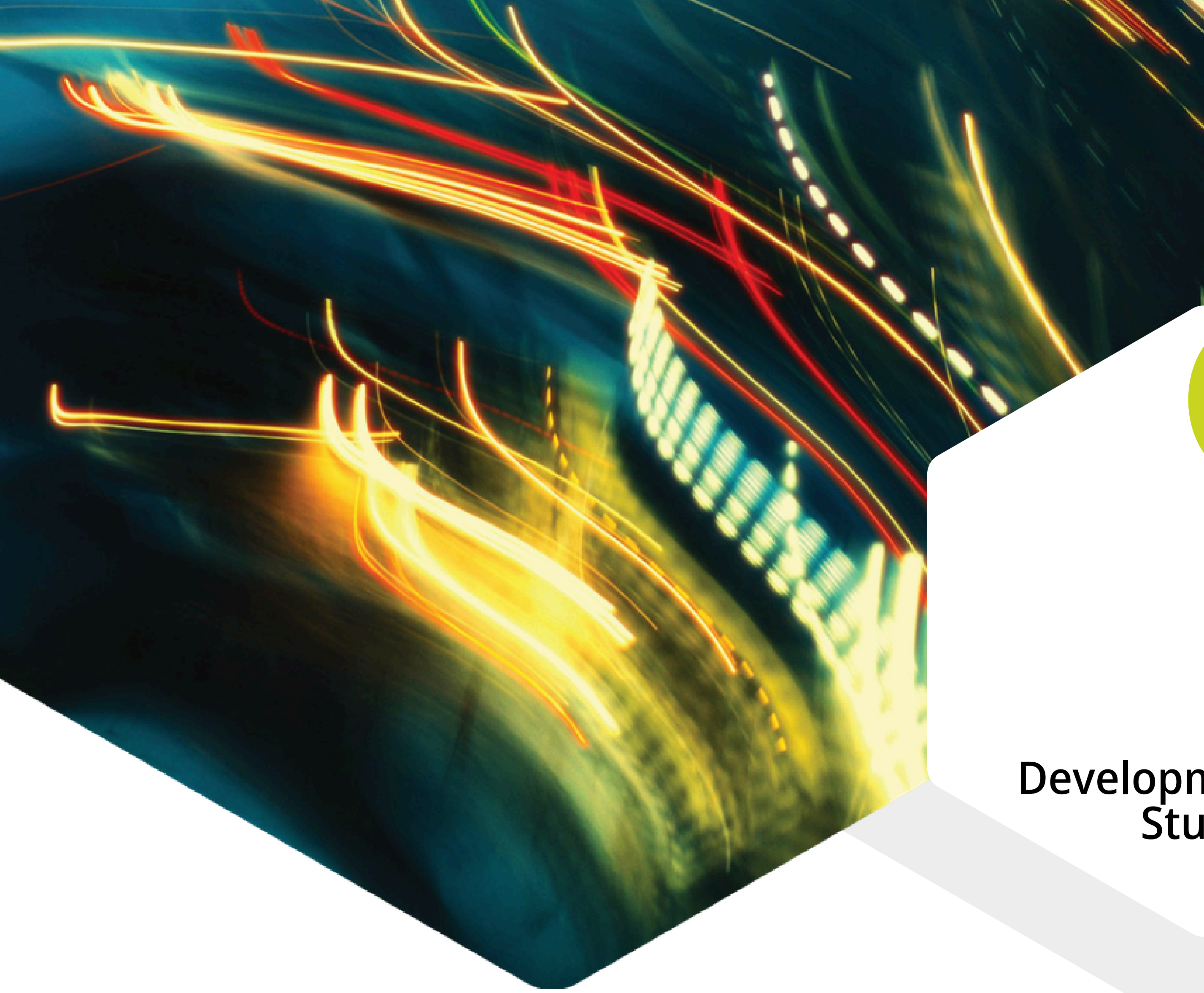


Development Studies

Assessing the Innovation Capabilities of Indonesia

Innovation Capabilities

WIPO

Assessing the Innovation Capabilities of Indonesia

Innovation Capabilities

Recent years have seen a global resurgence in industrial policies, driven by challenges like climate change, supply chain issues, and national security concerns. These policies reflect governments' expectations about beneficial industrial activities and involve strategic scientific and technological choices that shape innovation by directing resources and incentives.

However, determining which areas to prioritize is not straightforward. Innovation ecosystems vary greatly in terms of the diversity and complexity of their knowledge. Those that can successfully identify their innovation capabilities are able to focus their industrial policies on developing, nurturing, and maintaining competitive capabilities.

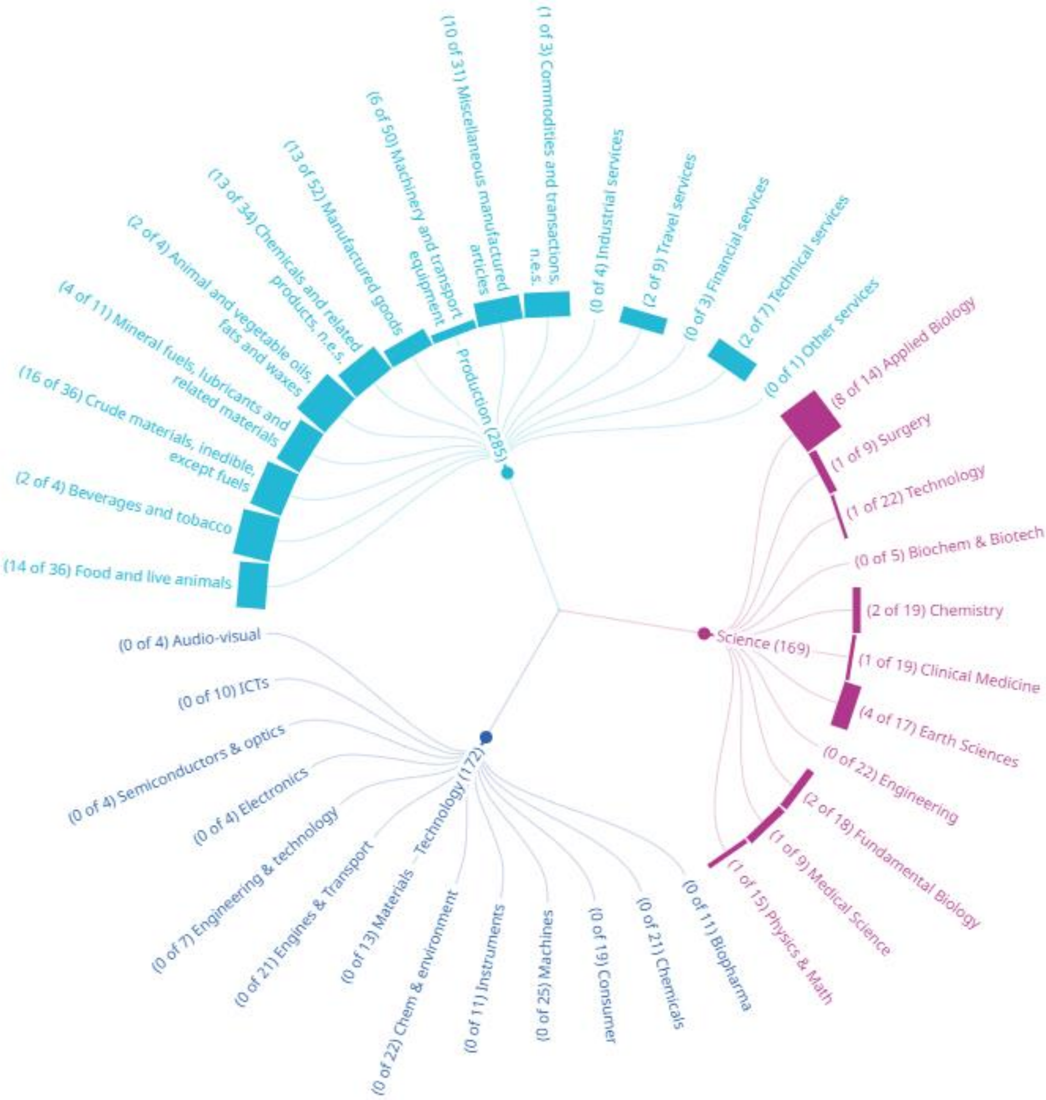
This study of Indonesia’s innovation capabilities assesses the state of the country’s know-how and aims at offering strategic advice to strengthen its innovation ecosystem and encourage collaboration amongst stakeholders. It is meant to be an input for the Committee on Development of IP (CDIP) project 26/4: “Systematization of statistical data and the design and implementation of a methodology for developing impact assessments on the use of the intellectual property system”.

Indonesia has 106 out of 626 innovation capabilities.

Figure 1A – Indonesia's innovation outputs across 3 dimensions of innovation, 4-year period.

Dimension	Outputs	Unit	Trend	Rank	Share (%)
Production	705	Billion USD in exports		31	0.88
Science	28,740	Scientific publications		53	0.14
Technology	2584	International patents		49	0.04

Figure 1B – Figure 1B – Indonesia's innovation capabilities across 3 dimensions of innovation, 39 domains, and 626 fields.



INDONESIAN INNOVATION CAPABILITIES

Innovation ecosystems thrive on fostering robust interactions among their scientific, technological, and productive stakeholders. Innovation capabilities represent the **ability of an ecosystem to deliver competitive outputs** in a certain field of the innovation process. This study maps 626 innovation capabilities coming from 11, 13 and 15 scientific, technological and production domains, respectively. These capabilities are matched to more than 150 WIPO member states.

The **World IP Report 2024** shows that innovative outcomes are highly concentrated in just a few countries. Over the past 20 years, the top eight countries account for 50 percent of exports, 60 percent of scientific publications and 80 percent of international patenting.

Indonesia **represents 1.26% of the global GDP, however**, as seen in Figure 1A, **it's share is significantly lower for all innovative outputs.** Namely, it contributes 0.88% to global exports, 0.14% scientific articles in international peer-reviewed journals and 0.04% international patent applications[1].

The higher participation in the first of the three dimensions makes the country a **significant global player in 50 production fields**; led, in terms of global share by fixed vegetable fats and oils (0.10% of world's exports), coal (0.09%), natural gas (0.04%), and footwear (0.02%).

However, **in relative terms, the country has specialized in 56 other fields**, meaning that its outputs in those fields are high, relative to what the rest of the world produces. This is the case for materials science, paper and wood (6.6 times the average country share), tropical medicine (×5.7), forestry (×4.9), motorcycles (×4.1), fisheries (×3.6), and parasitology (×3.0), amongst others.

As a result, **Indonesia has 106 of 626 innovation capabilities** (Figure 1B). Most (85) come from production domains, leaving the remaining (21) to science. The lack of technological capabilities is reflected in the overall low contributions in every technological field. For instance, Indonesia's largest contribution in this dimension is found in medical or veterinary pharmaceuticals, with 437 inventions in the last 4 years.

[1] See definition in Annex.

As a comparison, countries that have capabilities in this field have over 8.000 inventions in the same period.

How can these capabilities help decision makers? Identifying the regions knowledge is the first step to assess its position in the global innovation network. This information is crucial to find strategic paths that unlock their innovative potential.

WHO SHARES CAPABILITIES WITH INDONESIA?

As countries become more diversified in general their capabilities become less common across other countries. This is portrayed on Figure 2A. Germany, for instance, is specialized in more than 500 capabilities, and on average less than 22 other countries can compete on these capabilities. On the other end, Afghanistan is specialized in just two capabilities – fruit and nuts, and spices – which are very common, as around 40 countries are also specialized in them. **Indonesia's innovation capabilities are not as common, as, on average, they are found in 27 countries**.

These 27 countries are not always the same. **The countries that have the most similar capabilities are found in Asia and Latin America**, led by Vietnam (proximity of 0.39), Chile (0.38), Colombia (0.35), Thailand (0.35), and Peru (0.33).

Figure 2B shows that **Indonesia's capabilities also differ in term of their rarity, ranging from the most common (mycology), present in 67 other countries, to jute, present in only 6**. Additionally, almost all (99.5%) capabilities are present in countries that are more diversified than Indonesia (above the dotted line). Medical Chemistry, for instance, is a scientific capability that tends to appear in countries that have 250 other capabilities, while tropical medicine (125) and natural gums (70) can appear in countries that are less diversified, with the latter being below Indonesia's current diversity.

The overall trend of Figure 2B implies that **as capabilities get rarer, they appear in more diversified countries**. Is it desirable to [further] develop these rare capabilities? For instance, an innovation capability might be scarce because demand is low and thus the incentives to develop them are low. Likewise, there may be widespread capabilities, the rewards of which are high enough to motivate their development in an ecosystem, even at a high cost. Complexity indicators aim to solve this issue.

Indonesian capabilities are, on average, found in 27 other countries.

Figure 2A – Number of capabilities (diversity) of innovation ecosystems and average capability rareness (ubiquity)[2].

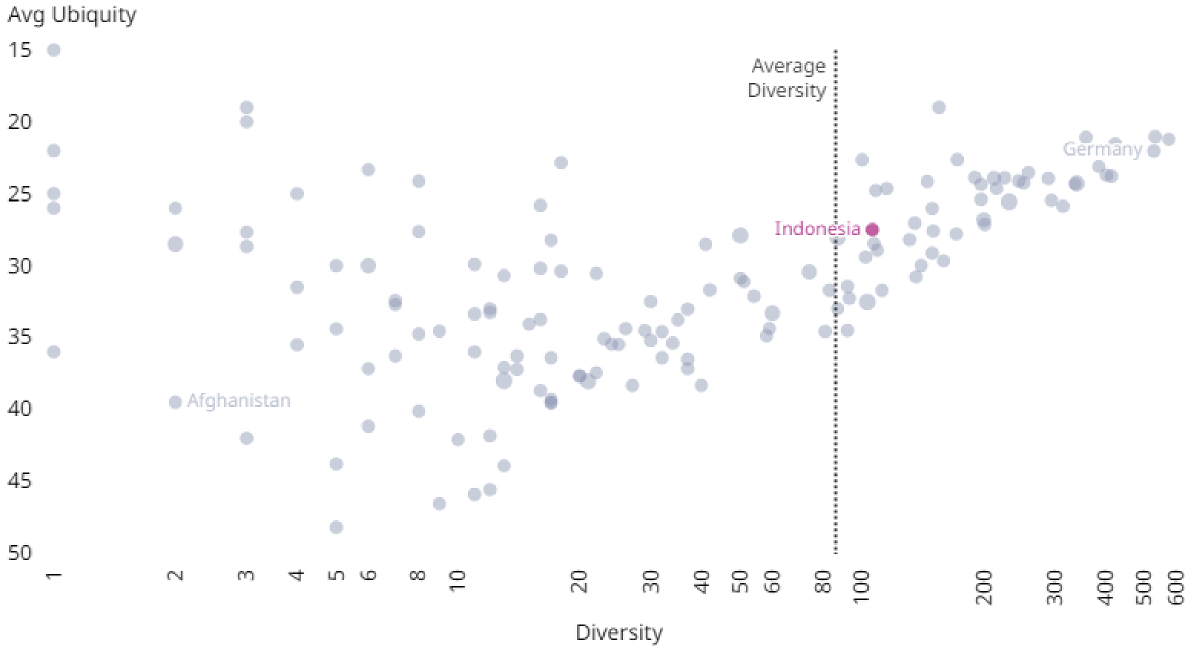
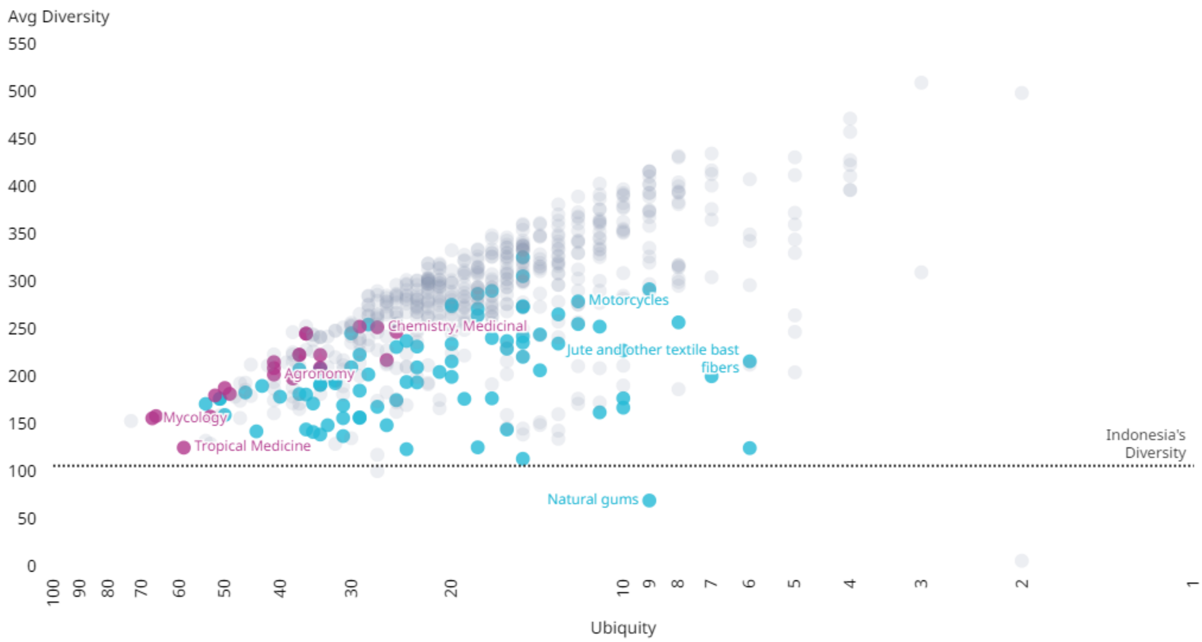


Figure 2B – Capability rareness (ubiquity) and average diversity of innovation ecosystems that have them.



HOW REWARDING ARE INDONESIAN CAPABILITIES?

Innovation **complexity indicators capture the amount and sophistication of know-how** required to generate an outcome in each field. It is calculated based on how many

[2] See definitions in Annex.

other countries can generate outcomes in that field and the complexity of those ecosystems.

Economies attaining technologically **complex production structures typically see higher economic performance**. However, attaining these rewarding capabilities is not a simple task. The most complex fields often require to be nurtured by complementary knowledge to be sustainable over time.

Figure 3 shows the distribution of the complexity of all innovation capabilities, comparing the Republic of Korea with Indonesia. Republic of Korea shows a wide set of capabilities that covers most of the domains, including the most complex ones. It is specialized in all fields related to semiconductors, ICTs and audiovisual technologies.

In contrast, **Indonesia's current capabilities lie on the lower end of the complexity spectrum**. This means that most of the know-how currently based in the region is widespread and tends to require less complementary know-how to be sustained. Some notable mentions for the country's most rewarding skills are printing machineries (rank 191th of 626), nitrogen function compounds (239th), musical instruments (321th), material science (paper and wood) (390th), physical geography (404th), and oceanography (414th).

The innovation complexity helps to benchmark the current capabilities of an ecosystem. However, these are not set in stone**: when ecosystems gain and lose capabilities, their complexity levels change**. How can stakeholders of ecosystems choose which capabilities to pursue? Its current capabilities can indicate which capabilities are safer to pursue relative to others, and the complexity of these targets can help measure the potential rewards of these decisions.

Indonesia's innovation capabilities are low complex production and science based.

Figure 3 – Innovation capabilities ranked by complexity, grouped by domains.

Dimension
Science
Technology
Production
Unattained
Indonesia
Republic of Korea
Applied Biology
Surgery
Technology
Biochem & Biotech
Chemistry
Clinical Medicine
Earth Sciences
Engineering
Fundamental Biology
Medical Science
Physics & Math
Electronics
Engineering & technology
Machines
Engines & Transport
Consumer
Audio-visual
ICTs
Semiconductors & optics
Instruments
Biopharma
Chemicals
Materials
Chem & environment
Food and live animals
Beverages and tobacco
Crude materials, inedibl...
Mineral fuels, lubricants ...
Animal and vegetable oil...
Chemicals and related pr...
Manufactured goods
Machinery and transport...
Miscellaneous manufact...
Commodities and transa...
Industrial services
Travel services
Financial services
Technical services
Other services
600
500
400
300
200
100
1
Complexity ranking

WHICH ARE INDONESIA'S OPPORTUNITIES?

The principle of relatedness states that economies tend to diversify incrementally, moving into activities that have similar skills to those they currently possess. Consequently, **Indonesian opportunities to increase complexity lie mostly in scientific and production domains**.

Why isn't combinatorial technology an opportunity? The relatedness of Indonesia to it is too low. Windows of **opportunities to leapfrog into unrelated knowledge are often too narrow and risky**. This is because ecosystems often lose those capabilities that are isolated from their related skills.

Combining relatedness and complexity indicators (seen in Figure 4A) helps innovation ecosystems such as Indonesia measure risks and rewards and decide their diversification paths. **High relatedness relates to lower risks of adoption, while higher complexity points towards higher rewards**. For the country, this means consolidating its current capabilities and looking for new ones by partnering with other ecosystems.

The average relatedness of a country to an attained field of innovation is close to 45%. This means that when a country has a skill, it often has about half of its related knowledge. However, countries manage to gain capabilities with a wide range of relatedness.

Indonesia's average relatedness to its current capabilities is around 19%, ranging from 14% to 48%. Most of the capabilities of the country (95 of 106) are lowly connected to related knowledge, hence, the fragility of their status points to a need to nurture them avoid their disappearance. Some notable exceptions of established capabilities are coffee, tea, tobacco, tropical medicine, rubber, nickel ores, copper ores, vegetable oils, and natural gas.

The smart diversification strategy points to **opportunities to develop new capabilities that will increase the country's complexity**, and where the relatedness density of the country is high enough to consider that the risk of pursuing them is relatively low (countries with similar relatedness have managed to attain it). These can be identified in the upper right quadrants of Figure 4A and exemplified as a list in Figure 4B.

Indonesia's relatedness is often higher for low complex fields. This is why its opportunities mostly appear in scientific and production fields that rank low on the complexity spectrum.

Additionally, Figure 4B shows for each opportunity the countries that obtained each capability and have compatible knowledge sets to Indonesia. **The most frequent possible partners are Chile, Vietnam, Thailand, Serbia and Colombia**. However, for some of these countries the capabilities might be fragile, indicating that they may disappear there in the future. The same opportunities can be found in countries where the capability is solidified, and this is the case for **Spain, India, Portugal, Brazil, and South Africa**, amongst others.

Most opportunities to increase complexity remain in science and production

Figure 4A – Complexity and relatedness mapping for Indonesia's unattained capabilities.

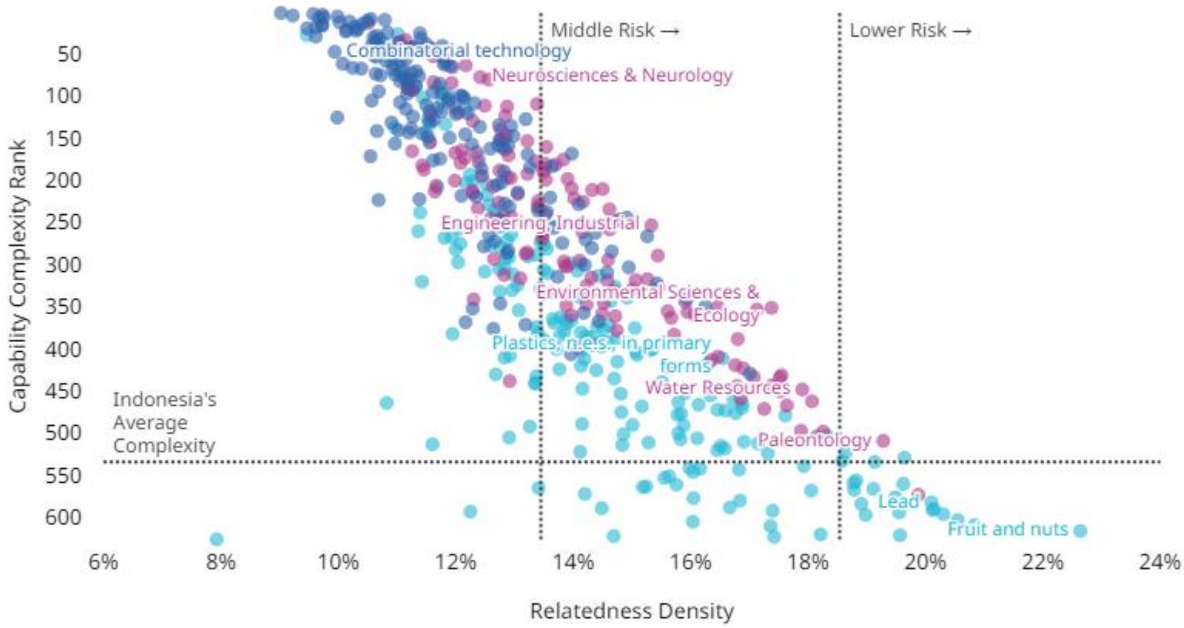


Figure 4B – List of top 10 opportunities for Indonesia, sorted by relatedness.

Domain	Field	Rel. Density	Rank (of 626)	Best Match	Safe Match
Manufactured goods	Metal containers for storage or transport	19.64%	529	Chile	Thailand
Earth Sciences	Paleontology	19.28%	509	Chile	South Africa
Food and live animals	Meat and edible meat offal	19.14%	534	Thailand	Thailand
Mineral fuels, lubricants and related materials	Petroleum oils and oils from bituminous minerals	18.64%	523	Colombia	Malaysia
Manufactured goods	Furskins, tanned or dressed	18.58%	533	Vietnam	Thailand
Food and live animals	Milk and cream and milk products other than butter or cheese	18.32%	503	Peru	South Africa
Applied Biology	Entomology	18.26%	498	Chile	South Africa
Technology	Logic	18.15%	504	Colombia	South Africa
Earth Sciences	Astronomy & Astrophysics	18.07%	462	Chile	Portugal
Earth Sciences	Water Resources	17.9%	448	Vietnam	Portugal

NATIONAL INNOVATION POTENTIAL

National and regional innovation policies can also exploit the relatedness between capabilities of different dimensions. Indeed, ecosystems are specialized in very different areas when it comes to trade, patents, and scientific publications. These connections, illustrated in Figure 5A, can shed light on the untapped innovative potential.

For example, with its scientific output, Sweden produces around half as many patents per year in electronics and chemicals compared to the average developed economy. In contrast, with the same scientific output, the European country manages to reach its potential patents for instruments, biopharma, and engines, and even greatly surpass it for ICTs.

In the case of Indonesia, the technological potential based on production is high for all technological domains. The scientific potential is relatively lower, but still points in the same direction. In other words, **the country is finding it hard to leverage its productive and scientific know-how into technologies**. In ICTs, instruments, and electronics, for instance, the country's productive and scientific activities should generate at least 3 times the number of patents that Indonesia currently has.

Notably, **the biopharma technological domain has the highest of all potentials, with between 171 and 1118 yearly extra patents** based on scientific and production activities, respectively. Indeed, there is untapped scientific activity potential based mostly on science, but also on production, that could be reached by improving the connections between the actors of the innovation ecosystem.

Science, in the Indonesian case, is better connected to technological advancements than production. Figure 5B summarizes these potentials by comparing them with the total actual patents of the ecosystem. The analysis reveals a significant innovation gap: Indonesia's current patent output represents only 8% of what should be expected given its production capabilities. While the country performs better in translating scientific activity into patents—achieving 38% of its science-based potential—substantial room for improvement remains in both areas.

Indonesia's science and production points towards potential technological inventions

Figure 5A – Yearly technological outputs vs. untapped potential. Comparison between Sweden and Indonesia

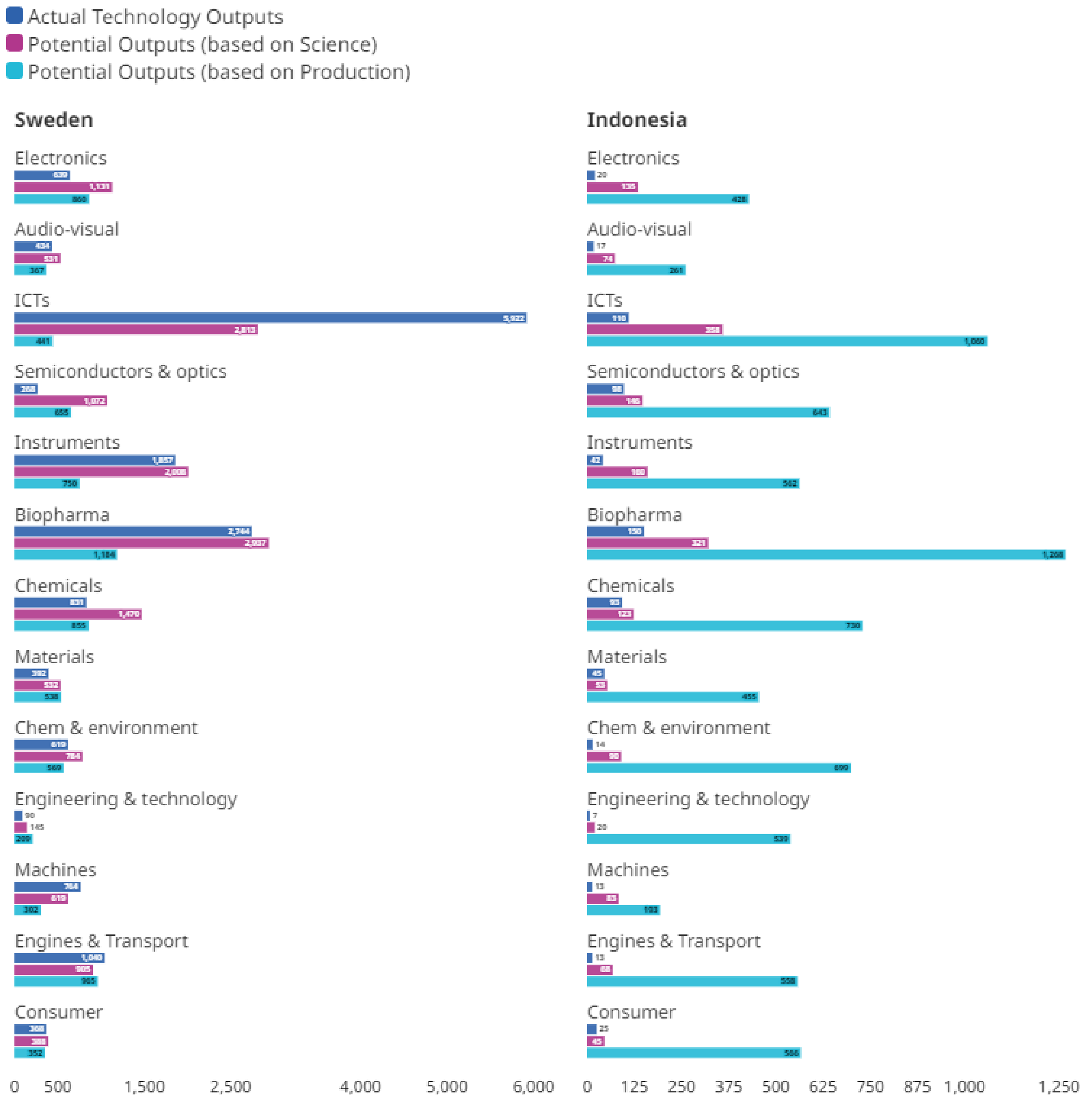


Figure 5B – Summary of Indonesian untapped potential

Units	Actual Outputs	Innovative Potential	Potential	Achieved Potential (%)	
Patents	646	Production based	7963	8	92
Patents	646	Scientific based	1676	38	62

Achieved (%) Untapped (%)

CONCLUSIONS

In conclusion, the resurgence of industrial policies globally underscores the need for strategic choices in scientific and technological fields. This direction shapes innovation by channeling resources and incentives into beneficial industrial activities. The study of Indonesia's innovation capabilities highlights the current state and potential for growth of the innovation ecosystem. The country shows a **range of low complex, ubiquitous production and scientific capabilities**, with almost no presence in technological domains.

The country's path to enhancing its innovation potential lies in **smart diversification strategies**, leveraging related fields of knowledge to build on existing capabilities while mitigating risks. The country's untapped technological potential, particularly in translating productive activities into technological advancements, presents a critical area for growth.

Three key takeaways from Indonesia's innovation complexity study are:

1. **Complexity**. The innovation ecosystem ranks above the middle of the complexity spectrum. Countries with similar sets of innovation capabilities can be found in Asia (Vietnam and Thailand) and Latin America (Chile, Colombia, and Peru).

2. **Opportunities**. The need for diversification is high, as 90% of Indonesian capabilities are not surrounded by the complementary knowledge needed for sustainable advancement. Opportunities to increase complexity with relative low risk can be found in the domains of manufactured goods, biology, and earth sciences. Most of these opportunities are related to science and production, and the know-how to obtain them can be found in Spain, India, Portugal, Brazil, and South Africa.

3. **Potential**. The Indonesian untapped technological potential is high across the board. Based only on the region's scientific outputs, there could be over 1.000 additional yearly patents coming from the country. The potential based on production is even higher, with around yearly 7.000 more patents coming from Indonesian inventors.

ANNEX

Definitions

Scientific publication data

Scientific progress, the bedrock of human knowledge, is reflected in international scientific publications. The study uses data on scientific articles published in internationally recognized academic journals and compiled in the Web of Science, Science Citation Index Expanded (WoS SCIE) collection, which are grouped into 169 distinct scientific subjects serving as scientific fields. These fields are grouped into 11 scientific domains. Countries are assigned scientific publications based on the university affiliation address. Fields in the social sciences and humanities were excluded from the analysis.

International patent data

Technological advancement is encapsulated in international patent family data sourced by combining WIPO patent databases and the European Patent Office's (EPO) PATSTAT. The study applies the definition of international patent families, which considers the first filings of those patent families that have sought protection in a country other than the applicant's country of origin. Patent data are grouped into 172 technology fields according to the international patent classification (IPC). Inventors' addresses provide the information to assign a country. These technology fields are grouped into 14 technological domains.

International trade data

Product innovation can find its expression in international manufactured exports. Products that are competing in the international market have assured a certain degree of competitiveness that can be related to an innovative product. We have used the UN COMTRADE database to trace the global journey of 274 distinct product fields for all countries and years. These fields are grouped into 15 production domains.

Innovation capabilities

Innovation capabilities are the scientific, technological and production know-how – tacit or codifiable – that exist in each country or region. They essentially represent the ability of a country to deliver competitive outputs in a certain field of the innovation process. In many cases, outputs include the skills and knowledge embedded in tools, procedures or computer codes that can be easily shared or shipped around the world. However, quite often they are tacit, meaning they are embedded in individuals and are not readily codifiable and hence not easily transferrable.

Country's specialization and diversification

This relates to the number of capabilities in which an economy specializes. The more innovation capabilities in which a country specializes, the more diversified is that country. Conversely, the fewer the innovation capabilities in which a country specializes, the more specialized is that country.

Capability ubiquity and rareness

This represents how many economies specialize in each scientific, technological and production field (i.e., capability). The more countries that specialize in a given capability, the more that capability is ubiquitous. Conversely, the fewer the countries that specialize in a given capability, the rarer that capability.

Capabilities proximity

This represents the connectedness between any pair of scientific, technological and production fields (i.e., capabilities). For any given pair of fields, proximity represents the probability that an average country will specialize in both fields at the same moment in time. It is based on the statistically significant co-occurrences of two capabilities in all countries.

Innovation complexity (capabilities)

This captures the amount and sophistication of know-how required to generate an outcome in each field (innovation capability). It ranks the diversity and sophistication of the know-how required to generate each field and is calculated based on how many other countries can generate outcomes in that field and the complexity of those countries. In effect, it captures the amount and sophistication of know-how required to generate an innovative outcome.

Innovation complexity (countries)

This captures the amount and sophistication of innovation know-how embedded in a country. It ranks a country based on how complex are its innovation capabilities.

Countries that are home to a great diversity of know-how, particularly complex specialized know-how, can generate a great diversity of sophisticated innovation outcomes (i.e., science, technologies, and products). High complexity countries specialize – in absolute or relative terms – in the most complex innovation capabilities.

Relatedness density (country)

This measures a country's ability to enter a specific field. It provides a distance (from 0 to 1) capturing the extent of a country's existing capabilities to generate outcomes in this field, and measures how close that field is to the country's current innovation outcomes. Moving to a "nearby" field has a greater likelihood of success, as it has more of the required related capabilities. Relatedness density measures the probability that a country generates outcomes in capability A given that it has a set of capabilities. Relatedness formalizes the intuitive idea that the ability to generate outcomes in scientific, technological or production fields can be revealed by looking at which other capability outcomes it can generate. Current capabilities can indicate where to go next. This is known as the principle of relatedness. Economies tend to diversify incrementally, moving into activities that have skills similar to the ones they currently possess.

Untapped innovation potential

This refers to potential output in a capability given the current outcome on related capabilities. It is calculated using the proximity connections between scientific, technological and production capabilities in the economies from cluster 1 in WIPR 2024, Figure 2.6 (i.e., a selection of advanced innovation ecosystems). These proximities are used to estimate the transformation weights of outputs from scientific capabilities to outputs from the technological capabilities depicted in WIPR 2024, Figure 2.16.

World Intellectual Property Organization 34, chemin des Colombettes, P.O. Box 18 CH-1211 Geneva 20, Switzerland

Suggested citation: WIPO (2026). "Assessing the Innovation Capabilities of Indonesia", Development Studies Series. World Intellectual Property Organization, Geneva, Switzerland. https://doi.org/10.34667/tind.60158

The publication was prepared by the Innovation Economics Section, with contributions from Federico Moscatelli and Clément Sternberger, under the direction of Julio Raffo.

Cover: Getty Images / wigglestick – MicrovOn