Innovation Capabilities

Introduction to concepts of smart diversification

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Innovation Ecosystems group highly specialized individuals to produce sophisticated outputs

Source: Harvard Growth Lab, WIPO

Main indicators

How can Innovation Capabilities inform policy?

Innovation Capabilities

The **ability** of an innovation ecosystem to **deliver competitive outputs** in a certain field of innovation.

Identified by **specialization** patterns:

- **Absolute**: being a leader in a field.
- **Relative**: having a high participation, compared to the world average.

Usually measured as a **binary** variable.

Types of indicators

Based on what they describe

Characteristics of:

- Innovation Ecosystems
- Innovation Capabilities

Relationships between:

- Ecosystems and Capabilities
- Different Ecosystems
- Different Capabilities

Main indicators for Ecosystems (1)

Diversity

Measures **the number of innovation capabilities an ecosystem masters**.

Ecosystem	Share of fields	Rank
Honduras	4%	4th
Mexico	27%	2nd
Canada	**54%**	**1st**
Singapore	24%	3rd

Canada has 54% of all innovation capabilities, the highest amongst all selected ecosystems…

Main indicators for Ecosystems (2)

Average Ubiquity

Reflects **how common are the capabilities** of an innovation ecosystem.

Ecosystem	Share of ecosystems	Rank
Honduras	70%	4th
Mexico	50%	3rd
Canada	35%	2nd
Singapore	**30%**	**1st**

… however, Singapore's capabilities are the rarest across all selected innovation ecosystems.

Main indicators for Capabilities (1)

Ubiquity

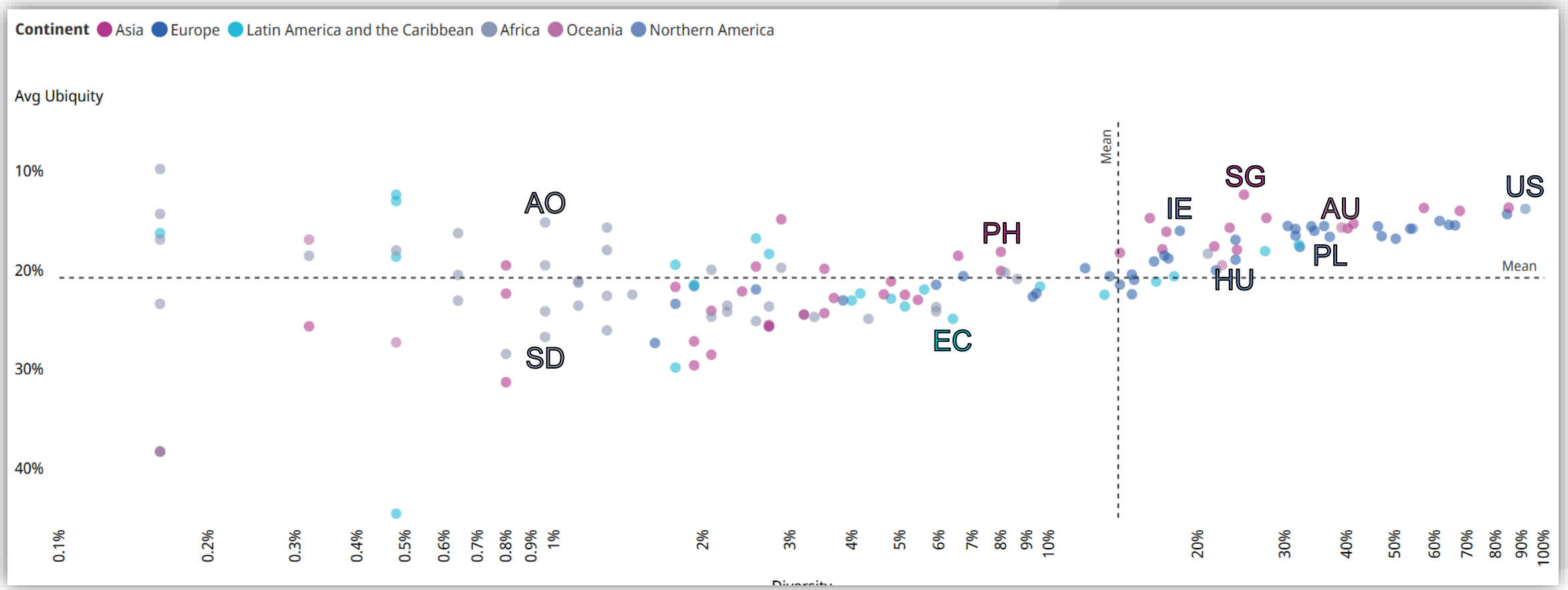
Indicates **how common a capability is** across innovation ecosystems.

Capability	Share of Ecosystems	Rank
Coffee	21%	4th
Cork	**3%**	**1st**
Optics	5%	2nd
Nanosicence	5%	2nd

Cork is the rarest capability that an ecosystem can master…

Diversity vs. ubiquity by national ecosystems

Based on capabilities co-occurrence of 626 scientific, technological and product fields, 2020.



Source: WOS SCIE, EPO PATSTAT, UN COMTRADE • 626 innovation capabilities based on scientific fields, IPC subclasses and product classification in scientific publications, international patent applications and exports data. Income levels follow the World Bank's classification of economies by income.

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Main indicators for Capabilities (2)

Average Diversity

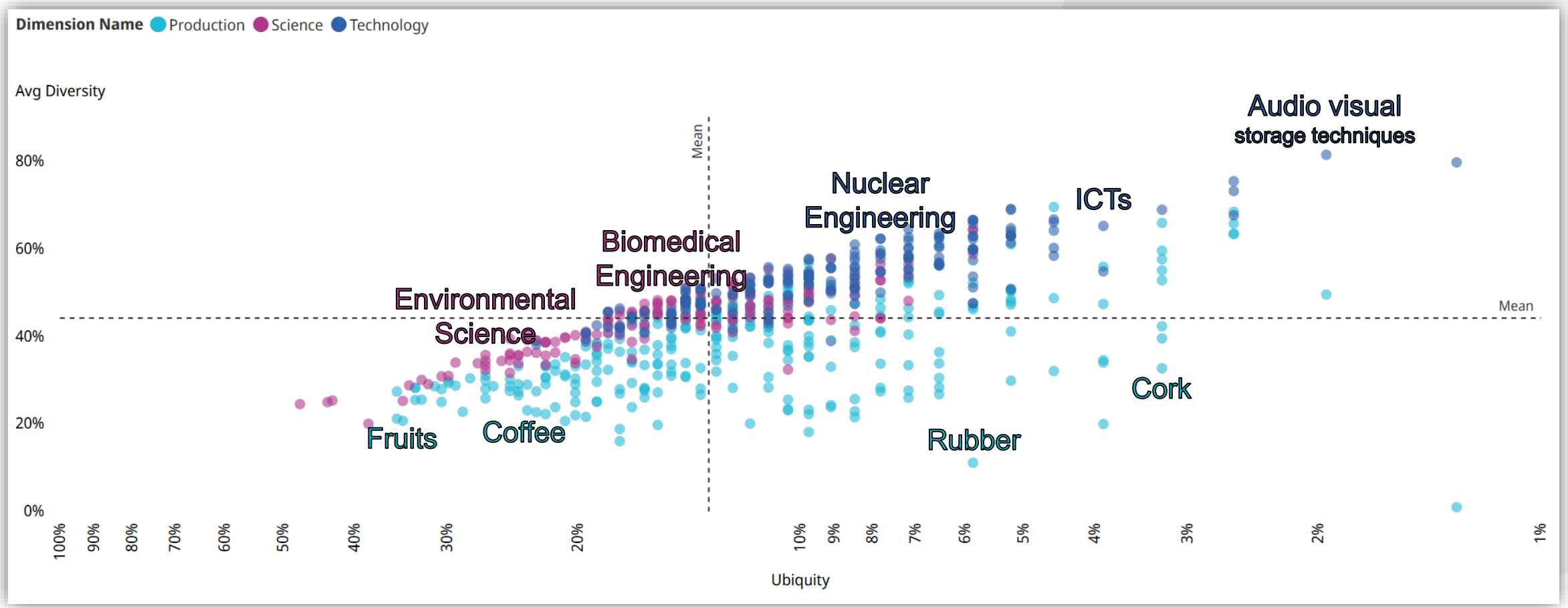
Reflects how diverse are the ecosystems that master each capability.

Capability	Share of fields	Rank
Coffee	23%	4th
Cork	32%	3rd
Optics	**63%**	**1st**
Nanoscience	59%	2nd

… however, Optics is mastered only in places with many skills. Cork may be rare, but easier to master.

Ubiquity vs. diversity by field of innovation

Based on capabilities co-occurrence of 626 scientific, technological and product fields, 2020.



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Main indicators within Capabilities

Proximity of fields

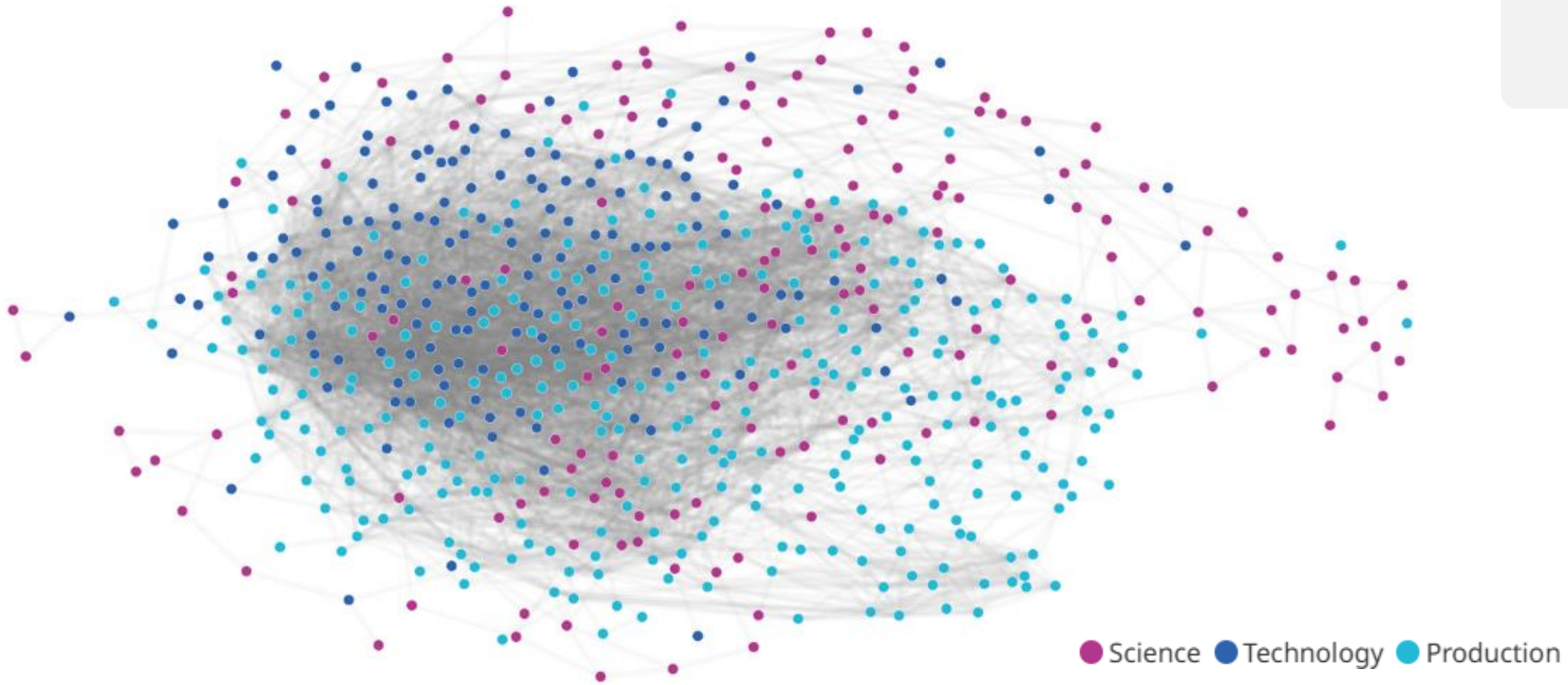
Indicates **how often two types of knowledge coincide in one place.**

Field A	Field B	Proximity
Materials	Applied physics	92%
Agronomy	Tropical medicine	49%
Printing machines	Petroleum oils	5%

Materials and applied physics tend to appear together in most of the times. Printing machines are not as connected to petroleum oils.

The innovation capability space

Using co-occurrence to measure the proximity between capabilities.



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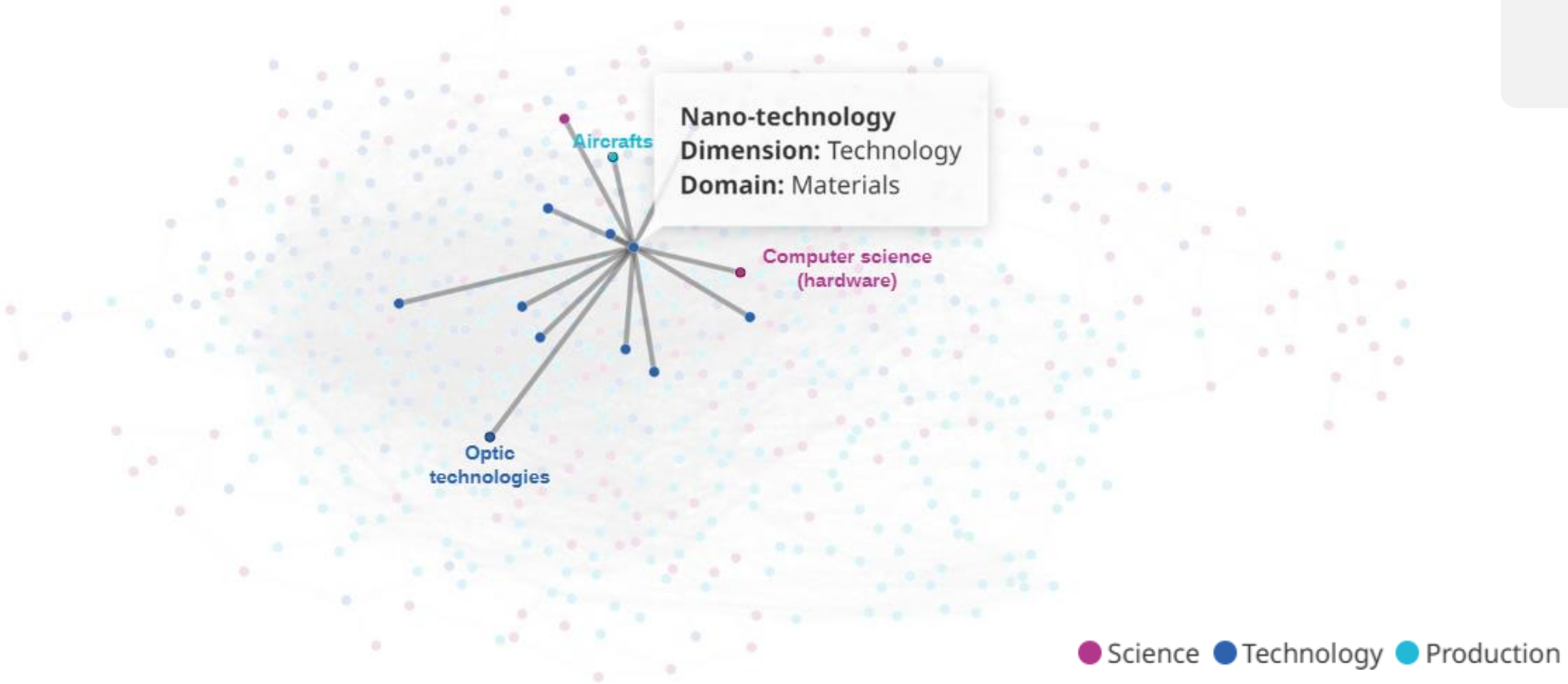

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Main indicators within Ecosystems

Proximity of ecosystems

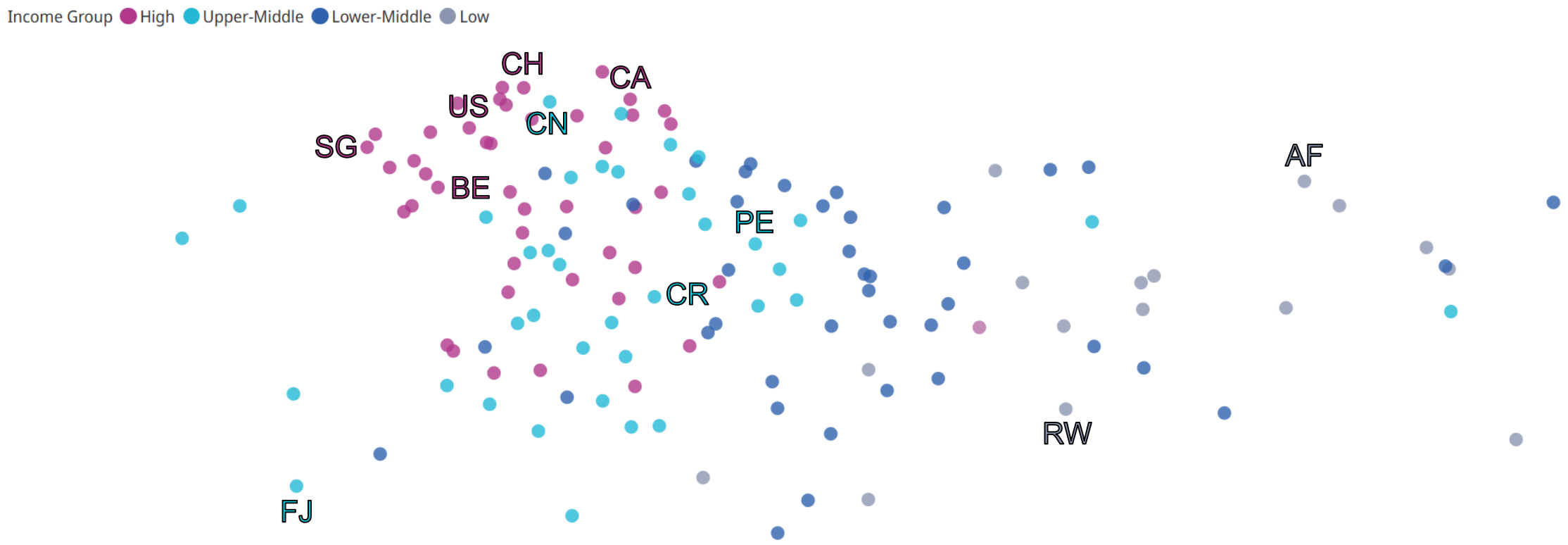
Reflects **how often two ecosystems coincide in one capability.**

Ecosystem A	Ecosystem B	Proximity
United States	China	87%
Belgium	Canada	54%
Peru	Switzerland	9%

China and the US share 87% of their innovation capabilities. Switzerland and Peru have very different skills.

The innovation ecosystem space

Using co-occurrence to measure the proximity between ecosystems.



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Main indicators between Capabilities and Ecosystems (1)

Relatedness

Indicates how close are the skills of an innovation ecosystem to an innovation field.

Ecosystem	Field	Relatedness
Italy	Optics	60%
Egypt	Optics	14%
Italy	Coffee	74%
Egypt	Coffee	26%

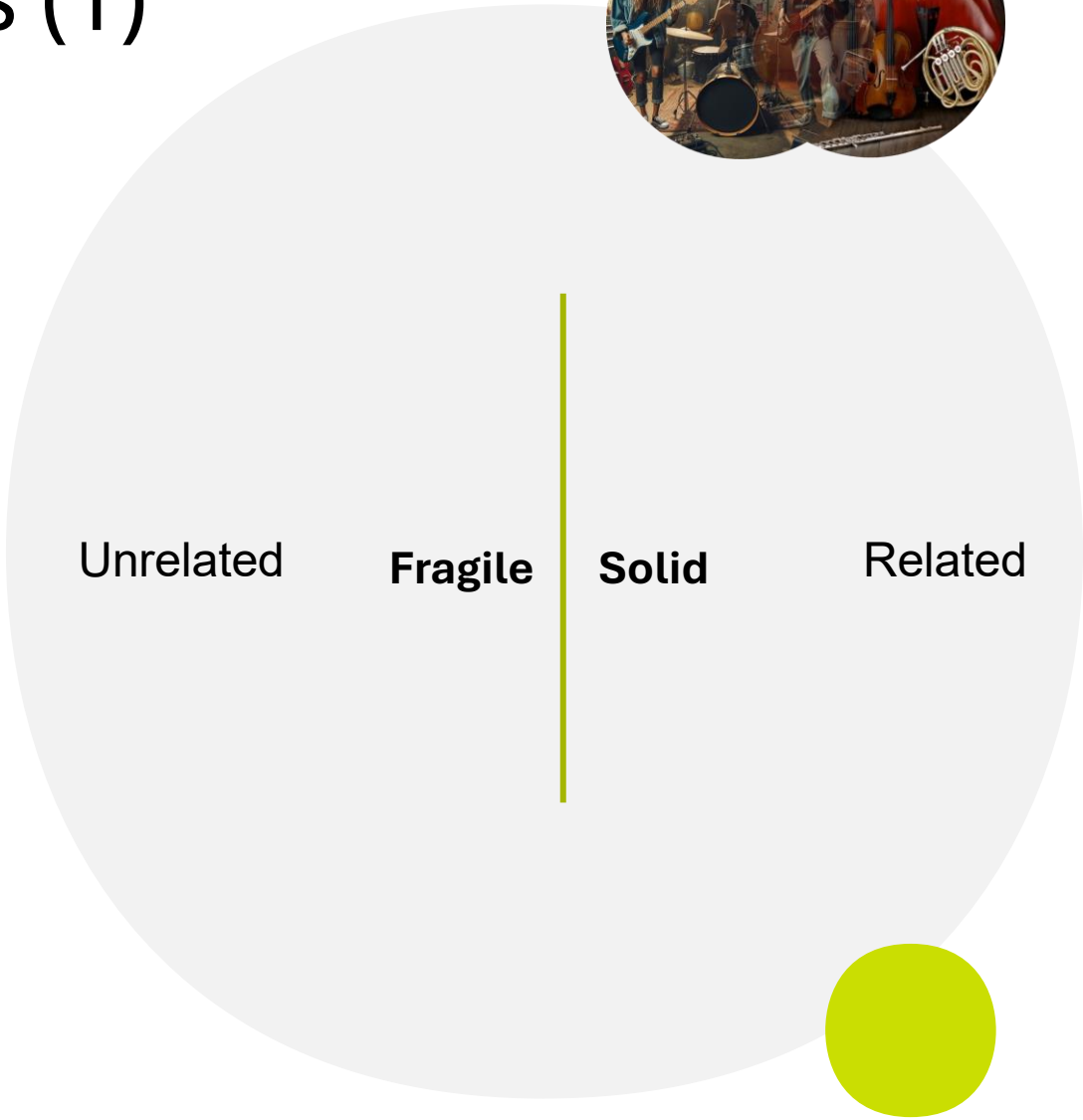
Despite for both ecosystems, its relatedness to coffee is higher than to optics, for Egypt the relatedness of coffee almost doubles the optics one, while for Italy, this difference is narrower.

Interpreting the main indicators (1)

For ecosystem current capabilities

- **Solid capabilities**. Current capabilities that are surrounded by complementary skills. **Ecosystems tend to keep them**.

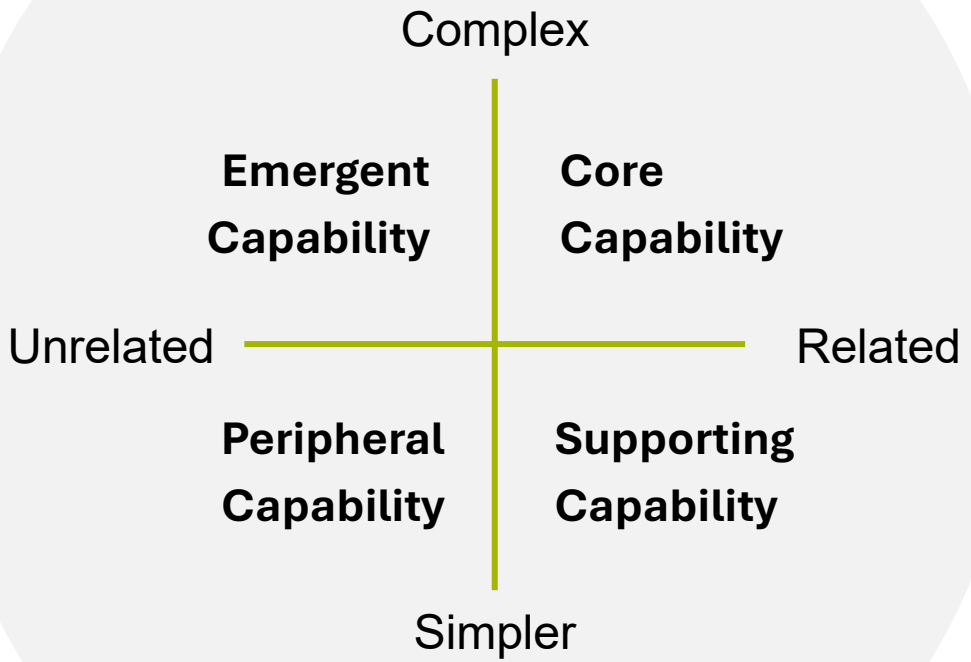
- **Fragile capabilities**. Current capabilities that are not surrounded by complementary skills. **73% of lost capabilities are fragile**.



Interpreting the main indicators (1)

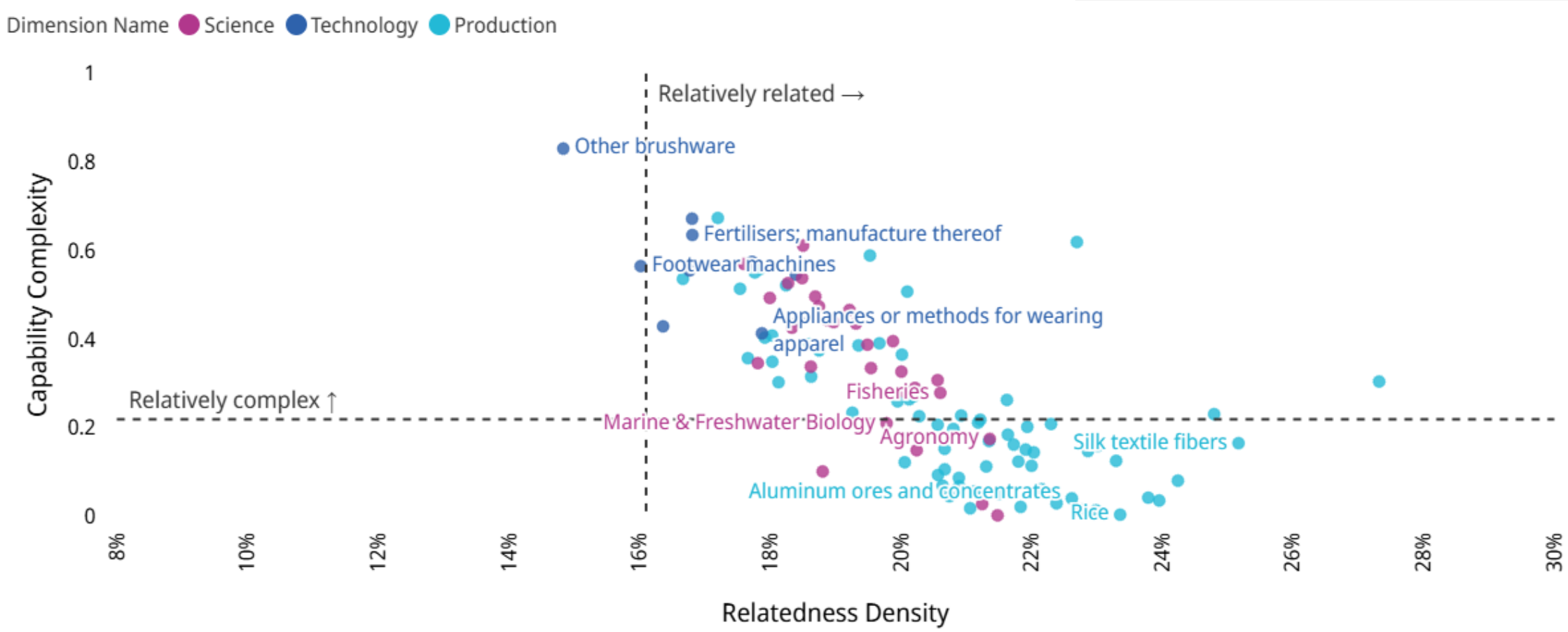
For ecosystem current capabilities

- **Established capabilities**. Current capabilities that are surrounded by complementary skills. **Ecosystems tend to keep them**.
  - **Core**. Complex for the ecosystem.
  - **Supporting**. Simpler for the ecosystem.
- **Fragile capabilities**. Current capabilities that are not surrounded by complementary skills. **73% of lost capabilities are fragile**.
  - **Emergent**. Complex for the ecosystem.
  - **Peripheral**. Simpler for the ecosystem.



Assessing the strengths of an ecosystems

Based on capabilities co-occurrence of 626 scientific, technological and product fields, 2020.



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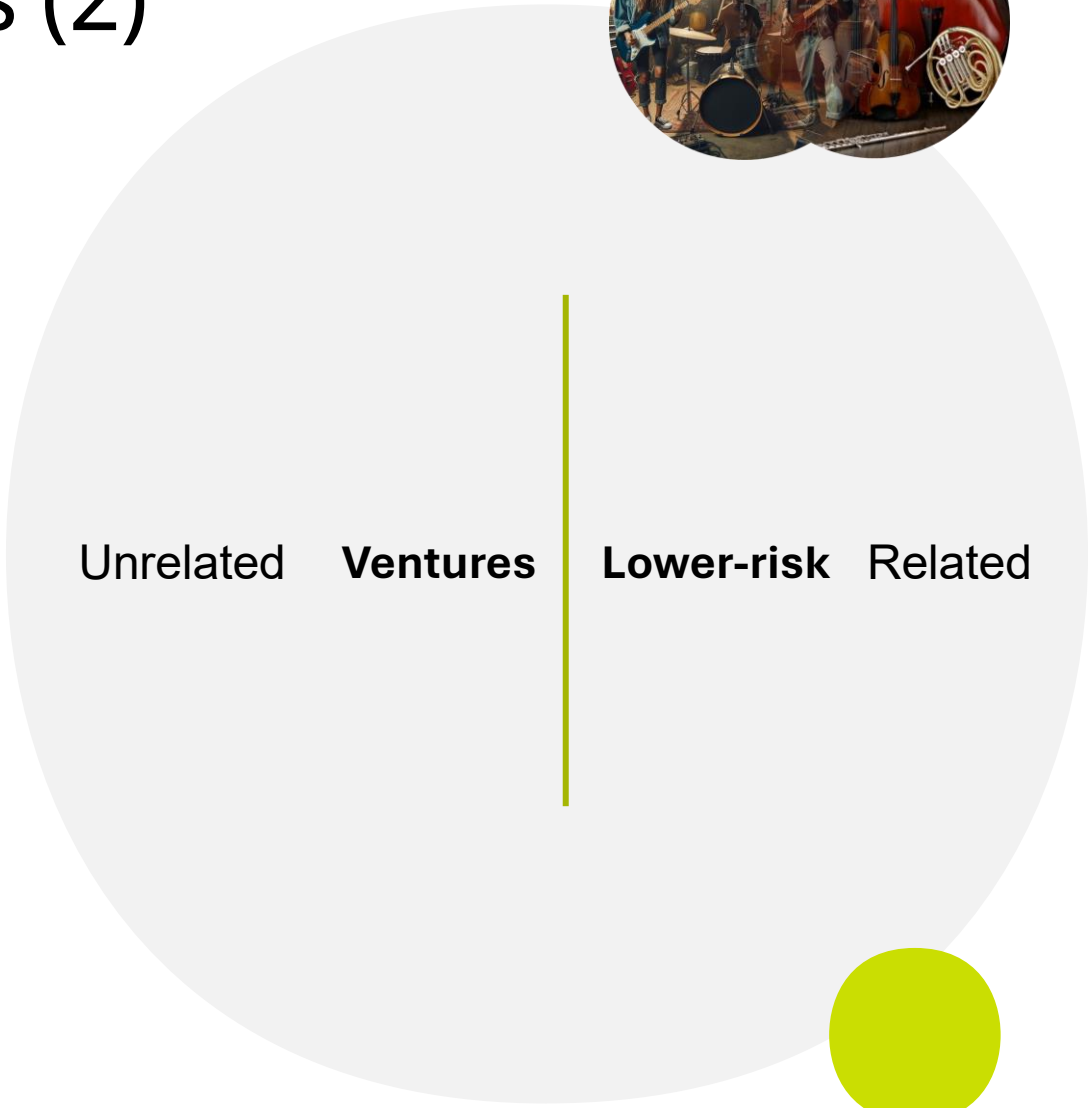
Interpreting the main indicators (2)

For ecosystem current capabilities

- **Lower-risk opportunities**. Unattained capabilities closely related to current ones. **Ecosystems tend to diversify into these 90% of the times**.

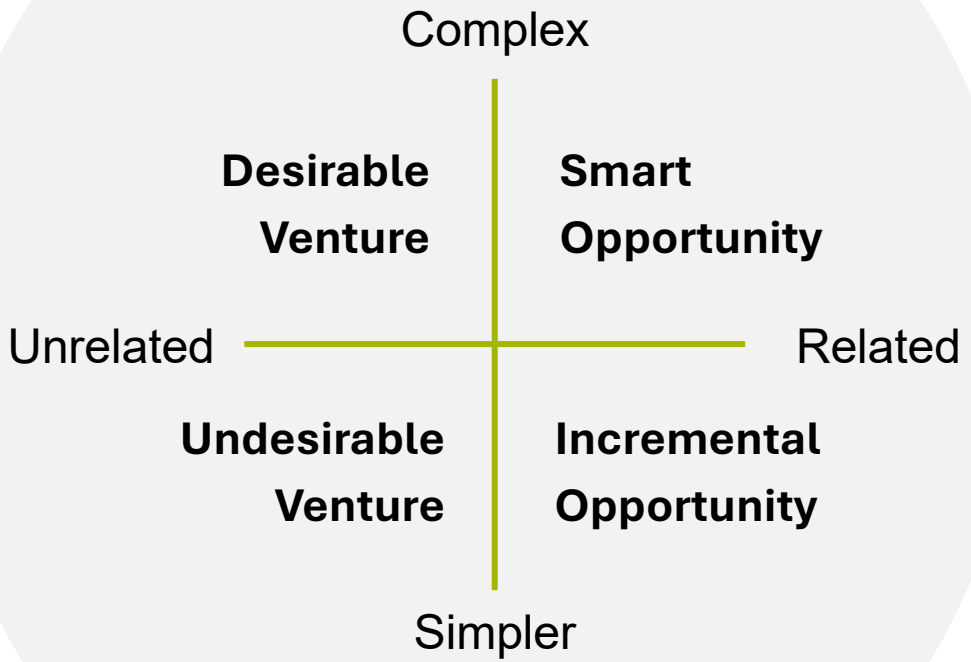
- **High risk ventures**: Unattained capabilities requiring unrelated ones, making them hard to master and keep on the longer term.



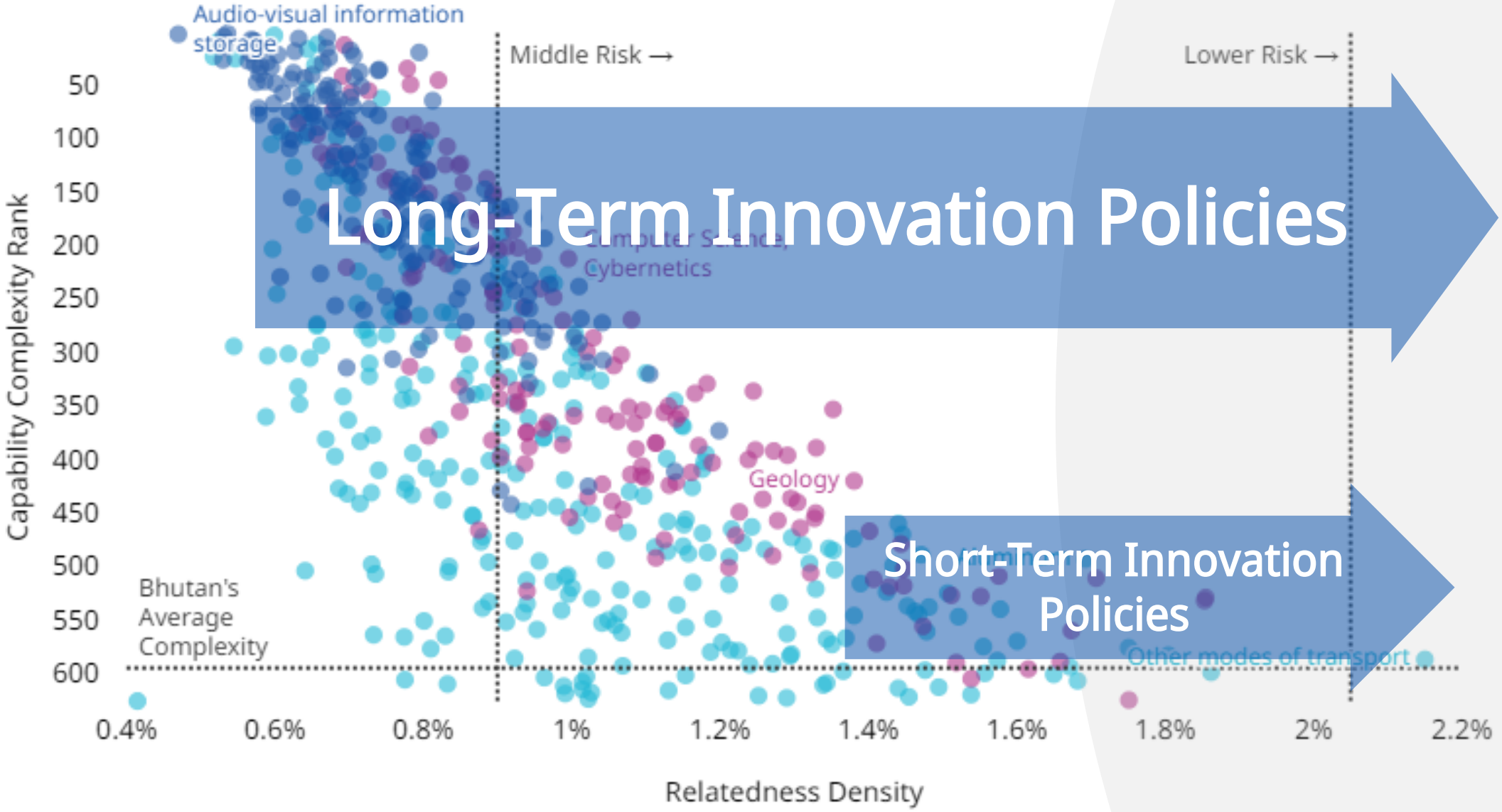
Interpreting the main indicators (2)

For ecosystem unattained capabilities

- **Lower-risk opportunities**. Unattained capabilities closely related to current ones. **Ecosystems tend to diversify into these 90% of the times**.
  - Smart opportunities. Complex for the ecosystem.
  - Incremental opportunities. Simpler for the ecosystem.
- **High risk ventures**: Unattained capabilities requiring unrelated ones, making them hard to keep.
  - **Desirable ventures**. Complex for the ecosystem.
  - **Undesirable ventures**. Simpler for the ecosystem.



Complexity and relatedness mapping for Bhutan's unattained capabilities



Main indicators between Capabilities and Ecosystems (2)

Potential

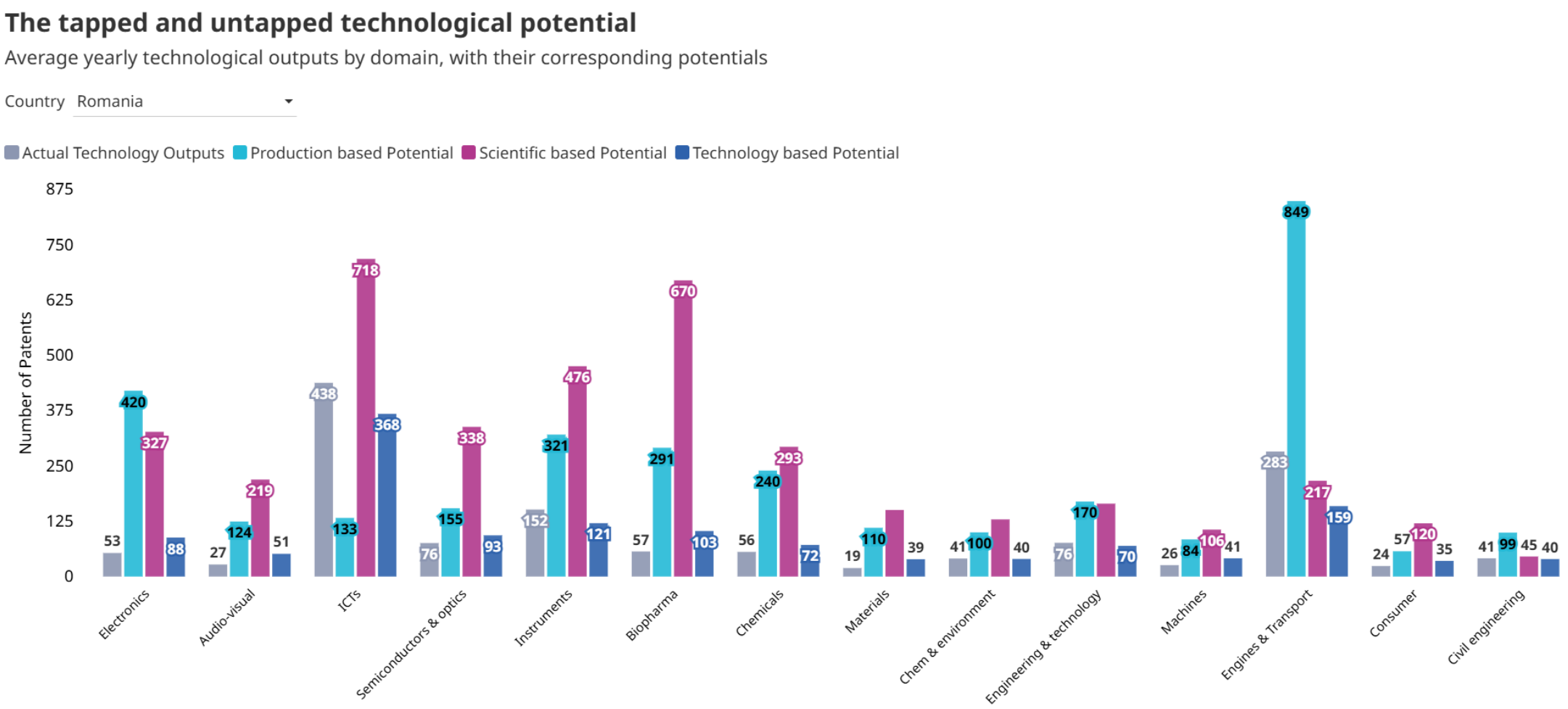
Reflects what an ecosystem could produce in an innovation field, given its current skills.

Ecosystem	Field	Potential
Italy	Optics	**+ 140% patents**
Egypt	Optics	**+ 2110% patents**
Italy	Coffee	**- 70% exports**
Egypt	Coffee	**+ 760% exports**

Italian scientific and productive capabilities could generate an extra 140% extra optical patents in the ecosystem…

Unveiling technological potential

Every innovation ecosystem harbors unseen innovation potential—unlocking it could spark groundbreaking advancements and growth.



Source: WIPR 2024

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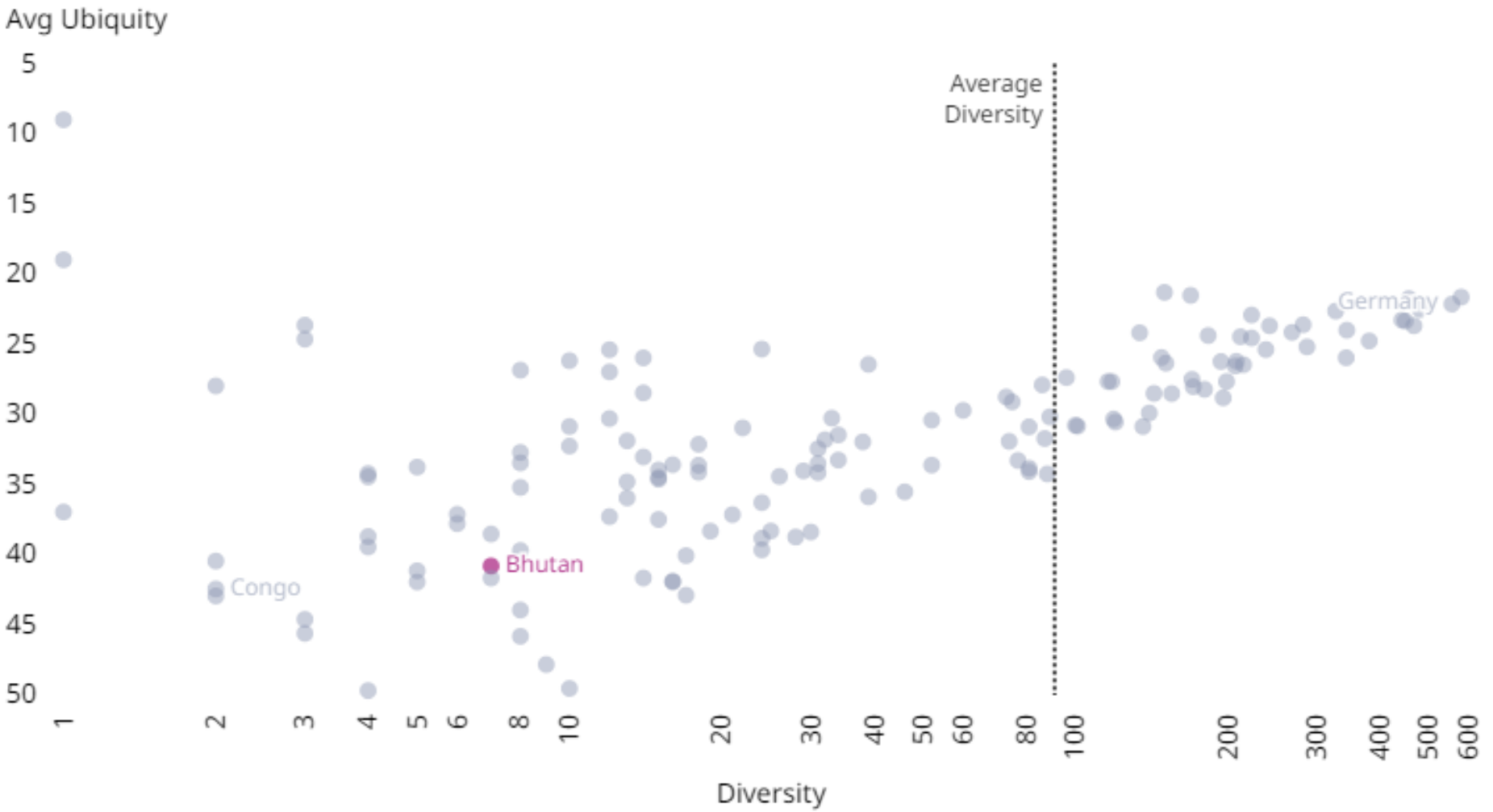
Bhutan capabilities



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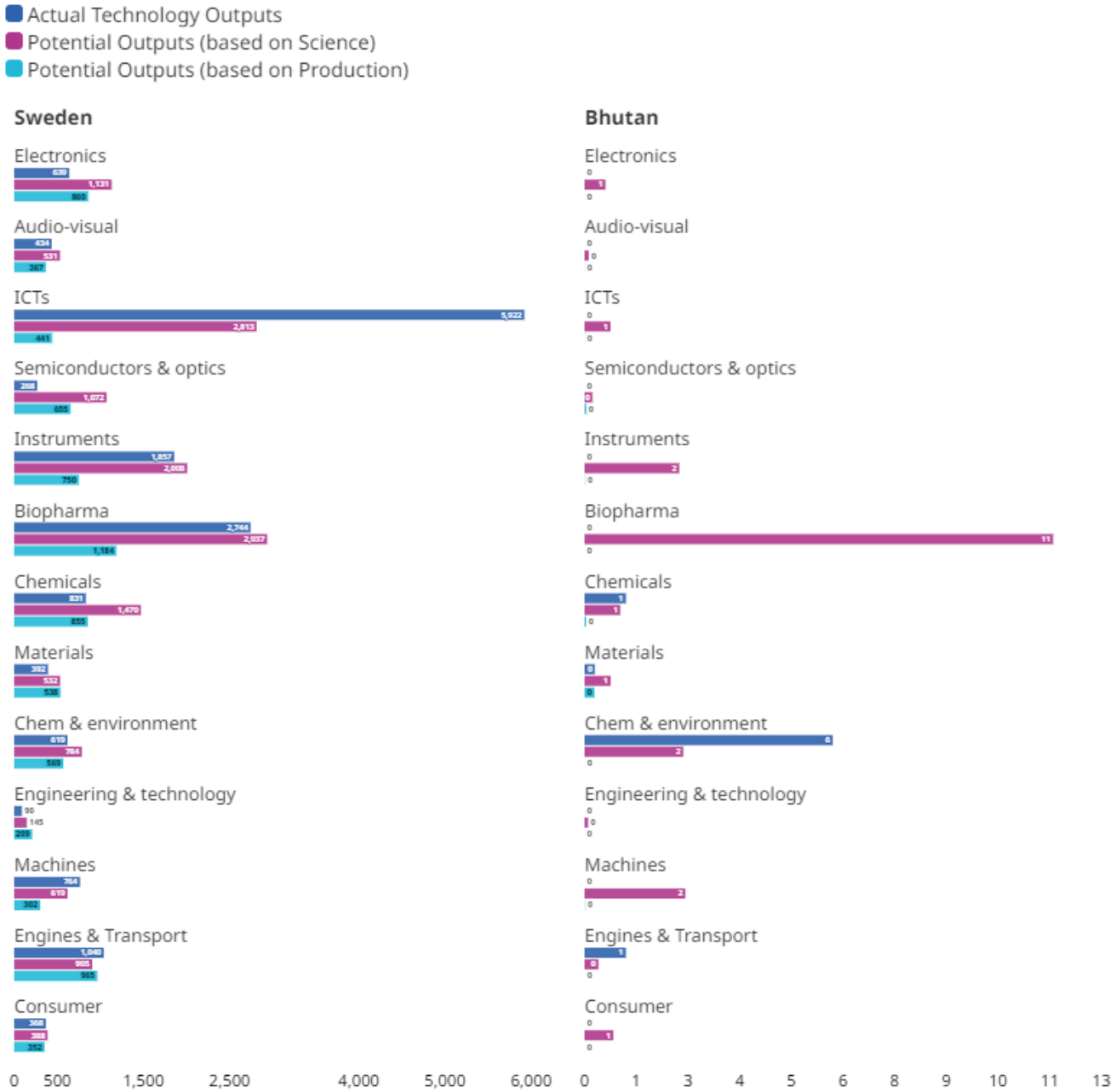
Bhutan's science points towards potential technological inventions

Yearly technological outputs vs. untapped potential. Comparison between Sweden and Bhutan



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Key takeaways

Mapping innovation capabilities can help policymakers implement innovation policies.

- Risk-reward framework
- Assess their development path
- Identify and solidify strengths
- Find missing links and new opportunities

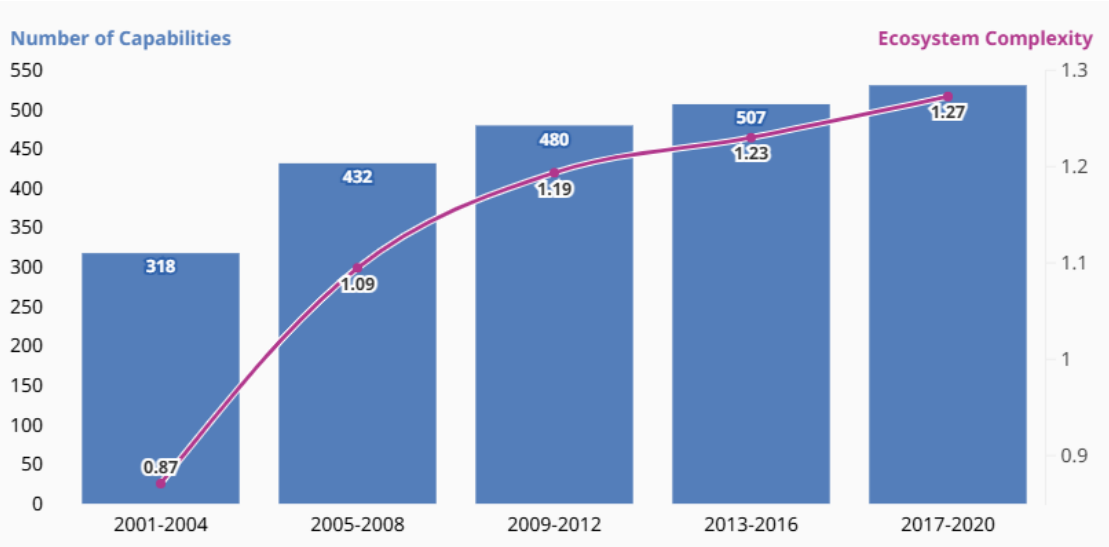
Activity

Interpreting Innovation Capability Indicators

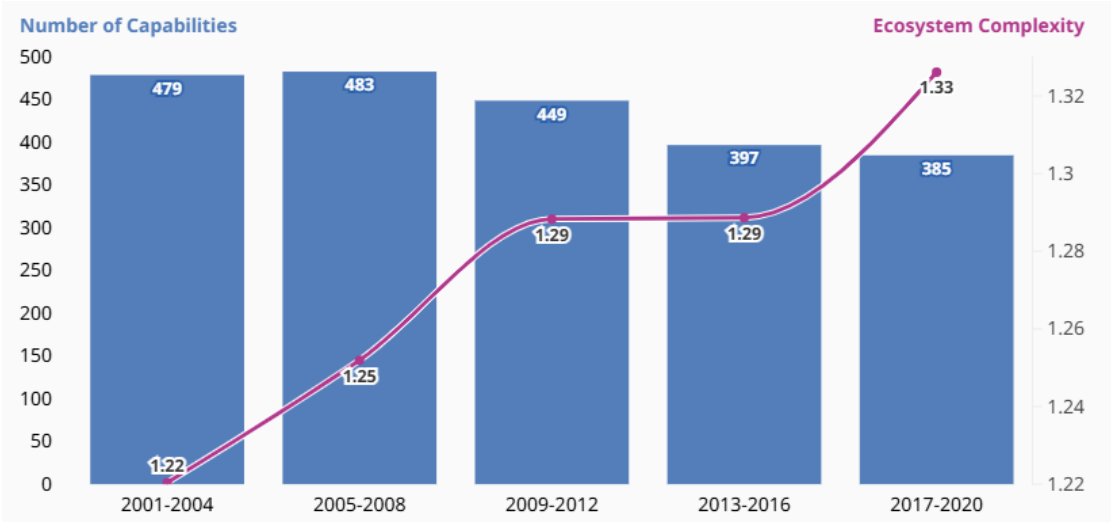
Unfolding the capability path (1)

Examining the evolution of the ecosystem's performance can help identify if the path to development is on the right track.

China



United Kingdom



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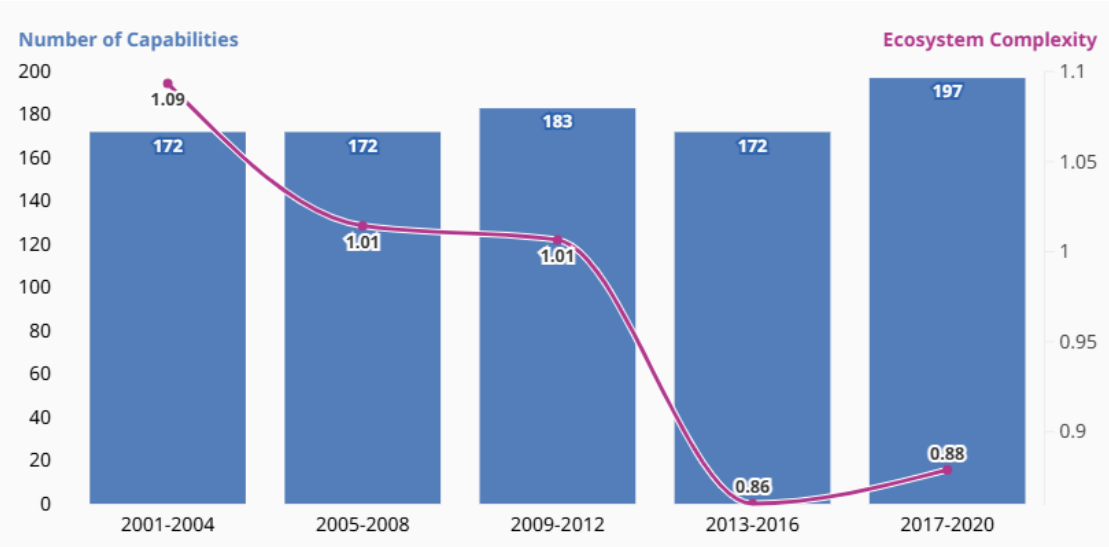
Unfolding the capability path (2)

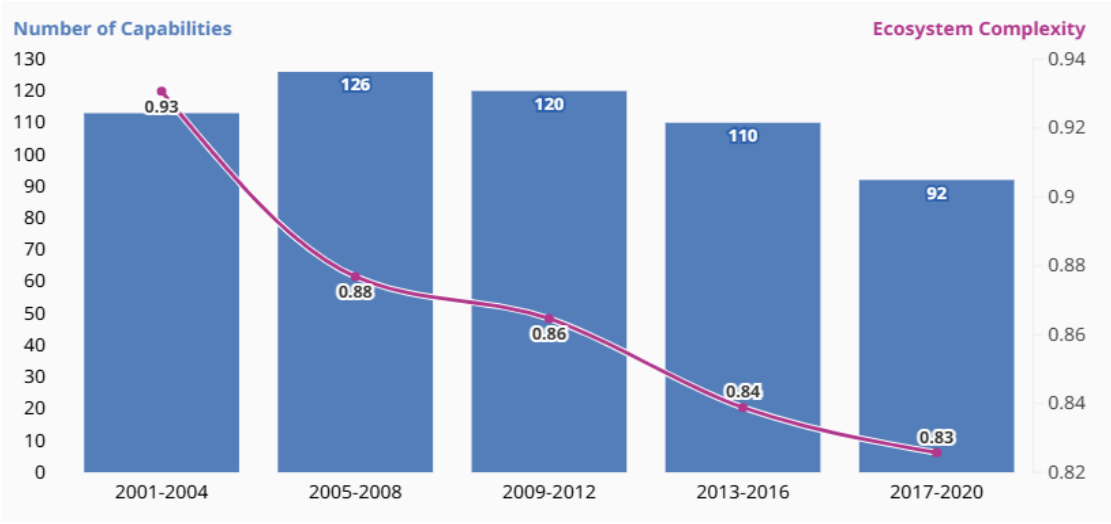
Innovation intensity measures the types of fields an ecosystem prioritizes for its innovation outputs.

Complex ecosystems tend to concentrate their specializations in more complex fields of innovation.

Russia



Slovenia

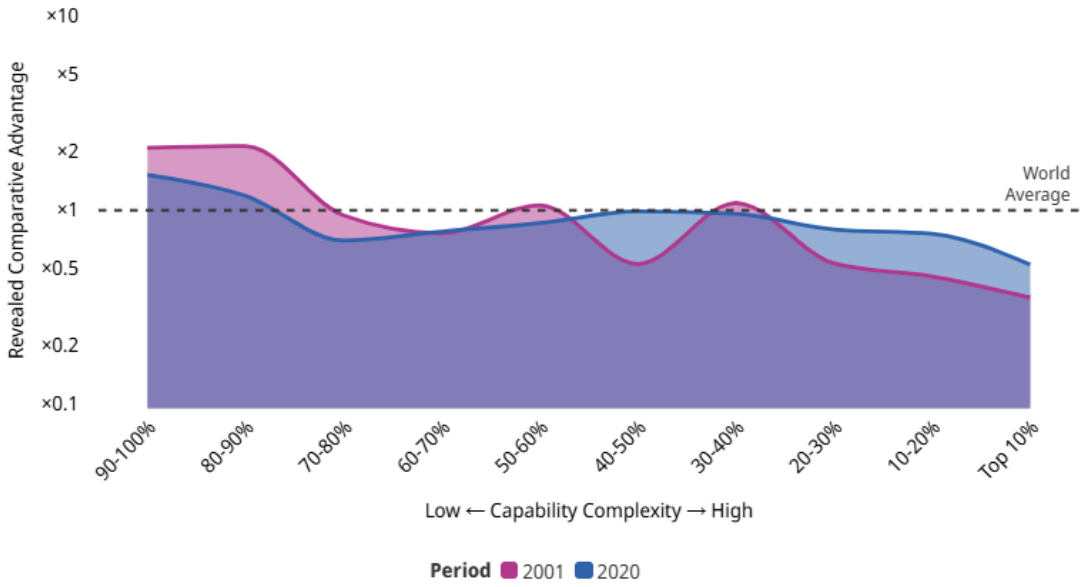


Optimizing innovation (1)

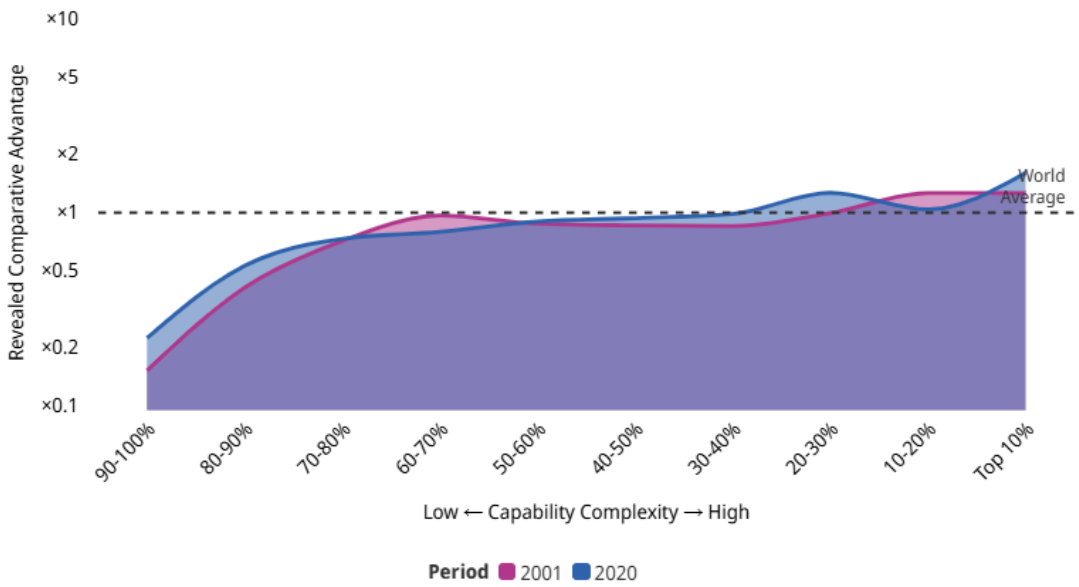
Innovation intensity measures the types of fields an ecosystem prioritizes for its innovation outputs.

Complex ecosystems tend to concentrate their specializations in more complex fields of innovation.

India



Japan



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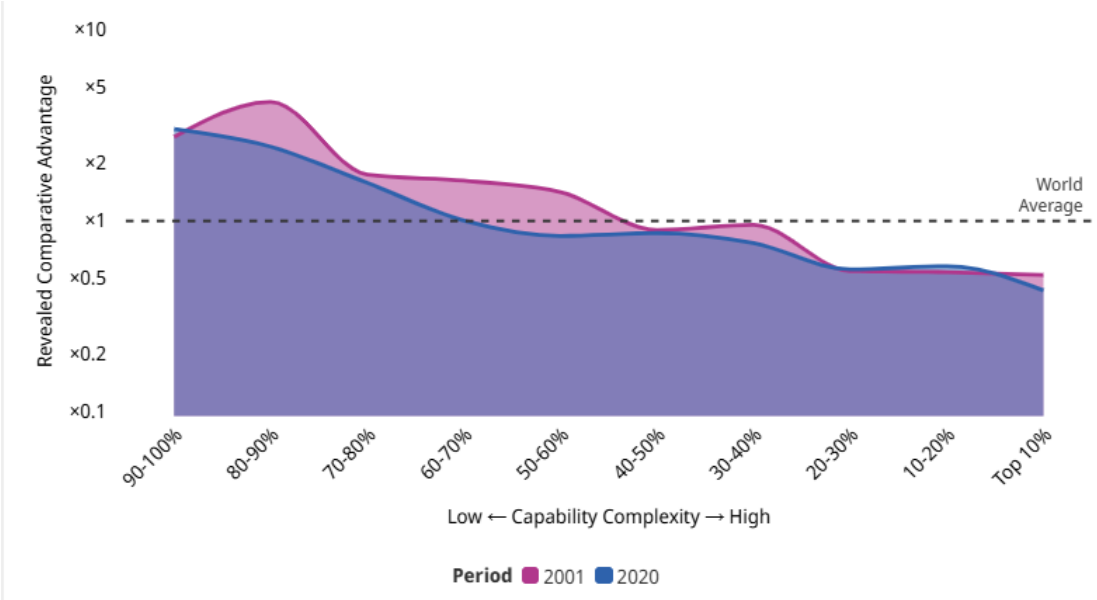
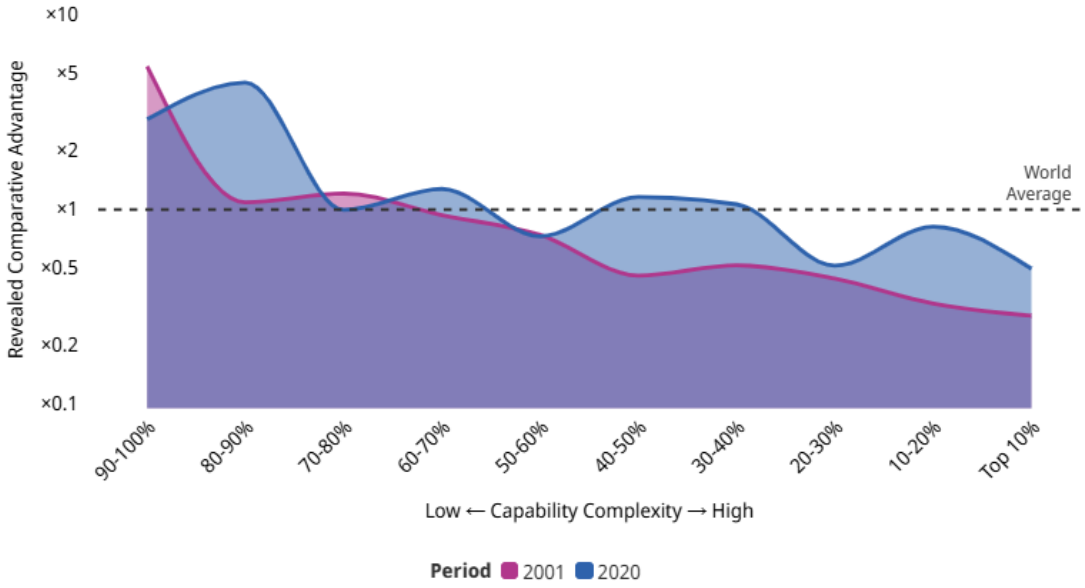
Optimizing innovation (2)

Examining the evolution of the ecosystem's performance can help identify if the path to development is on the right track.

Argentina



Morocco



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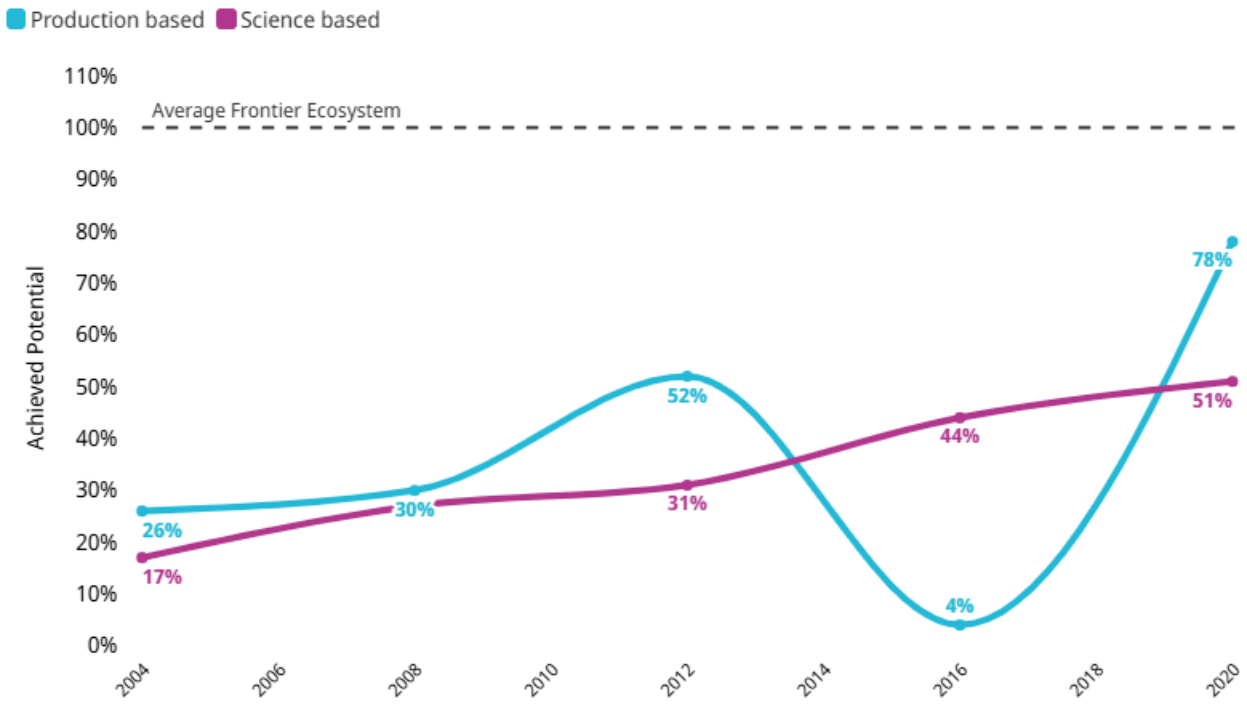
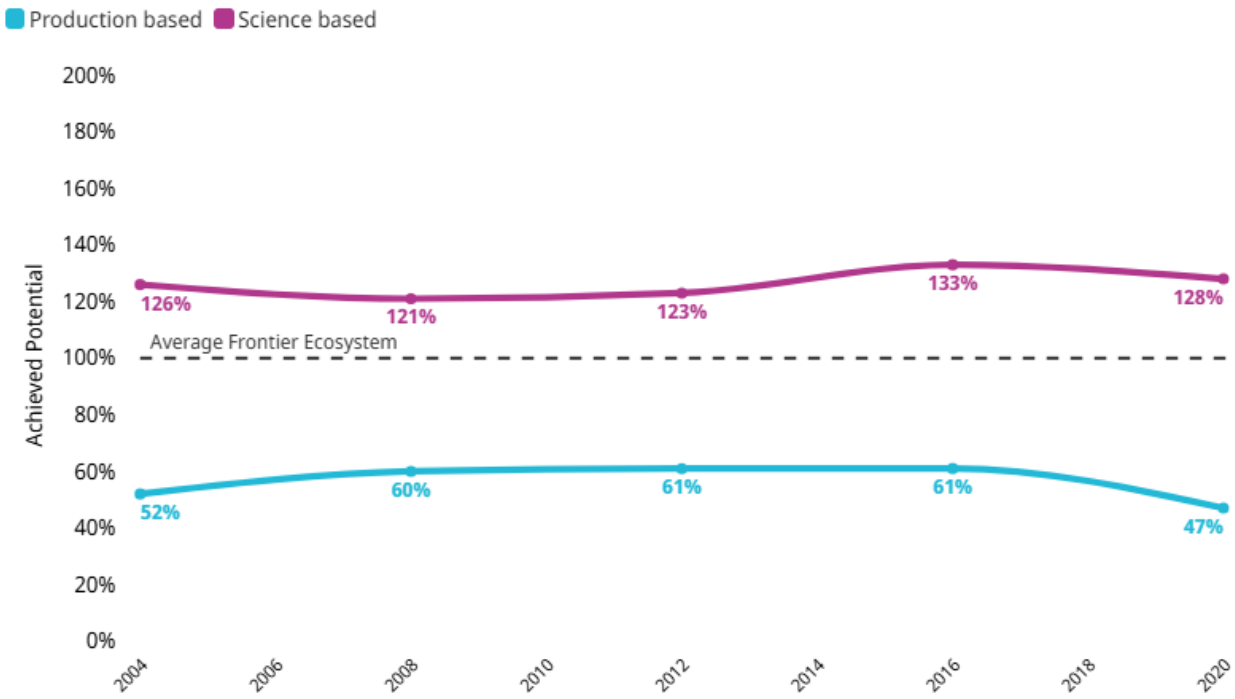
Tapping potential (1)

Science and Production can shed light into untapped Technological Potential

Chile



Netherlands



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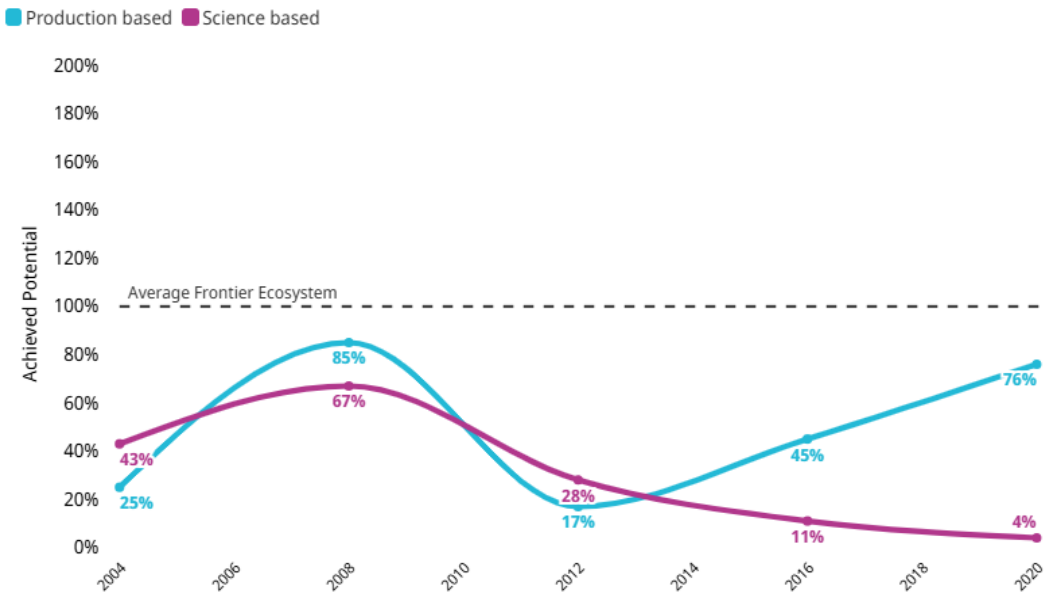
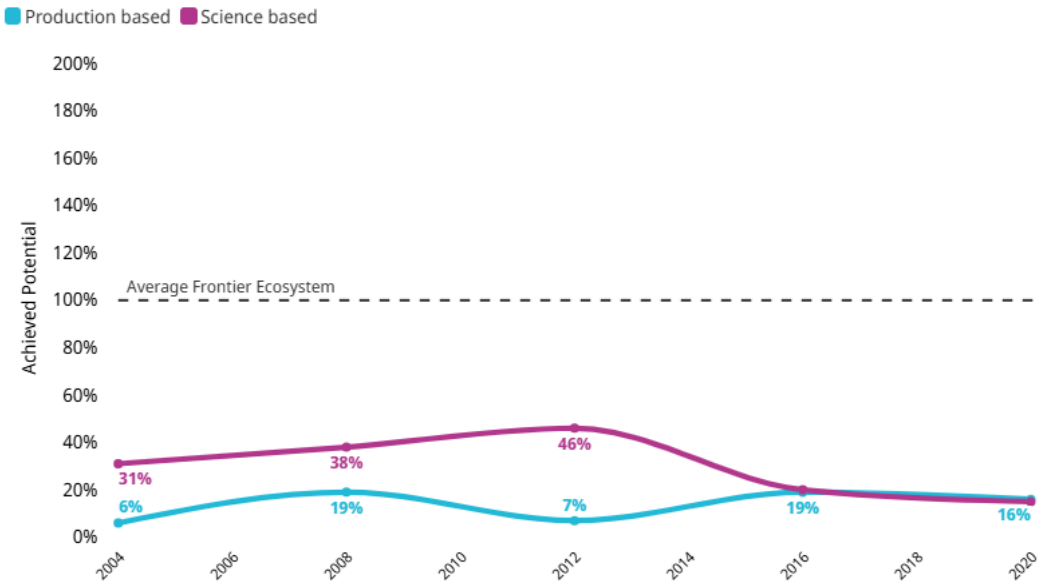
Tapping potential (2)

Science and Production can shed light into untapped Technological Potential

Pakistan



Qatar



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Exploring the world capabilities

Thank you!

chief.economist@wipo.int

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Photo credits: Getty Images

Main indicators

For ecosystems

Diversity

Measures **the number of innovation capabilities an ecosystem masters.**

Ecosystem	Share of fields	Rank
Cascadia	4%	4th
Lumindale	27%	2nd
Meridia	**54%**	**1st**
Millbrook	24%	3rd

Note: Complexity can be derived from diversity and ubiquity. Average ubiquity is the first iteration of the algorithm that defines the complexity of ecosystems.

Main indicators

For innovation capabilities

Ubiquity

Indicates **how common a capability is** across innovation ecosystems.

Capability	Share	Rank (of 626)
Coffee	21%	571st
Cork	3%	16th
Optics	5%	44th
Nanosicence	5%	64th

Average Diversity → Complexity

Reflects how diverse are the ecosystems that have each capability.

Capability	Share (of 626)	Rank (of 626)
Coffee	23%	605th E1
Cork	32%	516th D2
Optics	63%	29th X8
Nanosicence	59%	57th K5

Note: Complexity can be derived from diversity and ubiquity. Average diversity is the first iteration of the algorithm that defines the complexity of capabilities.

Main indicators

Between capabilities and ecosystems

Relatedness

Indicates how close are the skills of an innovation ecosystem to an innovation field[1].

Ecosystem	Field	Relatedness
Italy	Optics	60%
Egypt	Optics	14%
Italy	Coffee	74%
Egypt	Coffee	26%

Potential

Reflects what an ecosystem could produce in an innovation field, given its current skills[2].

Ecosystem	Field	Potential
Italy	Optics	1.4
Egypt	Optics	21.1
Italy	Coffee	- 0.7
Egypt	Coffee	7.6

[1] Note: Despite for both ecosystems, its relatedness to coffee is higher than to optics, for Egypt the relatedness of coffee almost doubles the optics one, while for Italy, this difference is narrower.

[2] The potential exercise places all the capabilities of an innovation ecosystem in a frontier economy, where the connections between the actors of the ecosystem are well established.

Main indicators

Within capabilities and ecosystems

Proximity of fields

Indicates **how often two types of knowledge coincide in one place.**

Capability A	Capability B	Proximity
Materials	Applied physics	92%
Agronomy	Tropical medicine	49%
Printing machines	Petroleum oils	5%

Proximity of ecosystems

Reflects **how often two ecosystems coincide in one capability.**

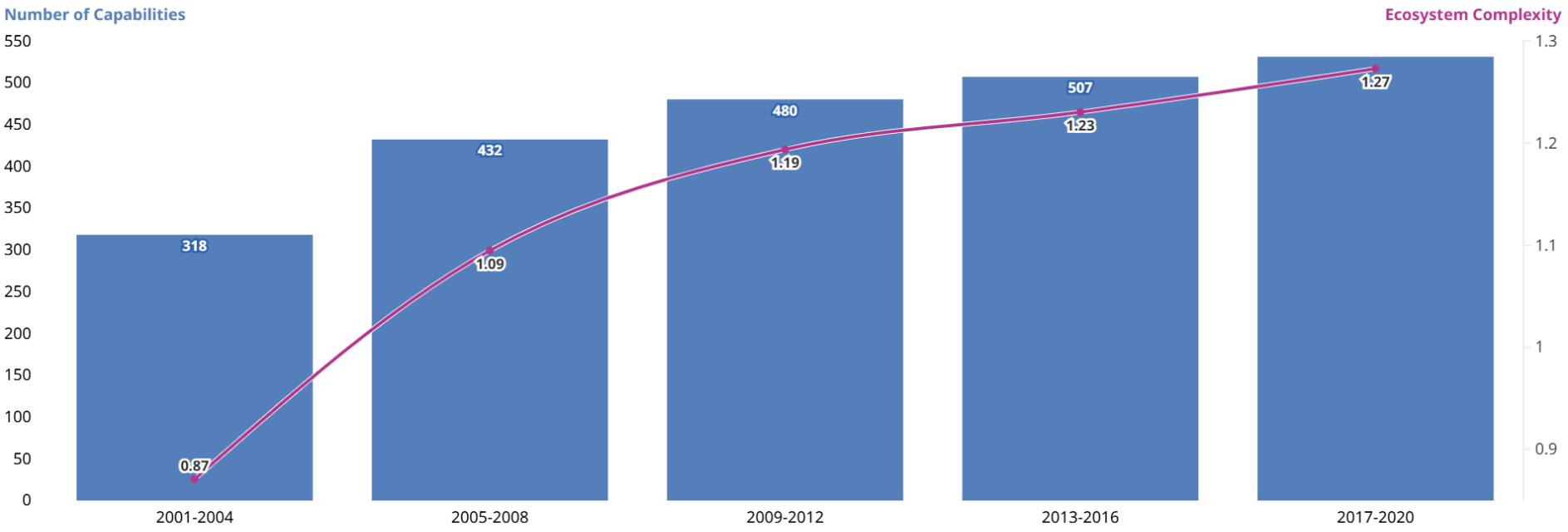
Ecosystem A	Ecosystem B	Proximity
United States	China	87%
Belgium	Canada	54%
Peru	Switzerland	9%

Unfolding the capability path

Examining the evolution of the ecosystem's performance can help identify if the path to development is on the right track.

As ecosystems diversify, they tend to adopt more complex capabilities
Evolution of Diversity and Complexity, 2001-2020

China



Source: WOS SCIE, EPO PATSTAT, UN COMTRADE • 626 innovation capabilities based on scientific fields, IPC subclasses and product classification in scientific publications, international patent applications and exports data.

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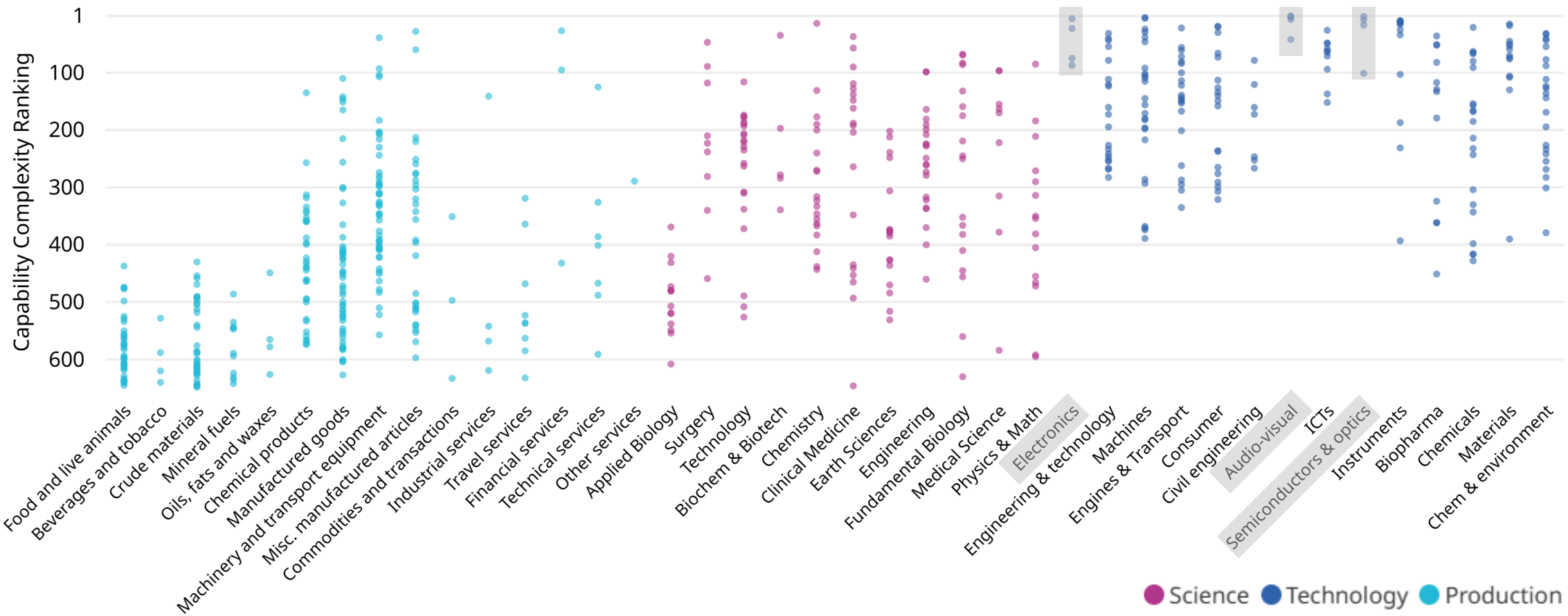
The complexity spectrum

All 626 world innovation capabilities, ranked by complexity levels



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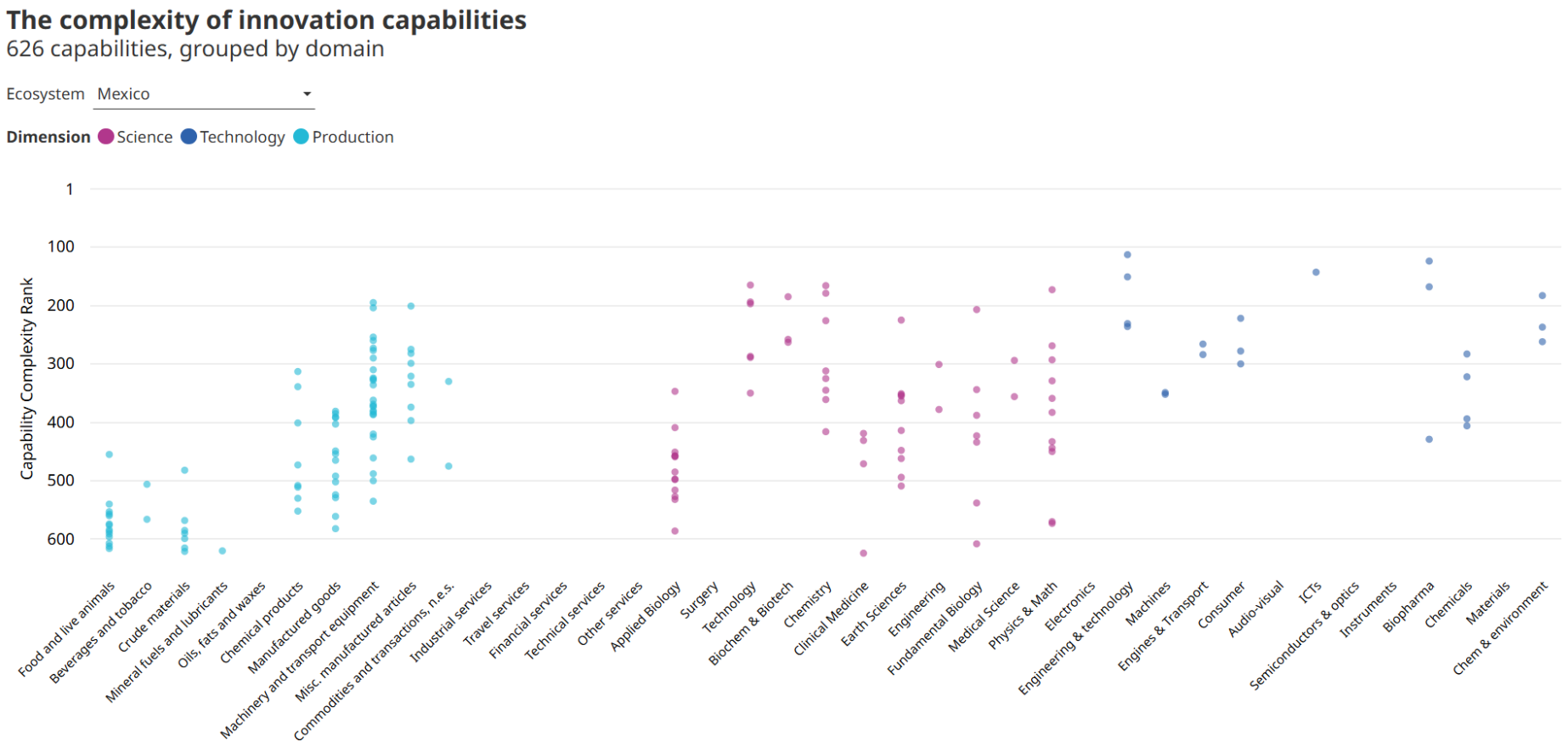
Assessing current capabilities

Ecosystems can understand which of their actual capabilities are the most precious and look into ways of nurturing them.



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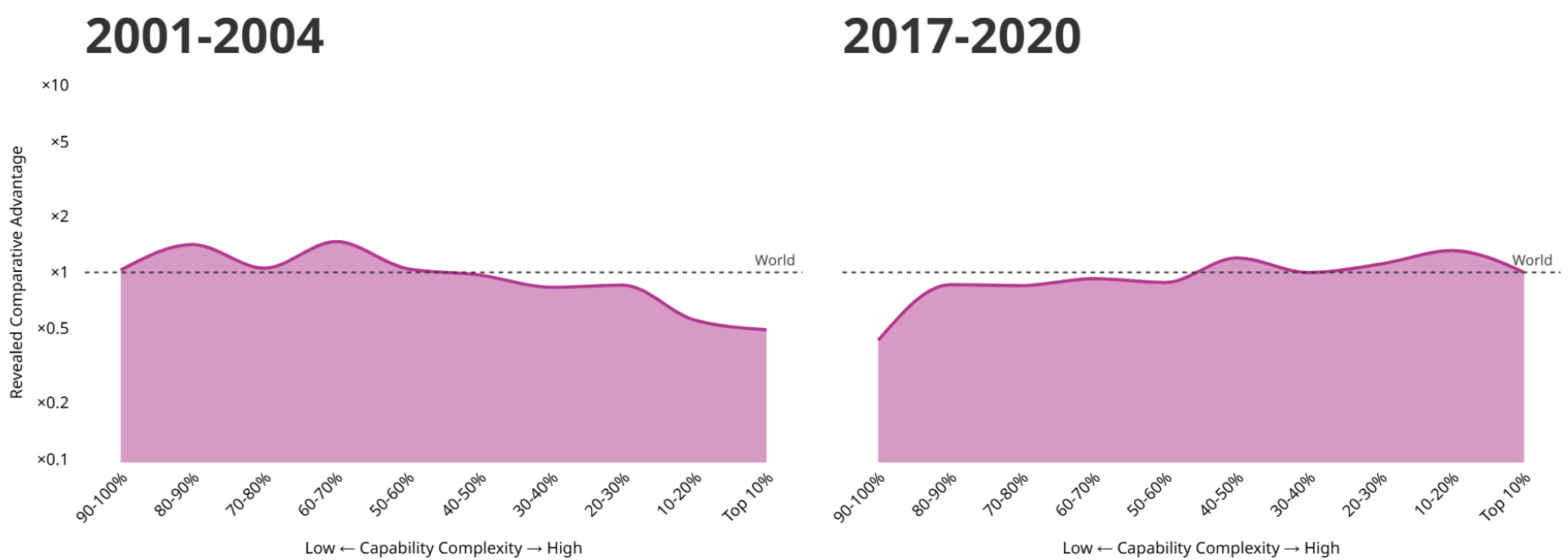
Optimizing innovation outputs

Innovation ecosystems that master complex skills face a new challenge: optimizing their outputs by strategically focusing on their most valuable capabilities.

The Intensity of an Innovation Ecosystem's Outputs

Specialization levels of innovation ecosystems by capability complexity, 2004 vs 2020.

Ecosystem China



Innovation intensity measures the types of fields an ecosystem prioritizes for its innovation outputs. Complex ecosystems tend to concentrate their specializations in more complex fields of innovation.

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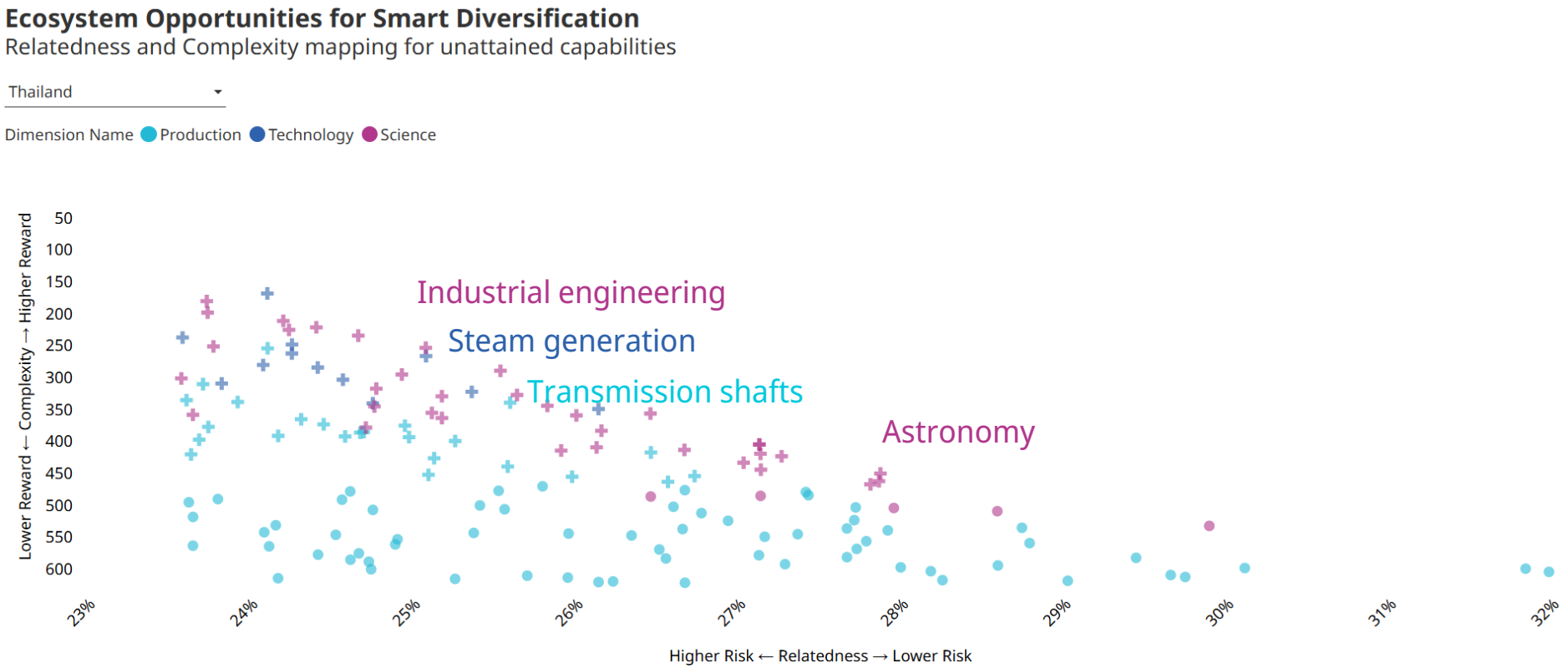
Finding new opportunities

By identifying their capabilities, innovation ecosystems can find where to look for new areas to develop and prioritize the most promising ones.



Source: WIPR 2024 • Capabilities marked with ✚ are relatively complex to the innovation ecosystem. Capabilities marked with ● are relatively simple to the ecosystem. The chart only shows capabilities that are relatively highly related to the ecosystem.

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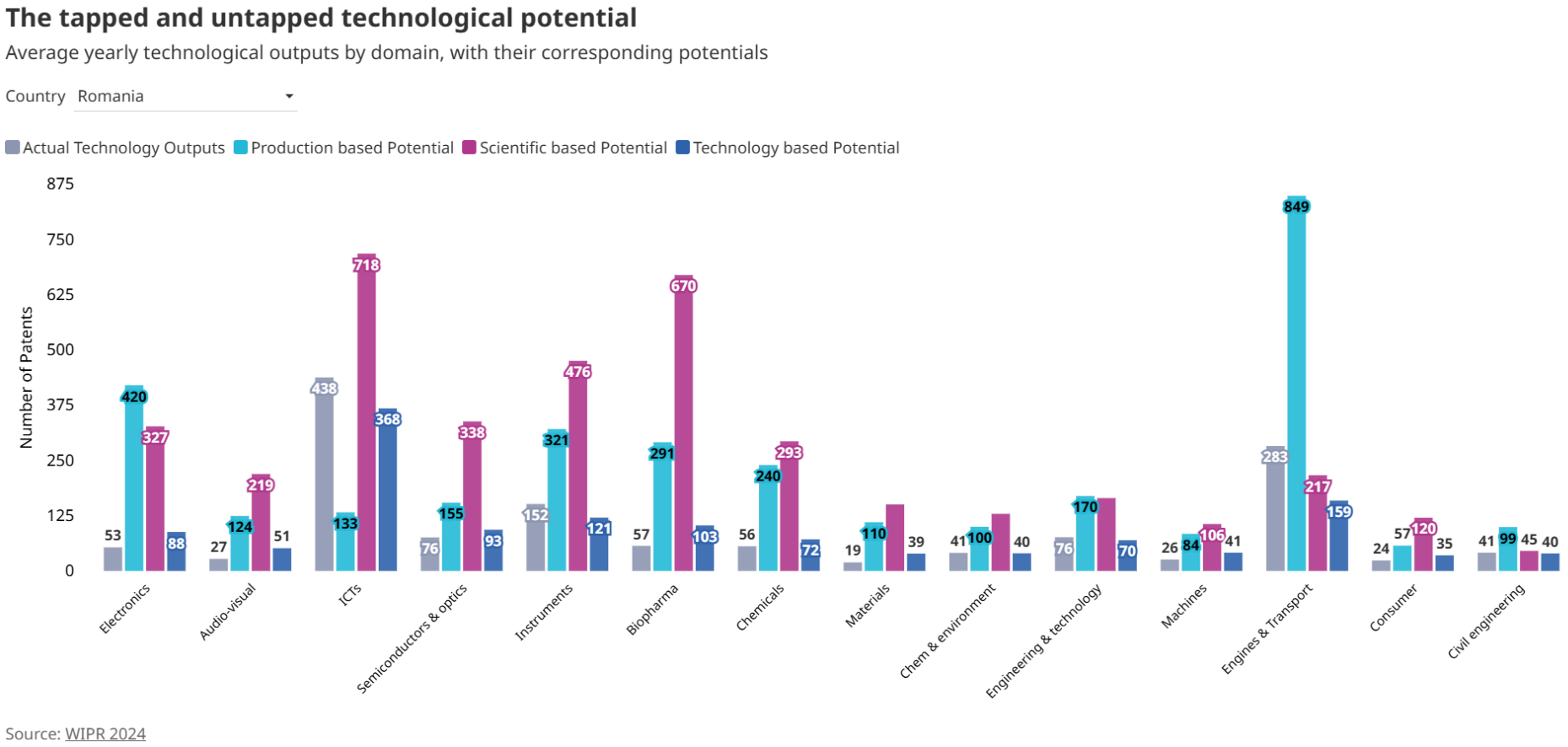
Unveiling technological potential

Every innovation ecosystem harbors unseen innovation potential—unlocking it could spark groundbreaking advancements and growth.



Source: WIPR 2024

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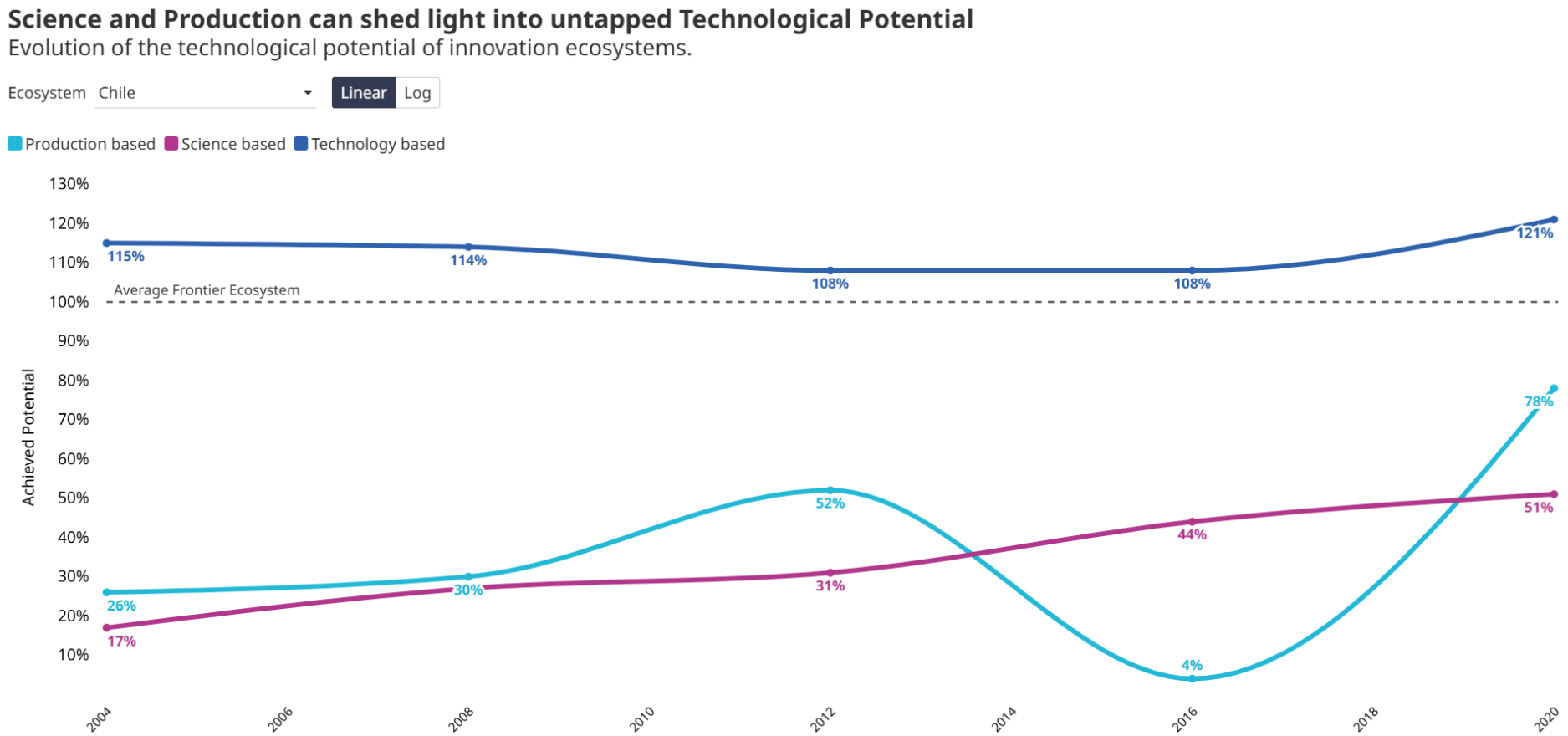
Unveiling technological potential

In innovation ecosystems, scientific research and industrial production converge to create technologies that drive economic growth. Can we measure whether this transformation is becoming increasingly effective?



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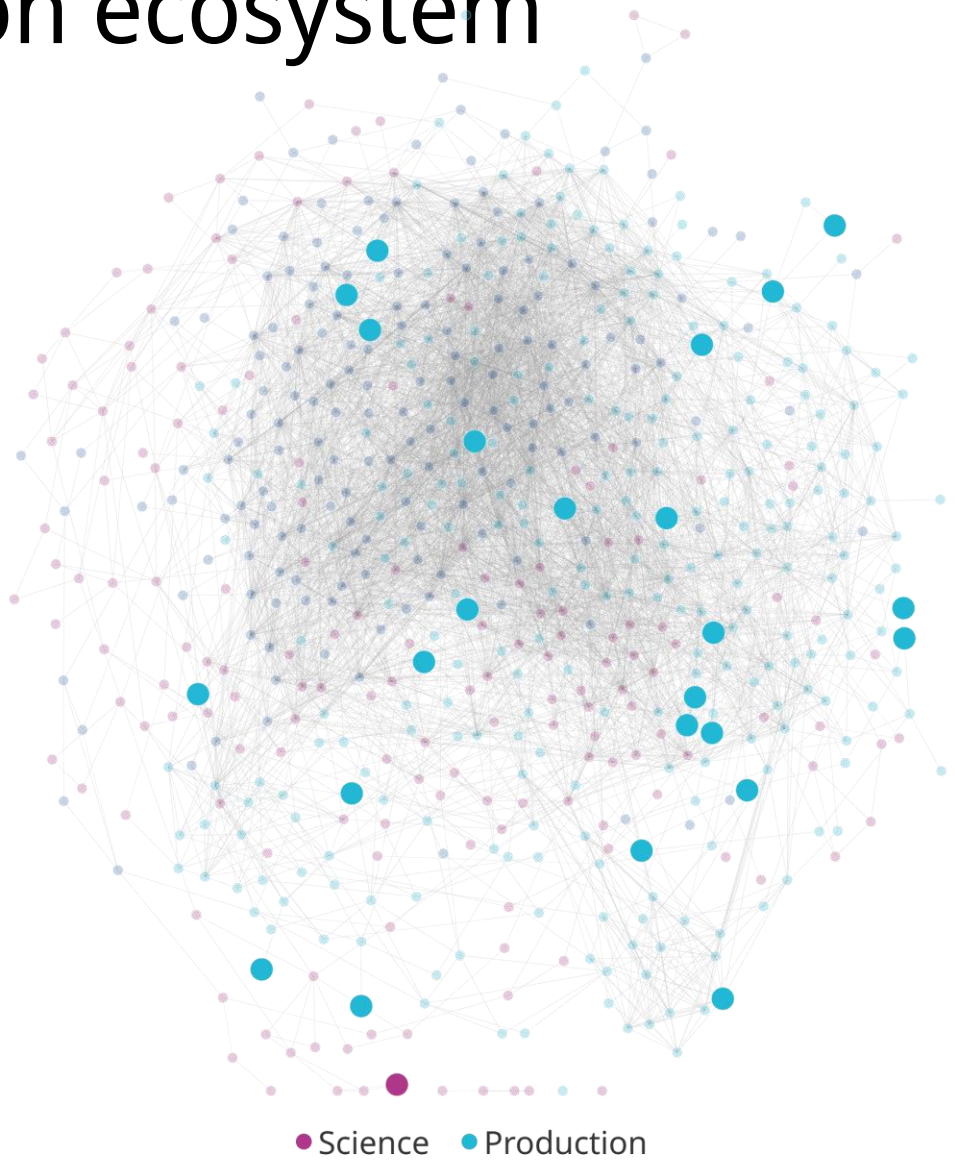
The snapshot of an innovation ecosystem

Key figures – Example: Dominican Republic

- The Dominican Republic has 4% of all innovation capabilities (ranked 77th↑).
  - Most from production fields .
  - Mainly disconnected.
  - Low complexity capabilities, in line with the region.
- The country traded complex capabilities for simpler ones during the last 2 decades (ranked 96th↓).
- Higher optimization of complex outputs (ranked 74th↑).
- 3 smart diversification opportunities in low complexity production fields (pottery, household equipment, works of art).
- Untapped technological potential in biopharma and instruments (+300 yearly patents).



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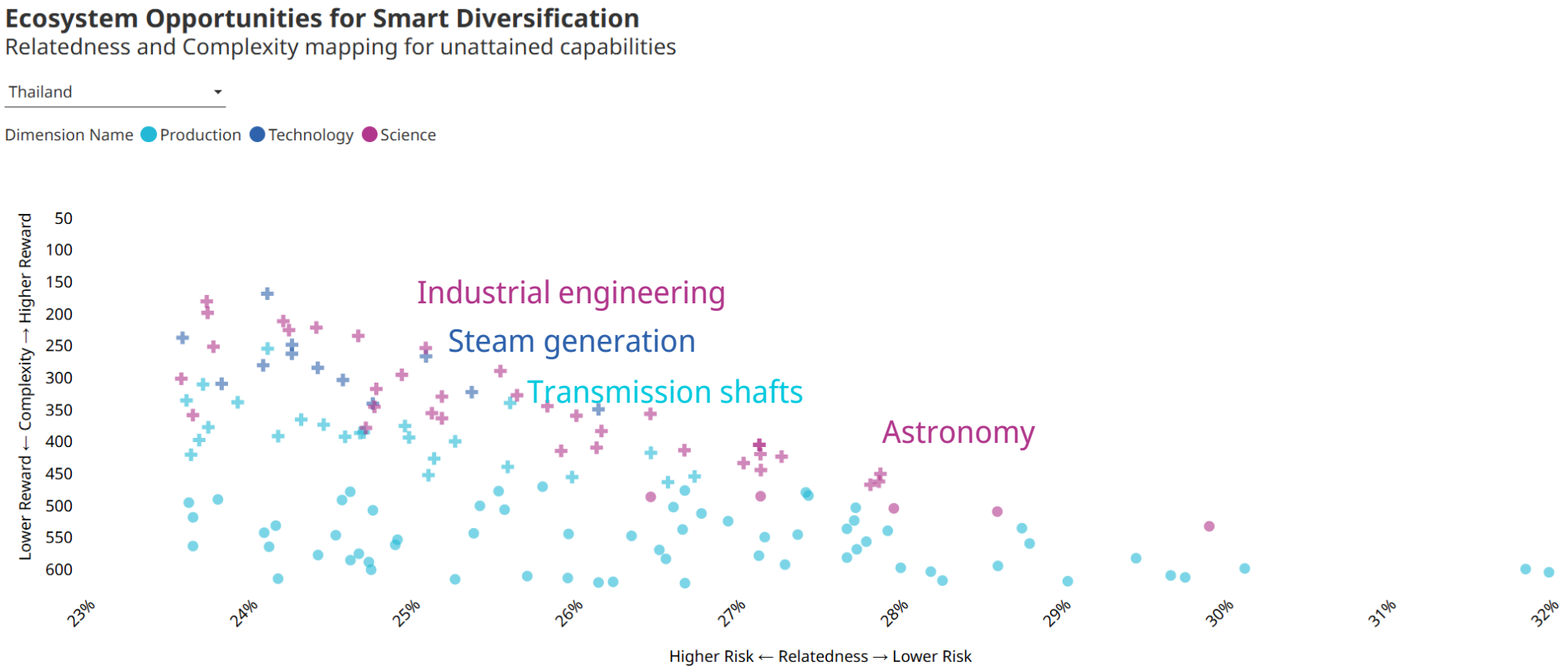
Finding new opportunities

By identifying their capabilities, innovation ecosystems can find where to look for new areas to develop and prioritize the most promising ones.



Source: WIPR 2024 • Capabilities marked with ✚ are relatively complex to the innovation ecosystem. Capabilities marked with ● are relatively simple to the ecosystem. The chart only shows capabilities that are relatively highly related to the ecosystem.