Executive Summary
World Intellectual Property Report

WIPO

Executive summary: Making innovation policy work for development

To bridge the gap between the poorest and richest countries, economists and policy makers need to address the question of how economies diversify. By building, diversifying and applying knowledge embodied in technology, economies can boost innovation and drive development. This report draws on original analysis and three case studies to explore how economies can successfully diversify their capabilities with the support of innovation policies.

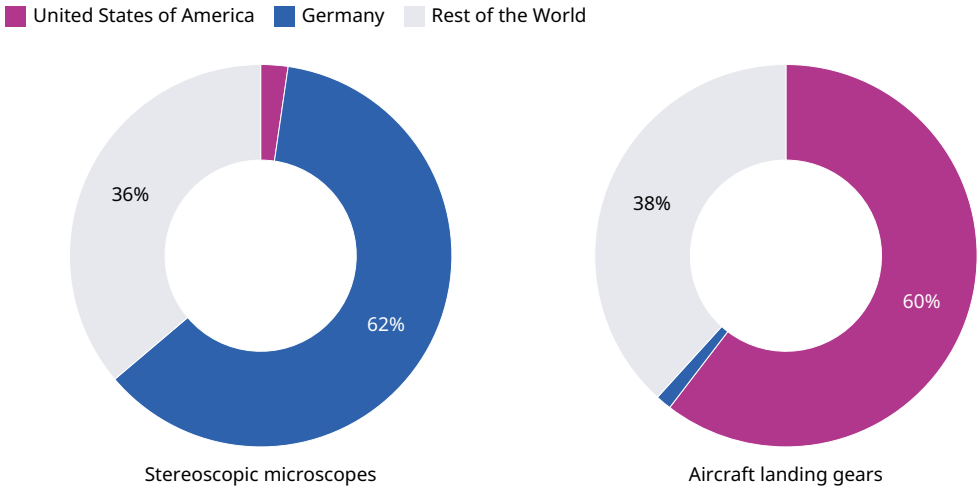
Knowledge is key

Knowledge is constantly increasing. Some of it is embodied in tools, machines or equipment; much more is codified through documentation, standardization and classification; while some knowledge remains tacit – that is, stuck in individuals' brains. Take the ICT industry, for example: knowledge starts as an idea in a researcher's head; some of that is shared through publications, speeches, patents or other means; and only a proportion ends up in devices such as computers, smartphones and autonomous vehicles. These products are easily traded internationally, but the knowledge and capabilities to produce them is not.

Because tacit knowledge cannot easily be transferred, it becomes concentrated in certain places, which means that particular regions or countries dominate certain sectors. To take just two examples of niche areas of expertise: in 2021 Germany exported 62 percent of the world's stereoscopic microscopes and the United States exported 60 percent of the world's aircraft landing gears.

Regions or countries can dominate certain sectors

Figure 1 Exporters of selected products in 2021



Note: For complete notes and sources, see Chapter 1, Figure 1.1.

Leveraging innovation capabilities

One way to promote economic development is through the application and adaptation of existing innovation capabilities. Innovation capabilities can be categorized into scientific, technological and production dimensions.

Innovation capabilities based on scientific, technological and production know-how in a particular country or region can be measured by studying the data on scientific publications, patent applications and international trade respectively. In this report, this data is broken down into more than 600 fields (grouped into 11 scientific domains, 14 technological domains and 15 production domains).

Innovation policy design has to rely on Big Data techniques

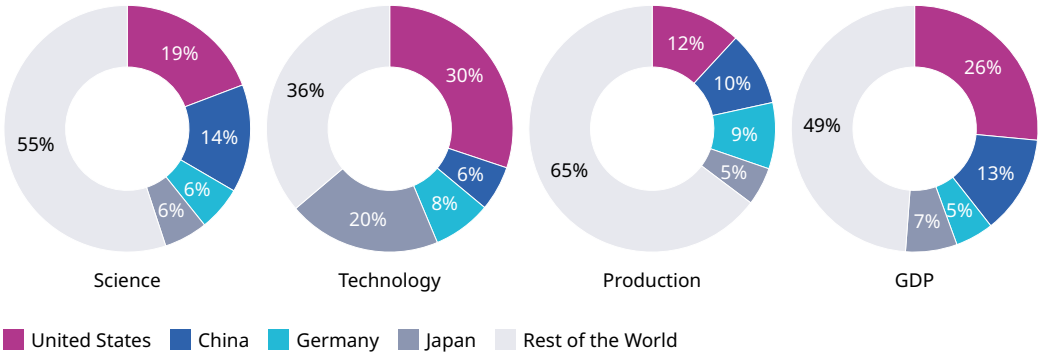
Figure 2 Millions of records used to map innovation capabilities in the World Intellectual Property Report 2024

Note: See Chapter 2.

Analysis of data from 154 countries reveals that innovative outcomes are highly concentrated. Over the past 20 years, for example, the top eight countries (5 percent of those analyzed) account for 50 percent of exports, 60 percent of scientific publications and 80 percent of international patenting.

Innovative outcomes are highly concentrated

Figure 3 Share of innovative outputs vs. GDP share, 2001-2020



Note: For complete notes and sources, see Chapter 2, Figure 2.1.

The top economies for scientific, technological and production capabilities are all high-income countries (such as the United States, France, Germany, Japan and the Republic of Korea) and/or large economies (such as China and India). However, income and size alone do not explain where countries stand. For example, Germany has a greater concentration of exports, scientific articles and patents than its share of GDP while Indonesia's share of exports is above its GDP share, but its share of scientific articles and international patents is substantially below.

Specialization and diversification

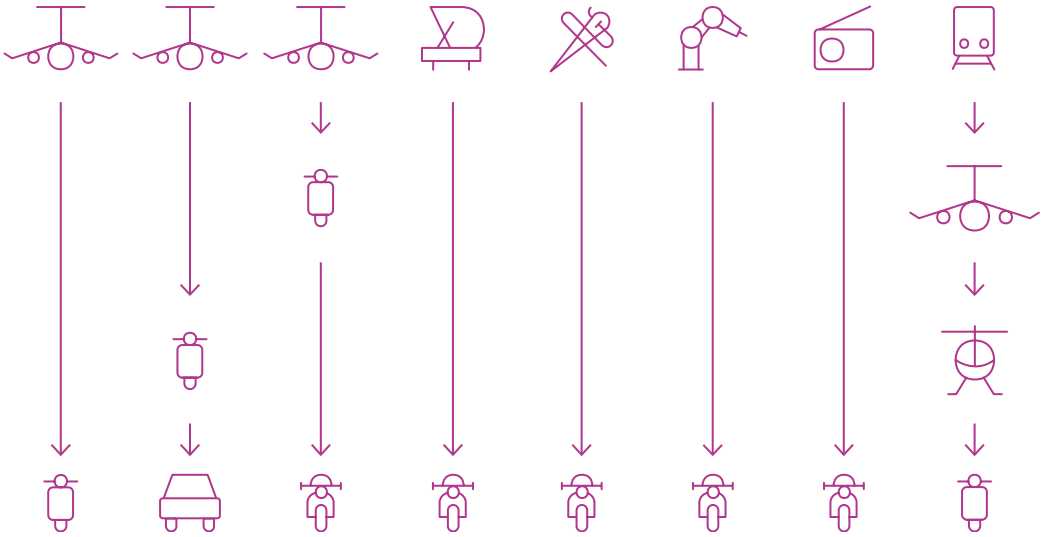
The concentration of knowledge leads to specialization in certain capabilities. By specializing in their existing strengths, countries and regions can achieve higher levels of productivity and innovation.

For instance, in the Emilia Romagna region in Italy, the proximity to iconic sport carmakers (such as Ferrari and Lamborghini) has allowed motorcycle firms (such as Ducati) to infuse racing

innovations into their designs. This has translated into improvements in engine, equipment, performance and other technological advances.

Many top motorcycle companies have emerged from related industries

Figure 4 **Motorcycle firms have built on capabilities to specialize over time**



Note: See Chapter 4.

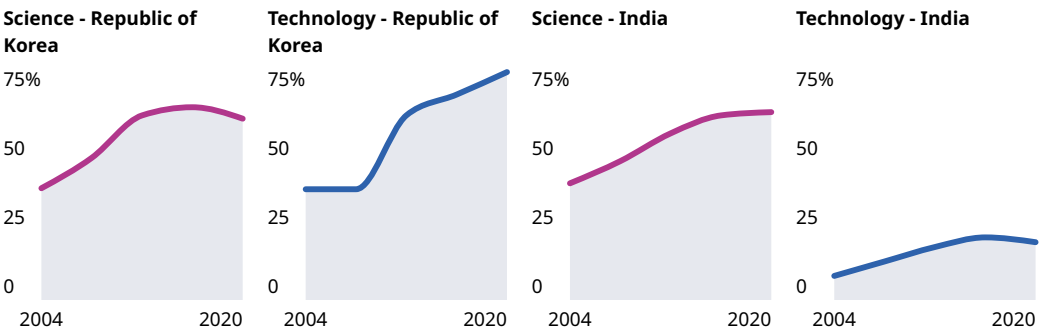
However, over-specialization can increase the vulnerability to external shocks, market volatility and value chain disruptions. That is why economies are constantly seeking to acquire or develop new specializations through diversification. For example, the Brazilian government introduced in 1975 a national program to produce ethanol from sugarcane production. This innovation policy allowed agribusinesses to quickly diversify out of coffee production and avoid the hit of a severe frost that disrupted the country's coffee industry.

Notably, diversification can be driven by combining existing capability specializations. One of the reasons why countries with a greater range of economic activity (typically but not always rich countries) tend to grow more quickly is that they can diversify more easily – especially into products that are less common.

Between 2001 and 2020, for example, the Republic of Korea jumped from being specialized in only 40 percent of all technological capabilities to being specialized in 83 percent. During the same period, its specialization in scientific capabilities increased from 40 percent to 66 percent. Similarly, the number of scientific and technological capabilities that India is specialized in jumped from 42 percent and nine percent to 68 percent and 21 percent respectively.

Diversification can be driven by combining existing capability specializations

Figure 5 **Share of scientific and technological capabilities, Republic of Korea and India, 2001-2020**



Note: For complete notes and sources, see Chapter 2, Figure 2.4.

As countries become more diversified, their capabilities become less common. For example, Afghanistan is specialized in only two capabilities (the production of spices and of fruit and nuts) which are very common, whereas Germany specializes in more than 500 capabilities, and on average less than 12 per cent of other countries specialize in these.

Innovation complexity

One way of addressing the diversification question is by considering innovation complexity. Innovation complexity is the knowledge in an economy as expressed in the diversity and sophistication of the science, technologies and products it produces.

Consider if an economy were like a group of musicians: the musical diversity and sophistication of the group will depend on the number of musicians, the diversity of instruments they can play and the proficiency of their performance. The complexity of an economy ranges from a one-person band to a sophisticated philharmonic orchestra.

A broad set of innovation capabilities leads to more sophisticated economic outputs. Complex capabilities are rare and only diversified innovation ecosystems can make use of them. The concept of innovation complexity therefore enables a better understanding of how moving to new and more complex industries while building on relevant existing capabilities can lead to sustainable development.

More diversified economies tend to have a more complex basket of capabilities
Figure 6 Republic of Korea and Egypt's innovation capabilities, 2017-2020

Share of capabilities	Republic of Korea	Egypt
Total	57%	21%
Scientific	66%	38%
↳ Biology, chemistry and engineering	75%	53%
Technological	93%	2%
↳ Audio-visual, semiconductors and ICTs	94%	0%
Production	37%	22%
↳ Food and minerals	17%	43%

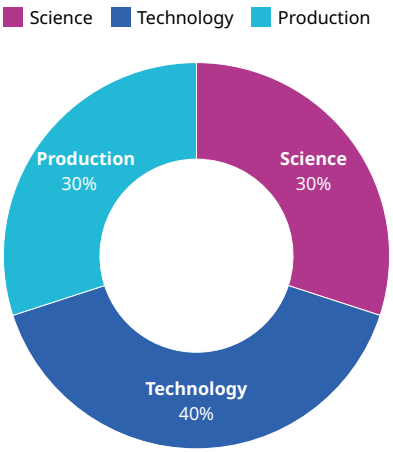
Note: For complete notes and sources, see Chapter 2, Figure 2.9.

Of the three types of innovation capabilities, technological capabilities are the most complex. Only a few very advanced economies that have diversified know-how can systematically generate technological capabilities. This can be seen by contrasting the Republic of Korea and Egypt. The former has a wide distribution of capabilities covering most domains and is specialized in all the fields related to semiconductors, ICTs and audiovisual technologies. The

latter is specialized in domains where complexity is lower, such as the production capabilities of producing agrifood, minerals and fuel, and to a certain extent manufacturing and chemicals and in the scientific capabilities related to chemistry, applied and fundamental biology and engineering; it has no particular specialization in any technological capabilities.

Technological capabilities are the most complex

Figure 7 Share of capabilities in the top 100 complex fields, 2017–2020



Note: For complete notes and sources, see Chapter 2, Figure 2.8.

In general, developed economies are both more diversified and more complex than less developed ones, and more likely to see higher growth. In short, economies grow by transforming their production structure from one dominated by low-tech, ubiquitous activities to one with rare outputs that are more reliant on skilled human capital.

Relatedness

Diversification is vital for growth. But what is the best way to diversify? The evidence suggests that diversification is more likely to happen incrementally as economies develop activities that have similar skills to those they already have.

Diversification favors activities that are more closely related to each other – this is known as the principle of relatedness. Countries looking to gain new capabilities should therefore identify where the most rewarding opportunities can be found, rather than trying to develop complex technologies without solid foundations. The principle of relatedness can also work in the opposite direction: countries can lose capabilities that are isolated from their related skills.

For this reason, countries and regions tend to specialize in technologies and products that are closely related to their past capabilities: think of Stuttgart in Germany (automotive technologies) and Silicon Valley (ICTs) and Boston (health technologies) in the US.

In general, the more related, unique and sophisticated capabilities that an innovation ecosystem has, the more complex technologies it will be able to develop. China, for example, gained incrementally complex technological capabilities between 2001 and 2020 in the ICT domain, particularly in speech or audio coding or decoding, electronic circuitry, electric elements for telecommunications, and computing methods and technologies.

Different forms of development

In the domain of agricultural technology, several regions have shifted away from traditional agricultural production by building on local innovative capabilities, leading to ethanol production in São Paulo in Brazil, the production of maize varieties for the African region in Nairobi, Kenya and the global export of crop biotechnology varieties and other agricultural technologies in Colorado, US.

New opportunities can be leveraged from existing capabilities

Figure 8 **The agriculture sector has sourced in new know-how that builds on existing capabilities**

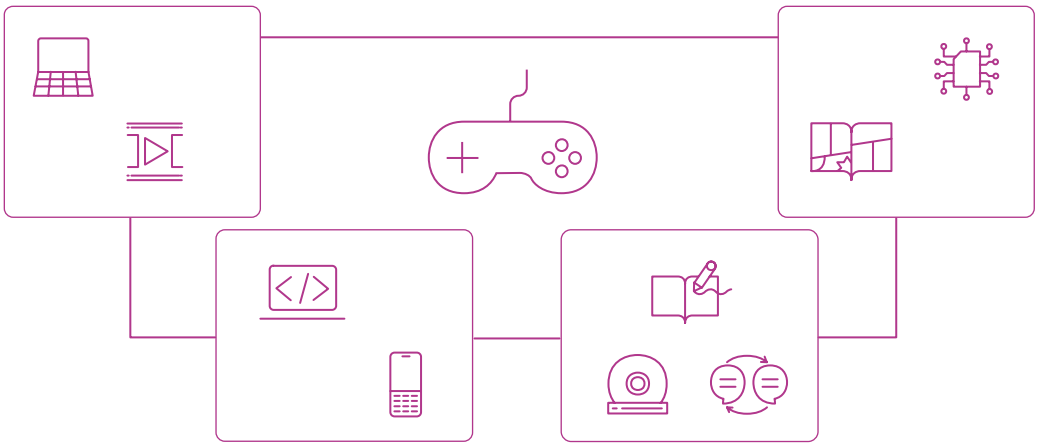
Note: See Chapter 3.

Similarly, the development of the motorcycle industry has been intrinsically tied to the capabilities cultivated in the closely related bike, aviation and automobile sectors. National motorcycle industries tend to chart courses shaped by their historical technological, institutional set-up and policy trajectories. In Italy, this has led to high performance and distinctive design; in Japan to advanced technologies and product reliability; and in India to cost efficiency and urban mobility features.

In some cases, new capabilities can develop based on several apparently unrelated existing capabilities. In the United States, for example, the video game industry was built on the robust computing sector combined with creative talent from Hollywood. Similarly, in Japan video games benefited from a strong electronic manufacturing base, which led to arcade games and later home console gaming, and artistic talent from the anime and manga industries. In Finland, teenage hobbyists led to the creation of the "demoscene," a subculture in which video game programmers and artists work together to create computer audiovisual demos despite limited hardware. The Polish videogame industry went to the next level by pairing game translation and distribution know-how with local literature and design talent.

New capabilities can develop from unrelated existing capabilities

Figure 9 **Video game capabilities developed from different pre-existing artistic capabilities**



Note: See Chapter 5.

Promoting industrial development

The concept of economic complexity and relatedness can help inform countries' industrial policy priorities: for example, advanced economies specializing in complex activities may be better able to diversify into other highly complex activities while less developed economies will only be able to diversify into less complex ones.

Science, technology and innovation (STI) ecosystems underpinned by solid innovation policies can promote investment in nascent technologies, which provide the foundation for future innovation and industrial development. Technological advances that benefitted from public funding, and which spawned new industries, include penicillin production, the Internet and autonomous vehicles.

In developing economies, a functioning STI ecosystem can also be instrumental in absorbing and adapting knowledge generated elsewhere. Universities and research institutes can lead the adaptation of new plant varieties and farming technologies to local conditions. Publicly funded research organizations have played a crucial role in the development of the pharmaceutical industry in India and the semiconductor industry in the Republic of Korea.

Government incentives to invest in innovation, such as R&D subsidies and tax credits and subsidized loans, as well as the intellectual property system, can incentivize the development of new technologies and production of innovative goods and services. Globally, most of the R&D in agriculture has been financed by the public sector. The Brazilian shift toward ethanol production, for example, was backed by public financial incentives for both the consumers as well as producers of ethanol.

Building an innovation ecosystem

The past few years have seen a revival of industrial policies, in response to challenges such as the global pandemic and climate change. For example, the European Green Deal of 2020 and the U.S. Inflation Reduction Act of 2022 provide incentives to promote the development and deployment of carbon-reducing technology. Many countries, including Italy and India in the case of motorcycles, are incentivizing the take-up of electric vehicles through subsidies and tax credits.

Analysis of economic complexity and relatedness can inform these policies by identifying missing links in the innovation ecosystem. For instance, it is possible to identify untapped technological potential by comparing scientific output and international patents, including through patent landscaping and other techniques. This can help policymakers to prioritize between domains and identify constraints in relations between academic institutions, industry and the IP system.

By managing innovation capabilities and mapping relatedness, countries can lay the foundations of long-term growth and competitiveness. Embracing principles such as complexity and smart specialization, as set out in the report, can help policymakers to make informed strategic decisions that deliver innovation, economic success and sustainability.

The 2024 edition of the *World Intellectual Property Report* introduces a new data-driven methodology designed to help policymakers make informed decisions by leveraging existing local innovation capabilities.

Complementing this framework are three case studies from the agriculture technology, motorcycle and video game industries. Spanning eight countries – Brazil, Finland, India, Italy, Japan, Kenya, Poland, and the US – the studies demonstrate how these countries have successfully boosted diversification within innovative and complex industries.

Combining economic analysis with in-depth industry studies, the report provides unique insights into how policymakers can harness and enhance existing industrial capabilities, to diversify and strengthen their national innovation ecosystems.

 / WIPO Reference 944/24/ExSum/EN; DOI:10.34667/tind.49284

WIPO
WORLD
INTELLECTUAL PROPERTY
ORGANIZATION

wipo.int