomplete and the early years should be read with caution. H Heuristics analysis.

These counts must be read carefully. Patent filings measure filing behaviour, and in China they have been boosted by public subsidies and targets. A filing is not a quality-adjusted invention, and the leaders in high-value fields still include firms and laboratories in the United States, Japan, Korea and Europe. The broader point is nonetheless robust. A world in which one economy files roughly half of all patents is not one in which the West holds a monopoly on invention, and that is the outcome that diffusion makes possible.

11.4 What the reversal teaches

Two lessons follow. First, diffusion is not a one-way transfer that leaves the originator's position intact; it creates new originators. Economies that absorbed Western technology in the nineteenth and twentieth centuries, Japan first and then Korea, Taiwan and China, became sources of new technology in turn, and their own learners are now doing the same. Second, local adaptation can produce innovations that the originator would not have created, because it works under different constraints. Mobile money sprang from a context in which bank branches were scarce and phone coverage was growing, and UPI from a state able to coordinate a public payments layer. For an analyst, the sign that a technology has really diffused is not that it is used everywhere, but that it is being improved everywhere.

12. Where Diffusion Is Incomplete

A report about what has spread must also say what has not. Hundreds of millions of people still lack electricity, billions lack safely managed sanitation or water, and the gaps cluster in one region. Understanding why they persist is as important as celebrating what has been achieved.

12.1 The unfinished inventory

Figure 14A counts the people not yet reached by six innovations. About 3.4 billion people lack safely managed sanitation and 2.1 billion lack safely managed drinking water, according to the [WHO–UNICEF Joint Monitoring Programme’s 2025 report](#). Some 2.1 billion lack clean cooking fuels and technologies and about 666 million lack electricity, according to the [Tracking SDG7 2025 report](#), with both figures for 2023. The ITU puts the offline population at 2.2 billion, and the World Bank’s Findex reports that [1.3 billion adults remain without an account](#). Immunisation has gaps of its own: [14.3 million children](#) received no vaccine in 2024.

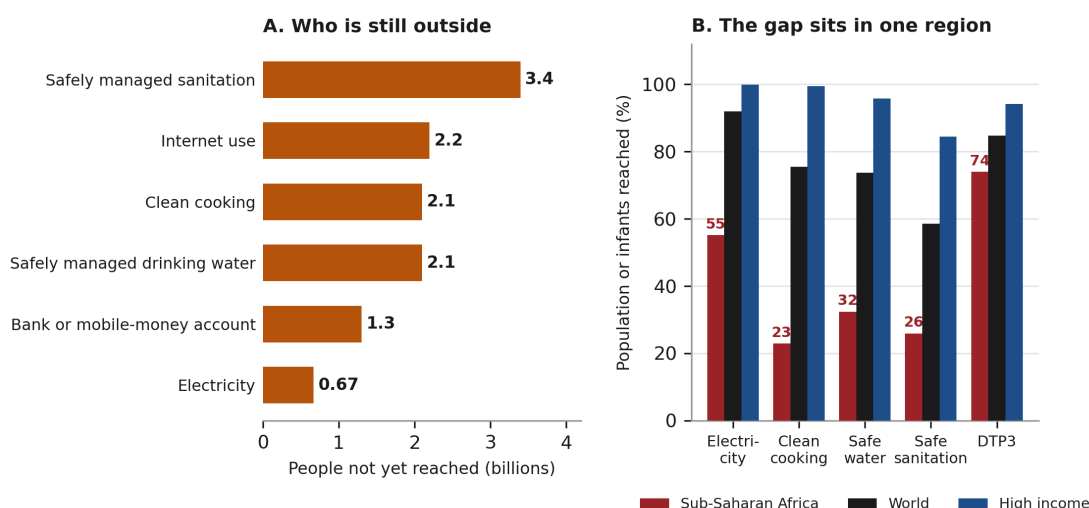


Figure 14. *The unfinished inventory: people not yet reached, and the regional concentration of the gap.*

Source: WHO–UNICEF JMP 2025 (water, sanitation; 2024); ITU Facts and Figures 2025 (internet); Tracking SDG7 2025 (cooking, electricity; 2023 data); World Bank Global Findex 2025 (accounts; 2024). Panel B: World Bank World Development Indicators (latest year, 2024). Counts are rounded and, being drawn from different agencies, are not additive: the same people appear in several categories. H Heuristics analysis.

Panel B of Figure 14 shows how concentrated the gaps are. Sub-Saharan Africa has electricity access of 55 per cent, against 92 per cent worldwide and 100 per cent in high-income countries; clean-cooking access of 23 per cent against 75 per cent; safely managed water of 32 per cent against 74 per cent; and safely managed sanitation of 26 per cent against 58 per cent. Even DTP3 immunisation, the most universal of the five, is 74 per cent there against 85 per cent worldwide. A very large share of the global shortfall is a regional shortfall.

12.2 Why some innovations stall

Four patterns explain most of the remaining gaps.

- **Network goods need public capital.** Sewers, grids, roads and schools are shared systems whose benefit depends on coverage and whose cost is front-loaded. They need fiscal capacity, regulatory capability and stable institutions. Products that an individual can buy, such as phones, spread faster than systems that a state must build. This is the same logic that placed sanitation behind the internet in Figure 1.
- **Last-mile economics.** The unit cost of connecting people rises as population density falls. The [*Tracking SDG7*](#) report notes that the population still without electricity lives mostly in remote, lower-income and fragile areas, and that distributed renewables are therefore central to closing the gap.
- **Fragility and conflict.** The JMP report finds that in fragile contexts, coverage of safely managed drinking water is 38 percentage points lower, and of safely managed sanitation 33 points lower, than elsewhere. Innovations that require continuity of service cannot reach where continuity cannot be guaranteed.
- **Form without function.** As Section 8 showed, a diffusion of formal institutions can leave their operational substance behind. Schools reach almost every child while learning lags; parliaments exist without a rule-of-law culture; accounts are opened and not used.

12.3 Closing the gaps: bypass and its limits

Latecomers can sometimes close a gap by skipping a stage. Mobile telephony skipped fixed-line networks, mobile money skipped bank branches and distributed solar can skip the national grid. The record in Sections 6 and 7 suggests that bypass works best for technologies whose unit of adoption is a person or household. It works poorly for systems whose unit of adoption is a city or a nation. A mini-grid can power a village but not a steel mill, and a pit latrine is not a sewer. Bypass also raises the intensity problem from Section 2: arrival through a thin, lower-capacity channel does not guarantee the depth of use enjoyed in the originating economies. The practical implication is that the unfinished inventory is partly a question of technology and partly a question of public finance and institutions, and that sequencing the two matters.

13. Lessons and the Next Test: What Diffusion Teaches About What Comes Next

The record of the past two centuries yields five regularities about how innovations travel. The newest general-purpose technology, artificial intelligence, offers the next test of them, and early data suggest it is diffusing faster at the level of arrival and at least as unevenly at the level of capability.

13.1 Five lessons from what has already spread

- **Diffusion follows structure more than age.** Technologies that individuals or households can adopt without public capital or large complements, such as phones and vaccines, spread fastest. Those that need networks and institutions, such as sanitation and grids, are slowest (Sections 3, 4 and 7).
- **Arrival is faster than depth.** Lags between invention and first adoption have shortened, but gaps in intensity of use persist and sometimes widen (Section 2; the data-use and urban–rural gaps in Section 7; the learning gap in Section 8).
- **Forms travel faster than functions.** Flags, constitutions, schools, corporate laws and bank accounts spread more completely than the practices that make them work (Sections 8 and 9).
- **Diffusion erodes the originator’s lead.** The more thoroughly an innovation spreads, the more the originator’s advantage dissolves into a shared platform, and learners become innovators (Sections 6 and 11).
- **“Already diffused” is a matter of degree.** On reach, three of eleven indicators exceed 85 per cent, six are between 70 and 85 per cent, and two are below 70 per cent (Figure 1). Claims that an innovation has “reached the world” should always be accompanied by a number.

13.2 What follows for decision-makers

These regularities have practical implications for four groups. **Governments in late-adopting economies** should prioritise the public-capital innovations that private adoption will not deliver, such as sanitation, grids and school quality, and should expect private-adoption technologies to arrive on their own. **Firms** that wish to sell into late-adopting markets should design for adaptation, since the winning form of an innovation is often a local variant. **Donors and development banks** should focus on the network goods and on the fragile contexts where bypass technologies cannot reach, rather than on technologies that markets already deliver. **Analysts and policymakers** should be sceptical of both extremes: neither “the West’s model is universal” nor “Western innovations are irrelevant to the rest” is supported by the evidence.

13.3 The next test: artificial intelligence

Generative artificial intelligence is the latest general-purpose technology, and the early evidence is a useful test of the five regularities. Microsoft’s AI Economy Institute estimates, in [Global AI Adoption in 2025](#), that 24.7 per cent of working-age people in the Global North and 14.1 per cent in the Global South used generative AI in the second half of 2025. Its [Q1 2026 update](#) puts the figures at 27.5 and 15.4 per cent, with a global rate of 17.8 per cent.

Two readings follow. At the level of arrival, the diffusion is very fast: the leader-to-laggard ratio is about 1.8 to one, against about 53 to one for the internet between high- and low-income countries in 2005 and about four to one in 2025 (Figure 15). AI products reach users through smartphones and the internet, which the earlier diffusions put in place, so it rides existing networks, as the first lesson predicts. At the level of depth, the picture is less encouraging. The absolute gap between North and South widened from 10.6 to 12.1 percentage points between the two reports, and the underlying capabilities, including computing capacity, data, skills and the ability to adapt models to local languages, remain concentrated. These data come from one company’s telemetry, and its North–South grouping differs from the World Bank’s income groups, so the figures are indicative and not definitive. They nonetheless suggest that the lag between invention and arrival is shorter than ever and that the intensity gap, the harder problem, has only just begun to show.

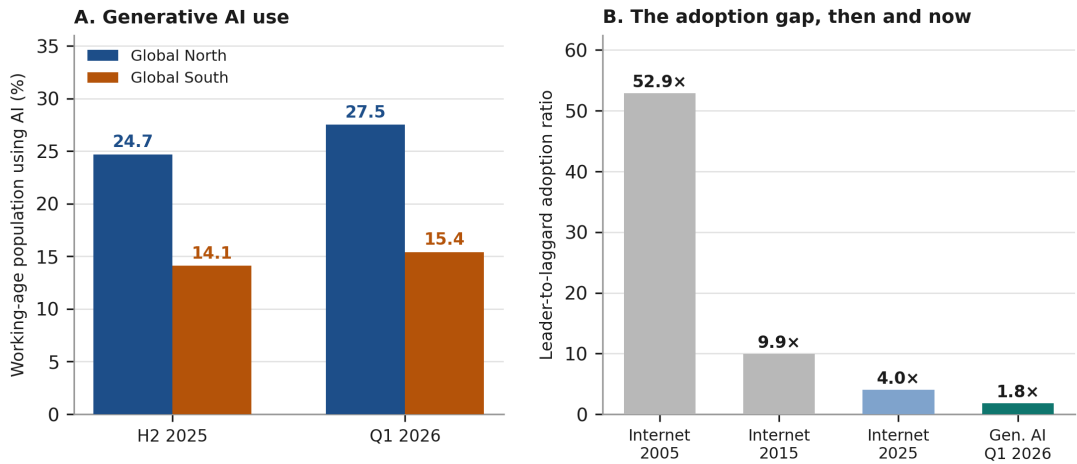


Figure 15. *The adoption gap, then and now: internet use and generative AI.*

Source: Microsoft AI Economy Institute, Global AI Adoption 2025 and AI Diffusion Report 2026 Q1 (share of working-age population using generative AI; Global North and Global South as defined by Microsoft); World Bank WDI IT.NET.USER.ZS for internet ratios (high-income vs low-income countries). Ratios compare different groupings and are indicative. H Heuristics analysis.

13.4 Summary scorecard

Table 10. Summary scorecard by domain

Domain	Headline evidence	Verdict
Health	Life expectancy 73 years (46 in 1950); DTP3 coverage 85%; smallpox eradicated	Substantial to near-complete; progress stalling
Energy and industry	92% with electricity; 666 million without (2023), mostly in sub-Saharan Africa	Near-complete; one regional gap
Food and agriculture	Cereal yields 4.2 t/ha (1.35 in 1961); Africa 1.7; 673 million hungry in 2024	Near-complete in form; uneven in intensity
Transport and trade	4.3 billion air passengers; 913 million TEU; 193 ICAO states	Near-complete
Information and communication	74% online; 112 mobile subscriptions per 100; 2.2 billion offline	Substantial; gaps in quality
State, law and education	193 states; literacy 88%; democracy in 49% of countries	Near-complete in form; partial in substance
Finance and standards	79% of adults with an account; 170 IFRS profiles; 1.3 billion unbanked	Substantial to near-complete
Language, sport and culture	About 1.5 billion English speakers; 211 FIFA members; 206 Olympic committees	Near-complete

Verdicts apply the four tests in Table 1. “Near-complete” means roughly 85 per cent or more of the relevant population; “substantial” means 70 to 85 per cent; “partial” means less.

13.5 Conclusion

The Western world’s innovations have already spread across the globe, in the sense that matters most: they now work, at scale, in societies with different histories and without the supervision of their originators. In most domains reach is above 70 per cent of humanity and in several above 90. The largest remaining shortfalls are in network goods that require public capital, and they cluster in one region. Meanwhile, the process has generated its own counter-currents, in mobile money, payments infrastructure and solar manufacturing, and its own successors in the next general-purpose technology.

The practical conclusion is to treat diffusion as a measurable, domain-by-domain variable and not as a story. For every innovation, the questions are the four in Table 1: how many people it reaches, in which places, with what local anchoring and how durably. Applied to what has already happened, they show a world that has absorbed most of what the West invented and has begun to invent in return. Applied to what is coming, they suggest where to look for gaps before they harden.

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Appendix A. Data Notes and Reproducibility

Every chart in this report was built from public series downloaded in October 2026. Table A1 lists the series, identifiers and latest years used, so that readers can reproduce or update each figure. Series identifiers beginning with letters and full stops are World Bank World Development Indicators codes; “OWID” denotes an Our World in Data dataset. Group aggregates (income groups and regions) are as defined and published by the source.

Table A1. Data series behind each figure

Figure	Series and identifiers	Source	Latest year
1	EG.ELC.ACCS.ZS; SH.H2O.BASW.ZS; SE.ADT.LITR.ZS; SH.IMM.IDPT; FX.OWN.TOTL.ZS; SE.SEC.ENRR (capped at 100); EG.CFT.ACCS.ZS; IT.NET.USER.ZS; SH.H2O.SMDW.ZS; SH.STA.SMSS.ZS; share of countries with electoral or liberal democracy	World Bank WDI ; OWID political regimes	2024–2025
2	Stylised logistic curves	H Heuristics illustration	n/a
3	US household technology adoption; years from first 10% to first 50% of households	OWID (Comin and Hobijn and others)	Up to 2019
4	Life expectancy at birth, world and regions	UN WPP 2024 via OWID	2023
5	Under-five mortality; SH.IMM.IDPT (DTP3)	OWID ; World Bank WDI	2024
6	EG.ELC.ACCS.ZS for world, regions and income groups	World Bank WDI	2024
7	Cereal yield (tonnes per hectare); AG.CON.FERT.ZS	OWID, from FAO ; World Bank WDI	2024; 2023
8	IS.AIR.PSGR; IS.SHP.GOOD.TU	World Bank WDI	2023; 2024
9	IT.NET.USER.ZS; IT.CEL.SETS.P2 (1995, 2015 and 2025)	World Bank WDI, from ITU	2025
10	UN membership at selected dates (51, 76, 99, 127, 154, 159, 189, 193); number of countries by regime type	United Nations ; OWID, from V-Dem	2011; 2024
11	World literate share; SE.SEC.ENRR	OWID ; World Bank WDI	2024
12	FX.OWN.TOTL.ZS (survey years 2011, 2014, 2017, 2021, 2024)	World Bank Global Findex	2024
13	IP.PAT.RESD (resident patent applications at national offices)	World Bank WDI, from WIPO	2024
14	Panel A: counts from JMP 2025, ITU 2025, Tracking SDG7 2025 and Global Findex 2025; panel B: WDI series as for Figure 1	JMP ; ITU ; Tracking SDG7	2023–2024
15	Share of working-age population using generative AI (Global North, Global South); IT.NET.USER.ZS for internet ratios	Microsoft AI Economy Institute ; World Bank WDI	H2 2025; Q1 2026

Latest years are as available in October 2026. Figure 2 is a stylised illustration and uses no data.