



TECHNOLOGY AND INNOVATION REPORT 2021

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CATCHING TECHNOLOGICAL WAVES



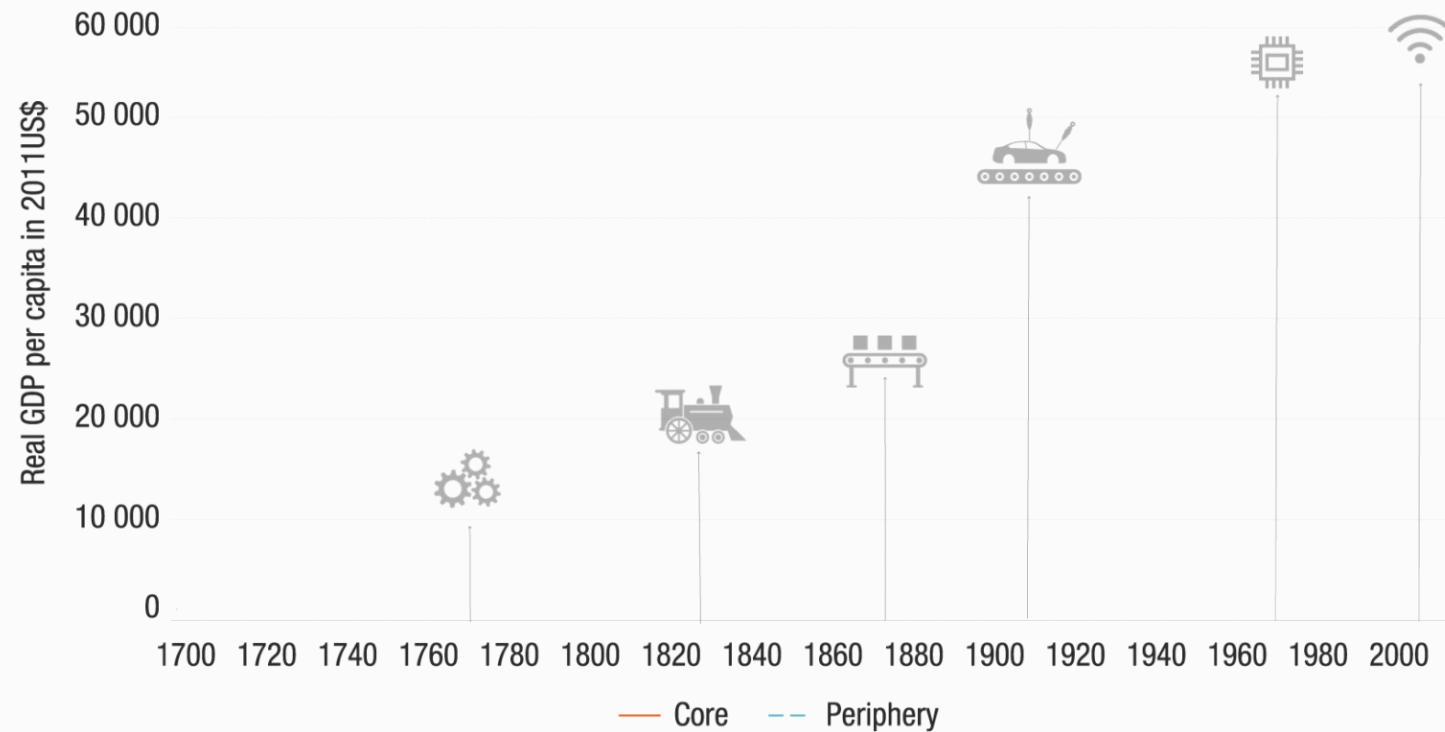
- Focus is on the impact of frontier technologies in developing countries
- Provides a comprehensive picture of the status and trend of frontier technologies
- Highlights the different effects of the two waves of technological change: the digitalization and Industry 4.0
- Few countries create the technologies that drive this change, but all countries will be affected by it
- Almost none are well prepared for the consequences

<https://unctad.org/webflyer/technology-and-innovation-report-2021>

CATCHING THE WAVES

The great divide, and waves of technological change.

Technological change and inequality through the ages



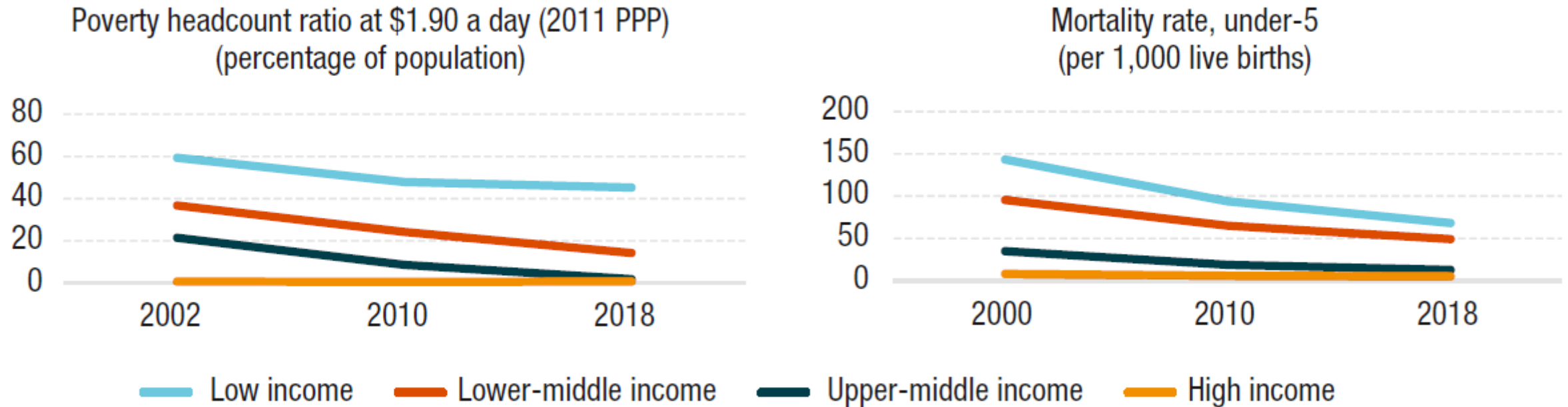
Source: UNCTAD's Technology and Innovation Report 2021

Source: UNCTAD, based on data from Maddison Project Database, version 2018, Bolt et al. (2018), Perez (2002), and Schwab (2013).

Notes: "Core" corresponds to Western Europe and its offshoots (i.e. Australia, Canada, New Zealand, the United States) as well as Japan. "Periphery" corresponds to the world, excluding the "core" countries.

PROSPERITY WITH INEQUALITY

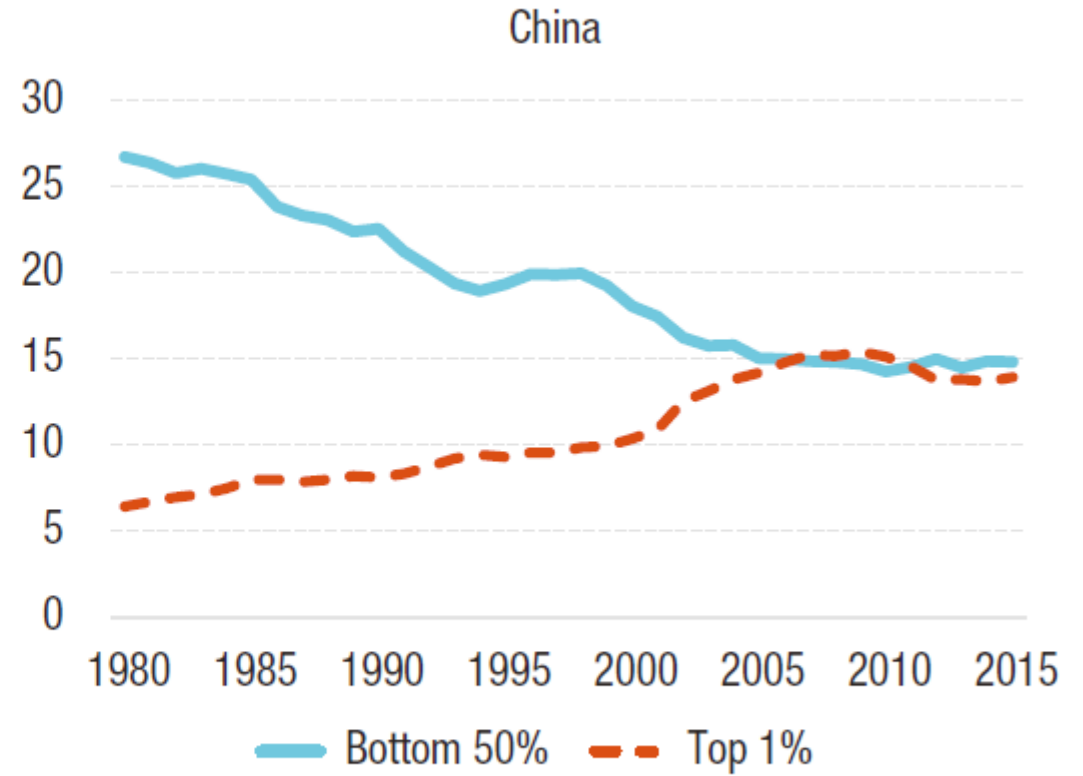
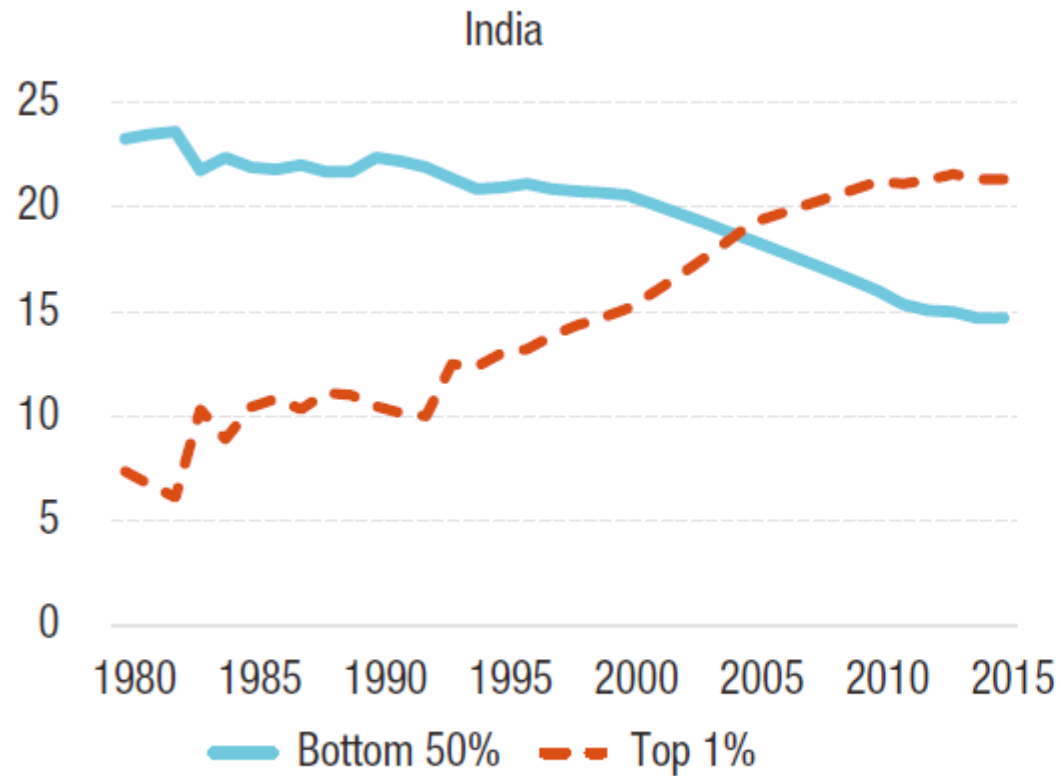
Gaps between country groups, selected SDG indicators



Source: UNCTAD based on data from the World Bank.

WIDE INCOME GAPS

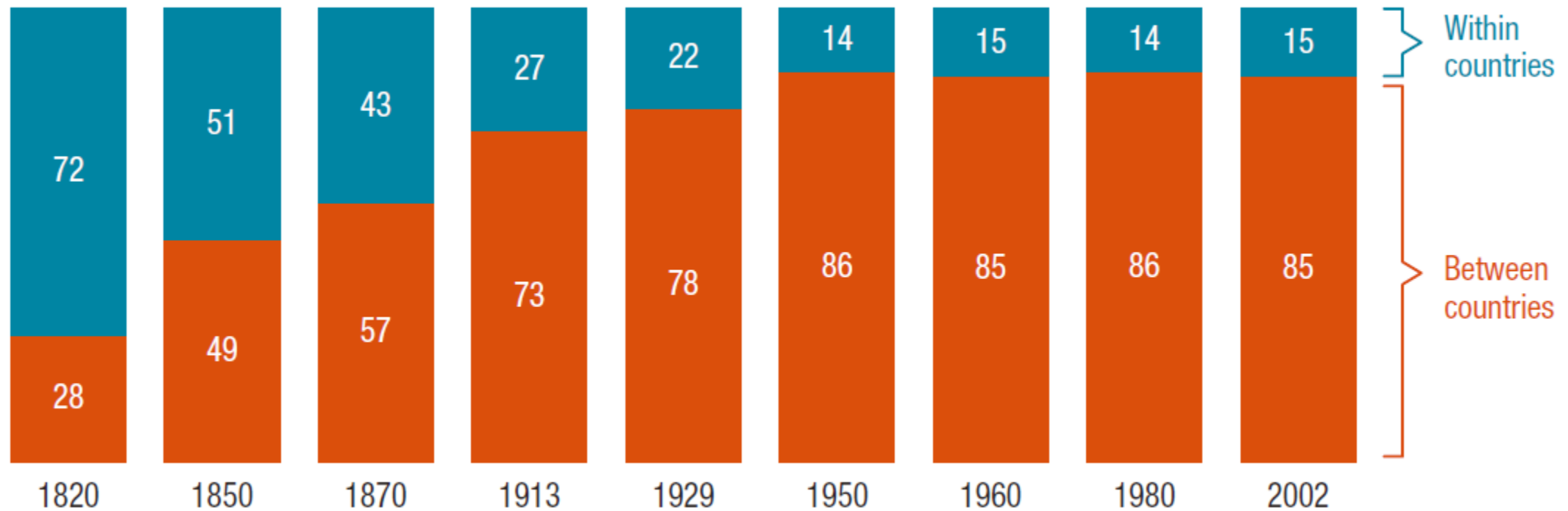
Increasing income inequality, China and India (share of pre-tax national income, percentage)



Source: UNCTAD based on data from the World Inequality Lab.

CONTRIBUTION OF INEQUALITY BETWEEN AND WITHIN COUNTRIES TO GLOBAL INEQUALITY

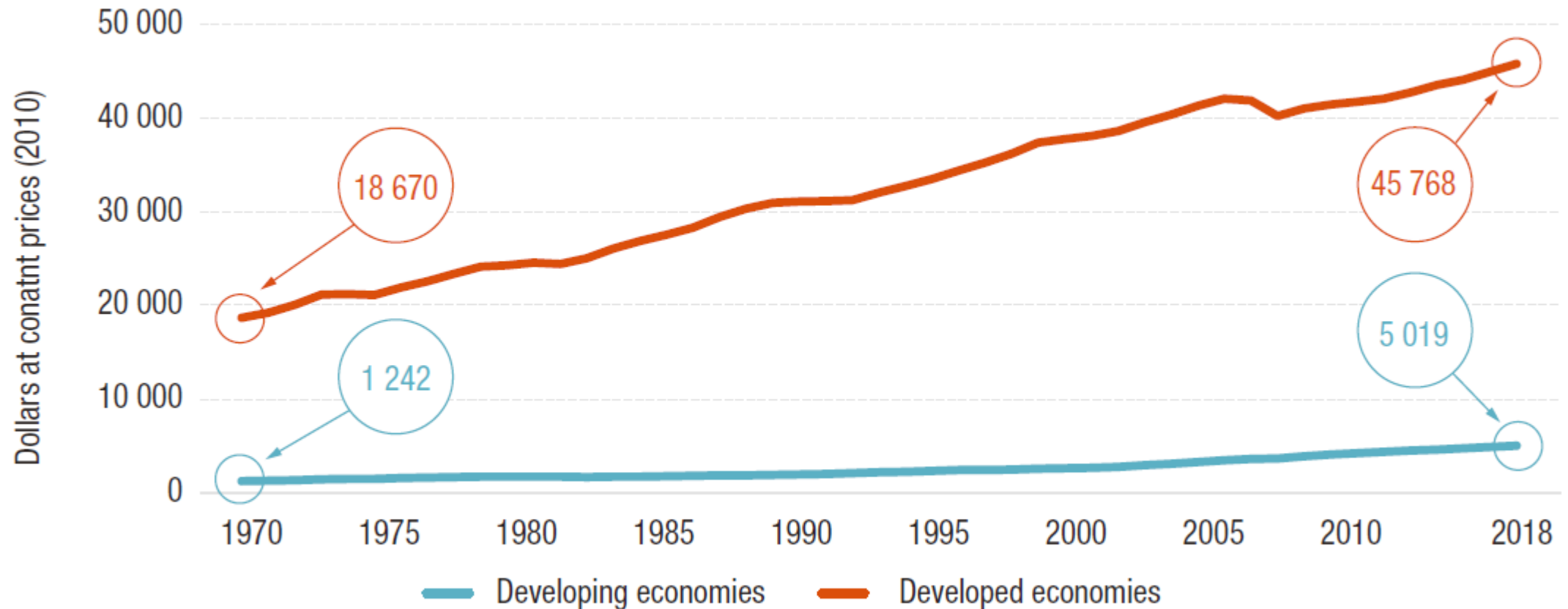
Contribution of inequality between and within countries to global inequality (percentage)



Source: UNCTAD based on Milanovic (2011).

INCREASING INEQUALITY BETWEEN COUNTRIES IN ABSOLUTE TERMS

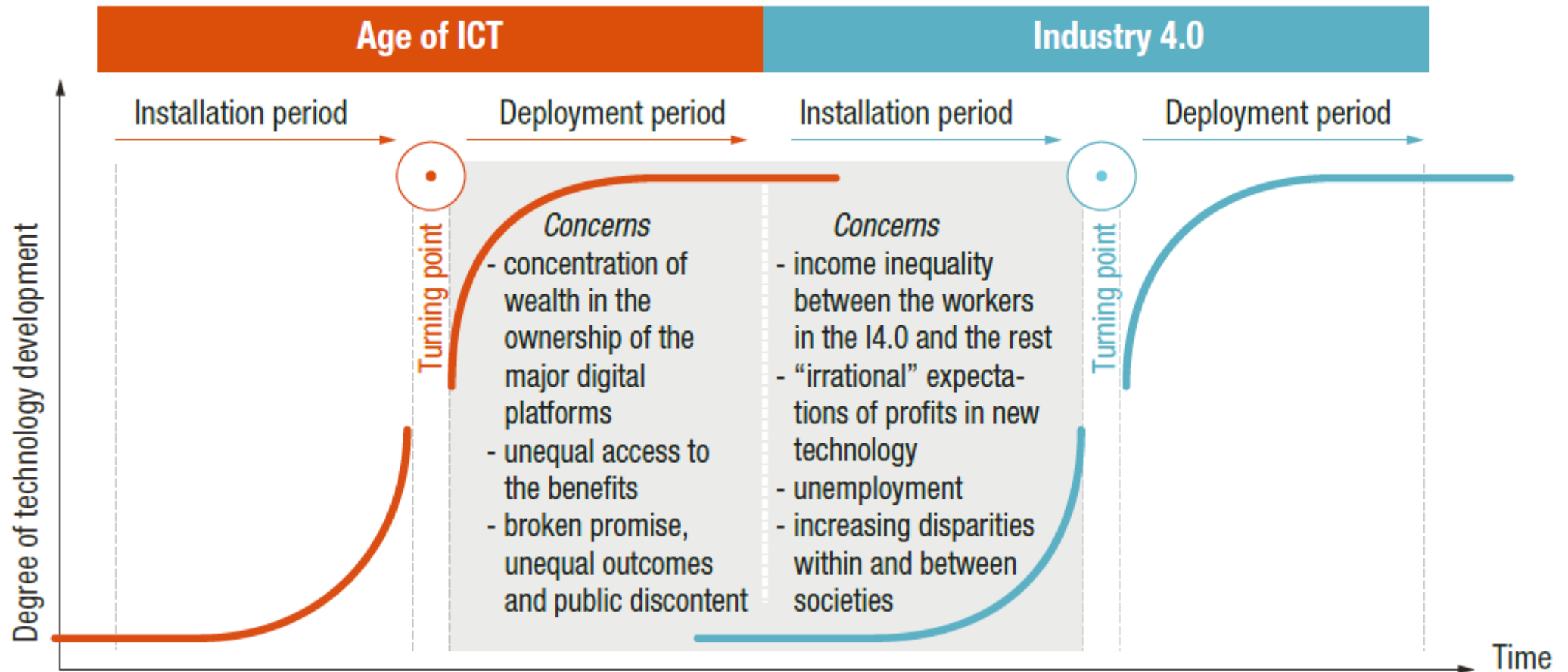
Rise of average GDP per capita in developing and developed economies



Source: UNCTAD calculations based on UNCTADstat.

TWO-PHASE REVOLUTIONS

Technological revolutions and inequalities



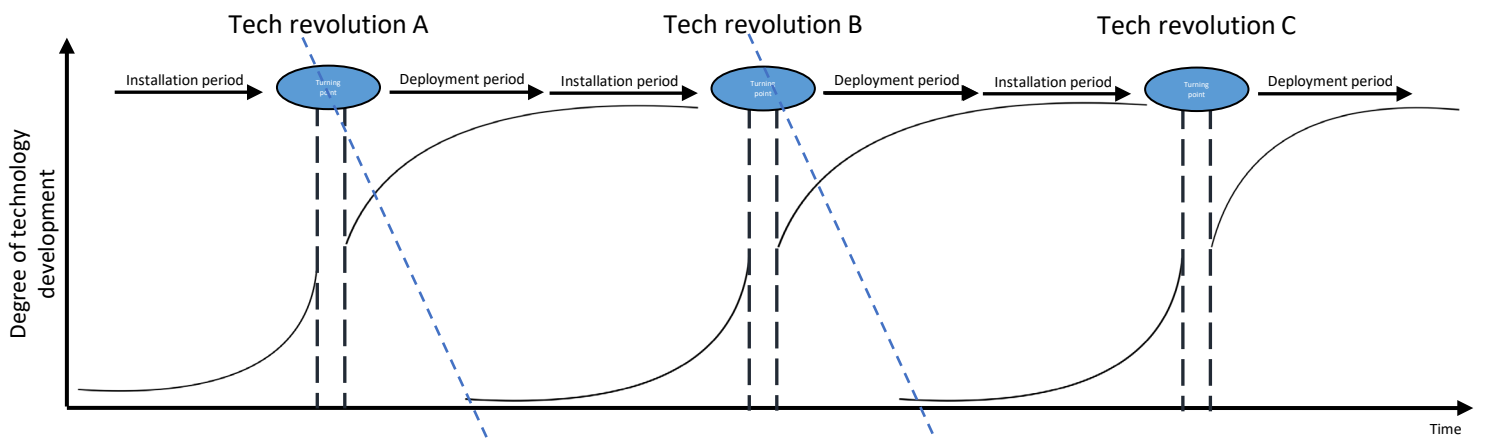
Source: UNCTAD based on Perez (2002).



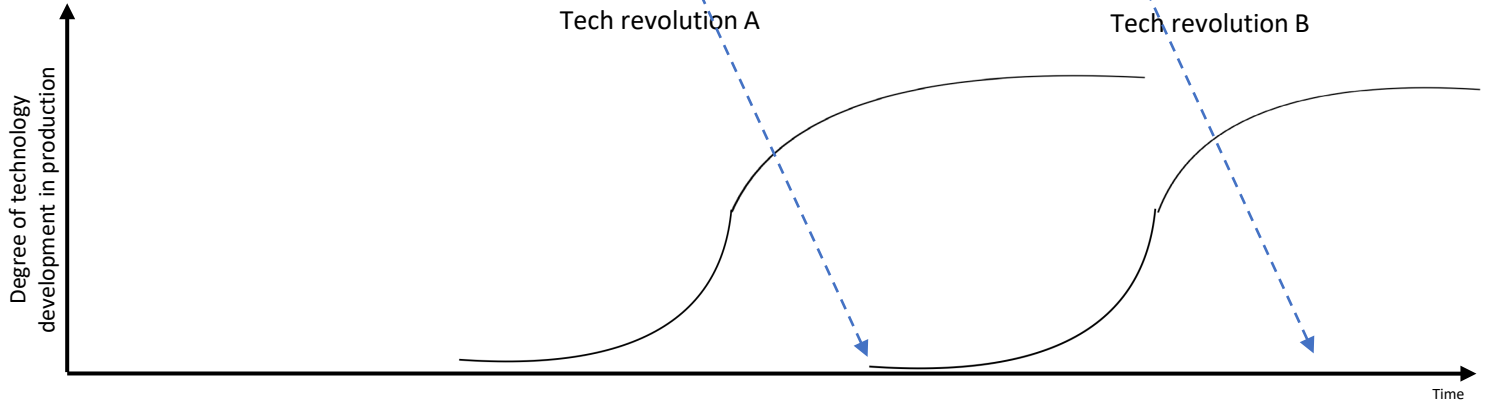
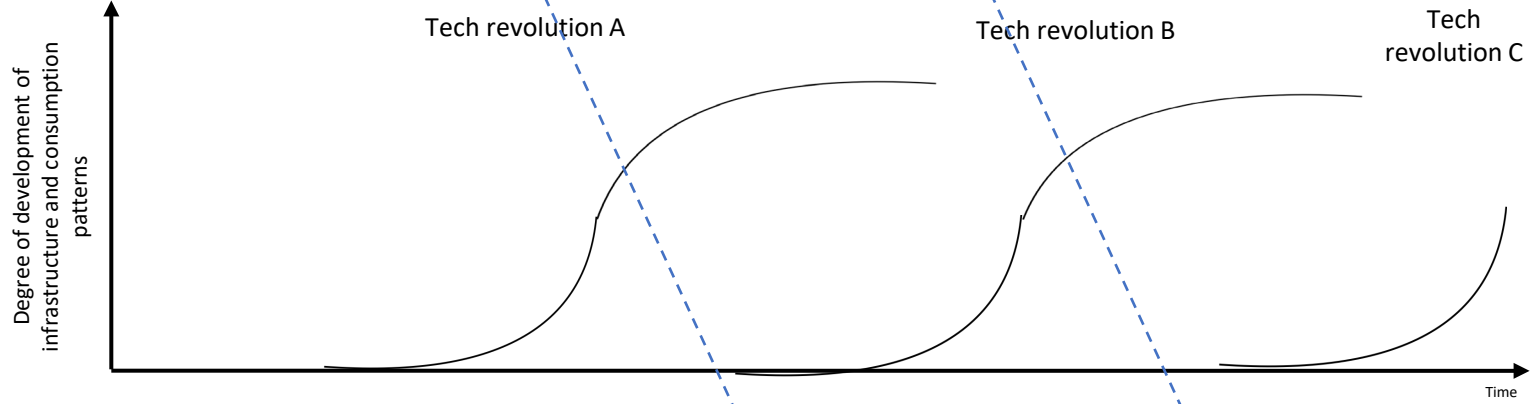
Tech revolution	Techno-economic paradigm
First	The industrial revolution (1771)
Second	Age of steam and railways (1829)
Third	Age of steel, electricity and heavy engineering (1875)
Fourth	Age of oil, automobile and mass production (1908)
Fifth	Age of ICT (1971)
Sixth	Industry 4.0 (2010s speculative)



Core countries

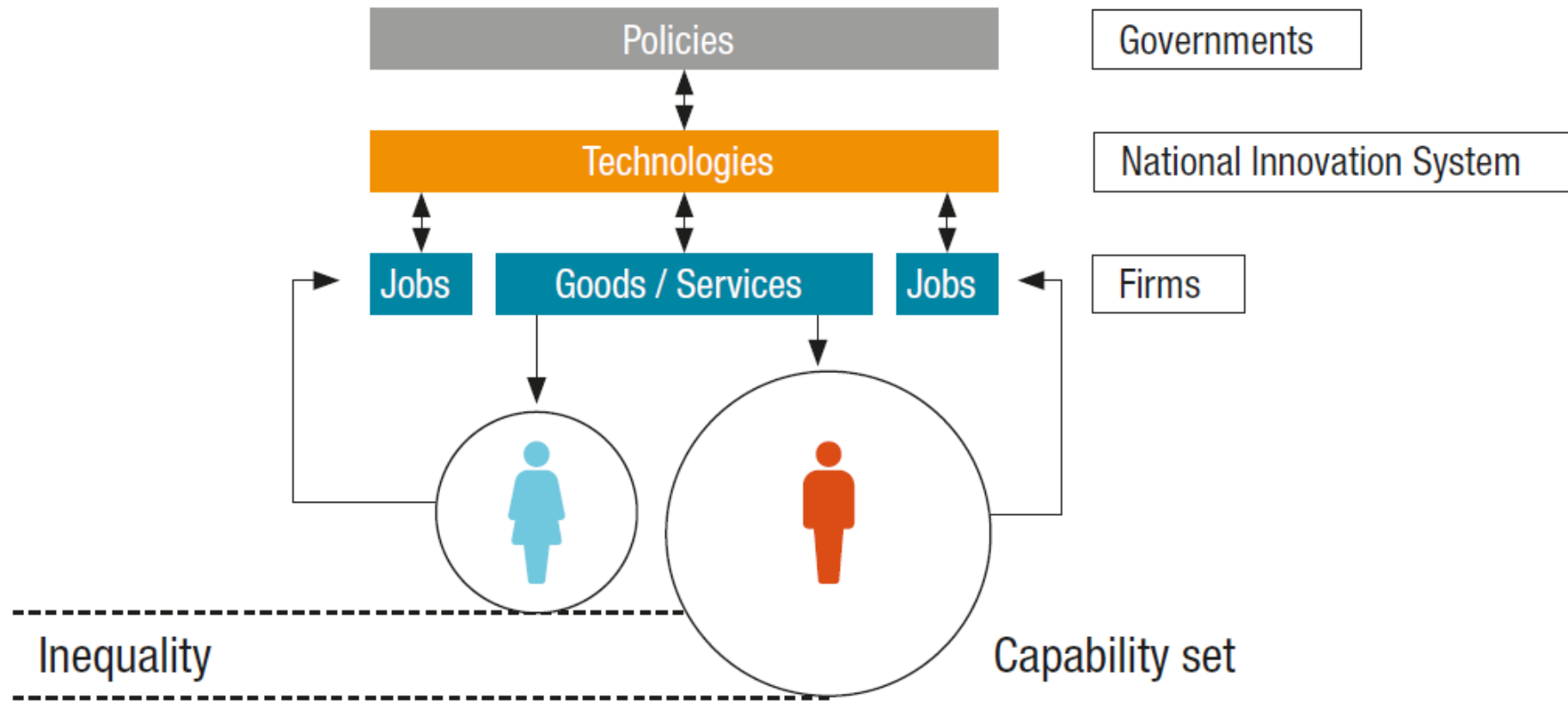


Peripheral countries



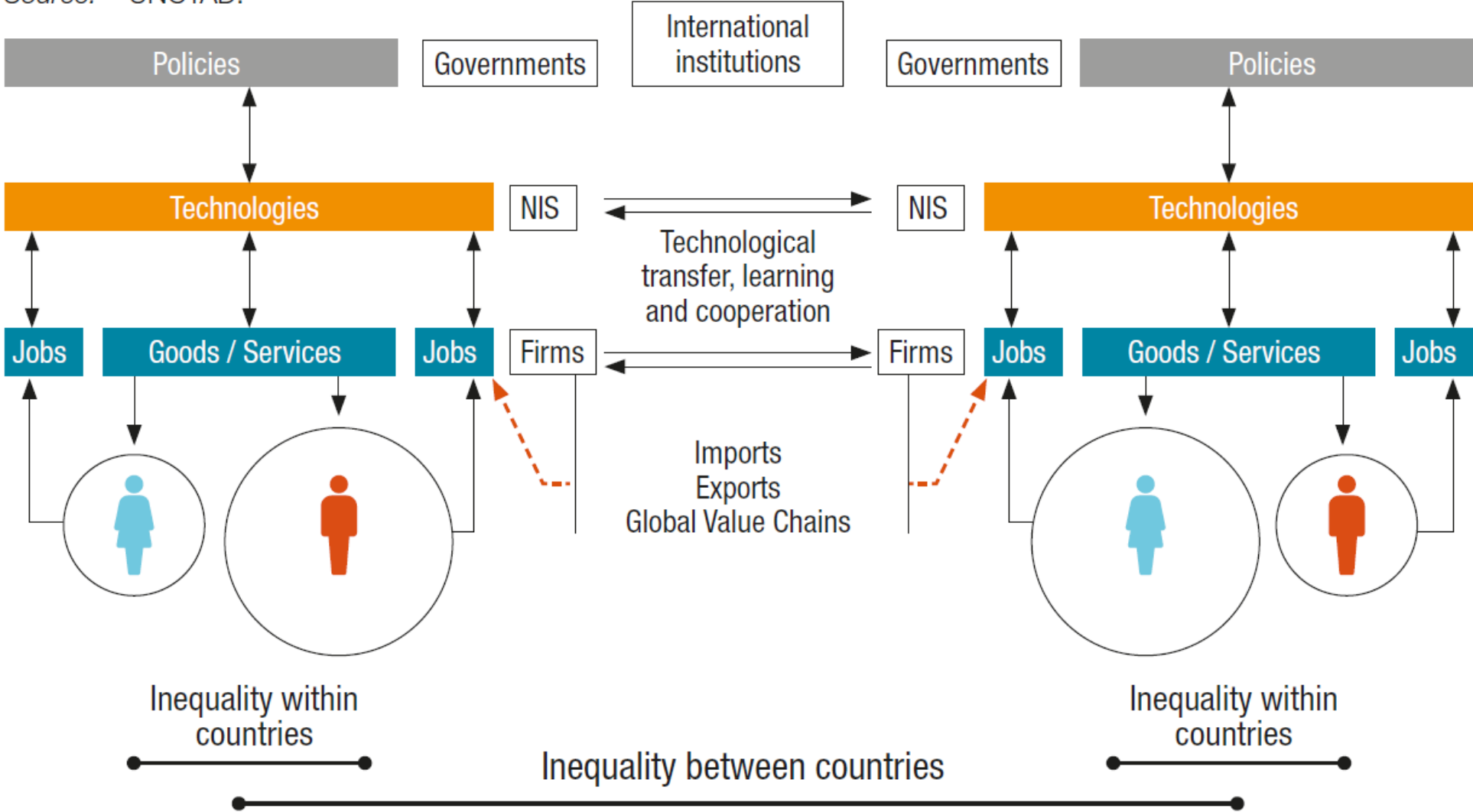
CONCEPTUAL FRAMEWORK

Conceptual framework: Technologies affect inequalities through jobs, and goods and services.



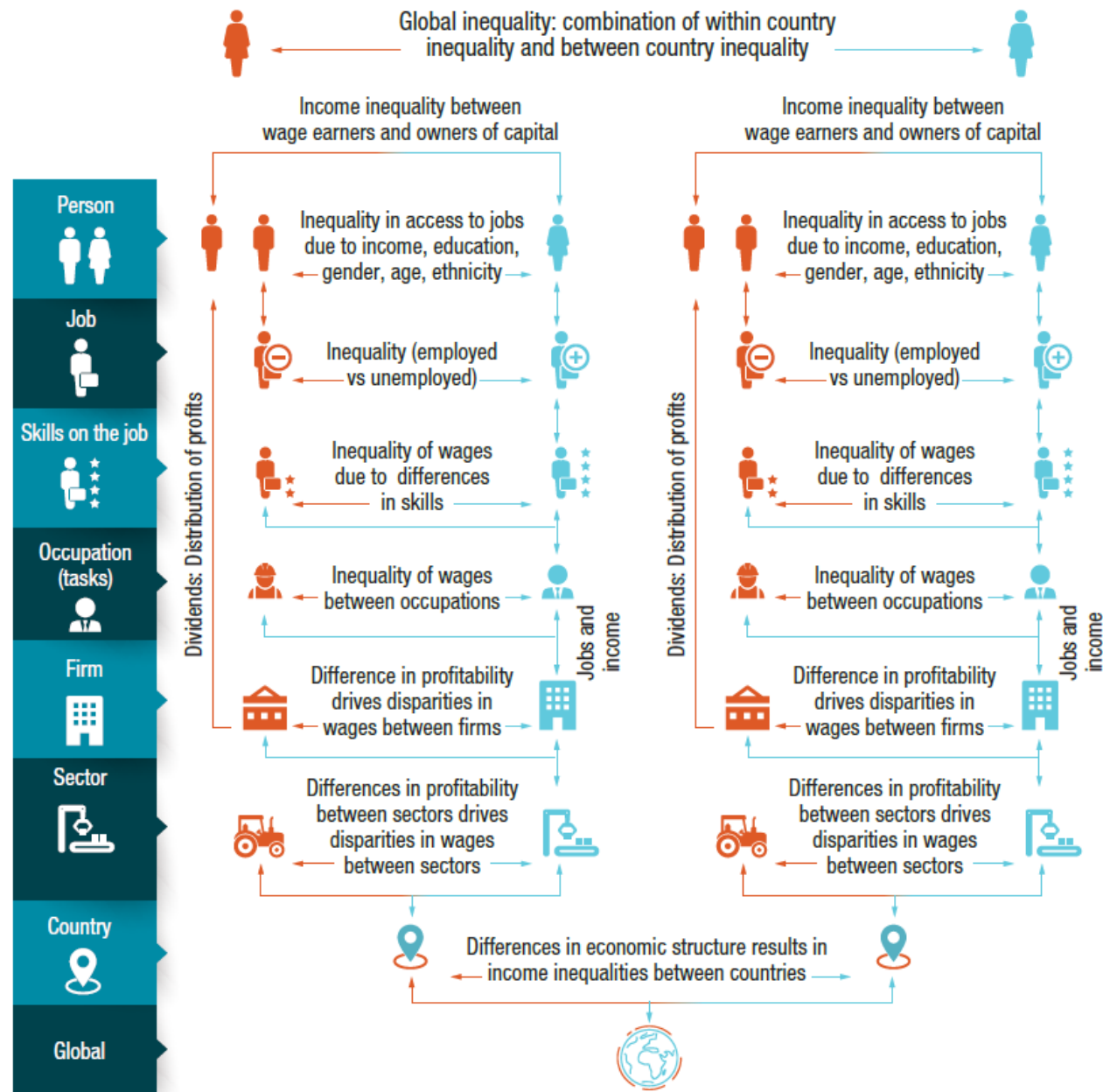
CONCEPTUAL FRAMEWORK

Source: UNCTAD.



HUMANS & MACHINES AT WORK

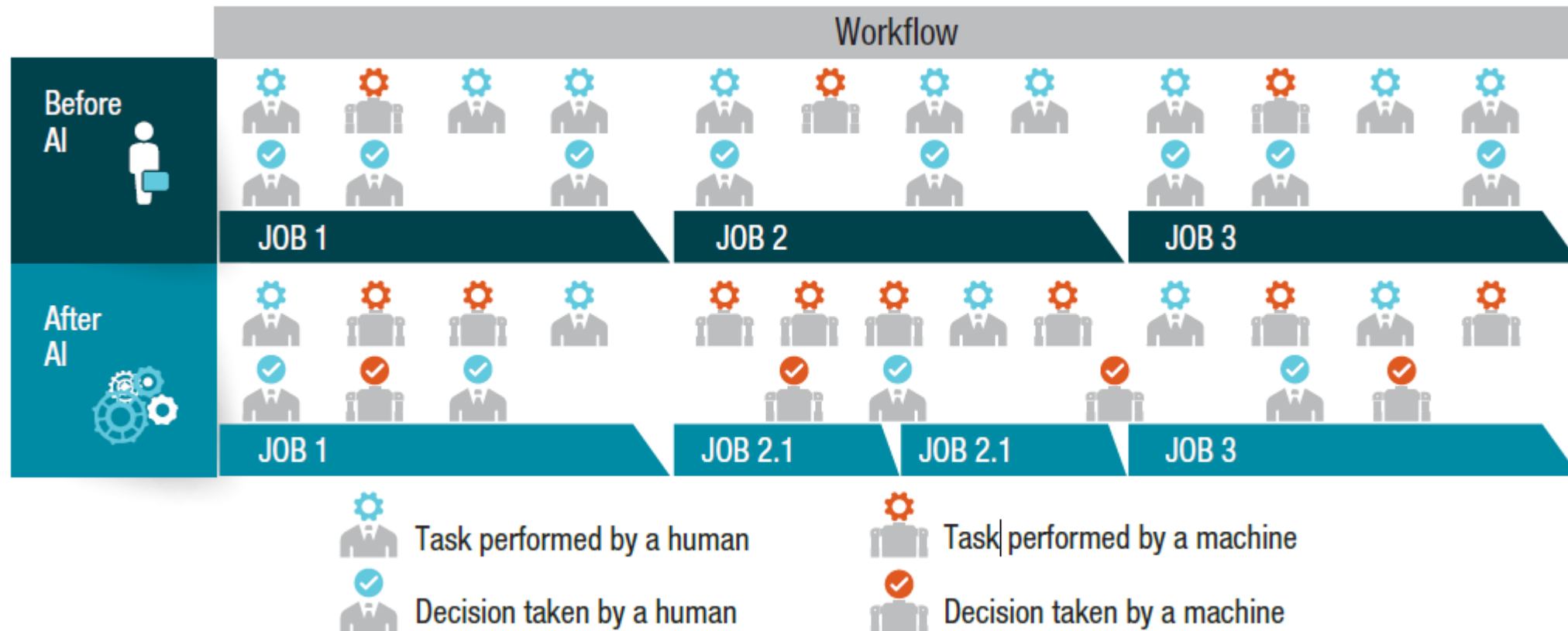
A chain reaction of inequalities



Source: UNCTAD.

AUTOMATION TAKING JOBS

Jobs, tasks, decisions and automation by AI



Source: UNCTAD based on Agrawal et al. (2018) and Acemoglu and Restrepo (2019).

AI AND GLOBAL ECONOMIC INEQUALITIES

TYPE OF INPUT DATA



1

If AI primarily uses 'big data' generated by users, this will mainly benefit the United States and China, whose digital platforms gather massive amounts of such data.



2

If it primarily uses big data gathered by the Internet of Things this would benefit other countries with strong manufacturing – such as the EU, Japan and the Republic of Korea.

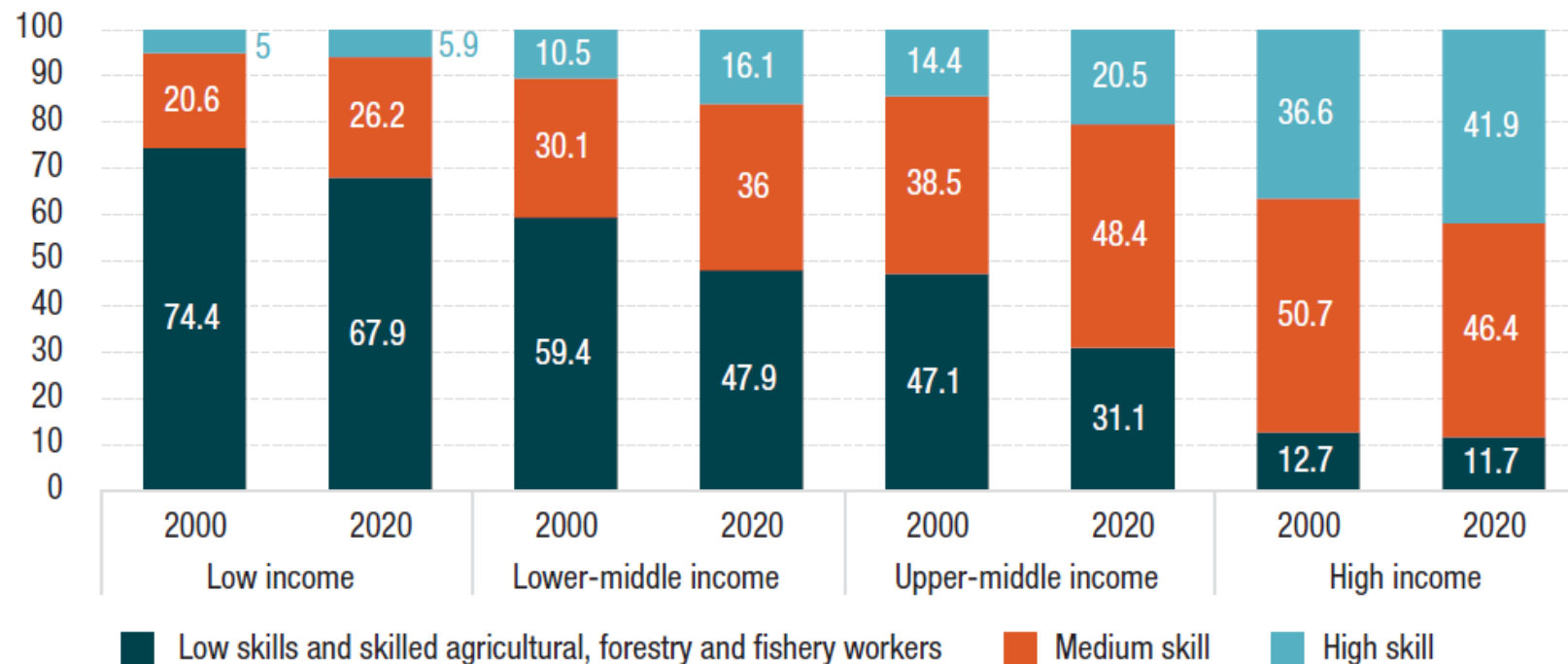


3

Allow computers to learn more like humans by equipping them with conceptual frameworks of how the world works, this would still demand resources and capabilities more likely to be found in the developed countries.

JOB POLARIZATION

Employment by skill level
(Percentage of total civil employment)



Source: UNCTAD based on data from ILOStat according to the ISCO-08.

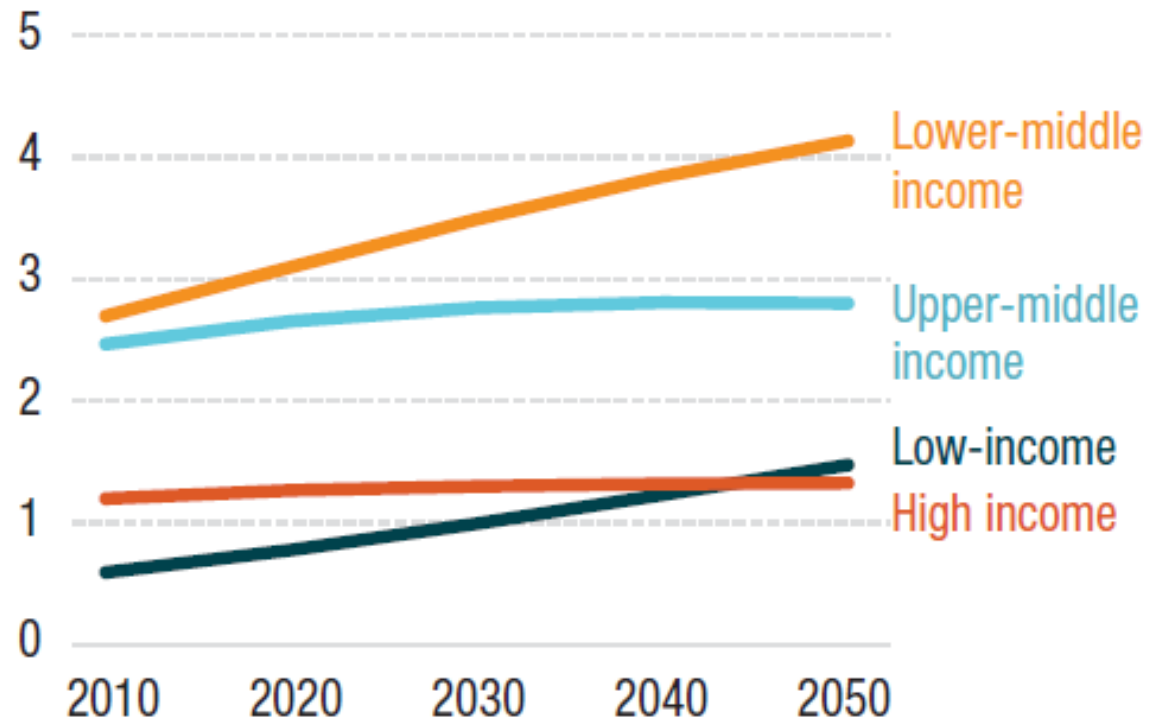
Notes: Following ISCO-08 construction logic, a high skill level refers to major groups 1 to 3, a medium skill level to major groups 4, 5, 7 and 8, and a low skill level to major group 9 (skilled agricultural, forestry and fishery workers correspond to group 6, which is also considered medium skill but is combined with group 9 in the data made available by ILOStat).⁵⁴

THE GIG ECONOMY



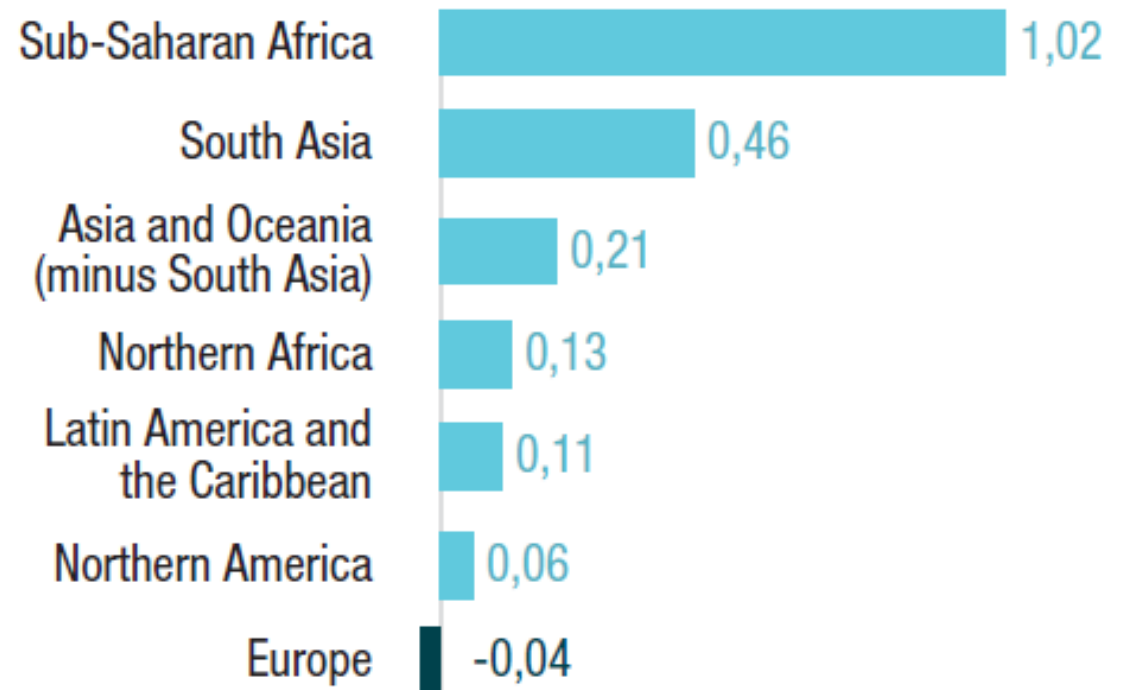
DEMOGRAPHIC CHANGES

Population, by country income group, billions



Source: UNCTADStat.

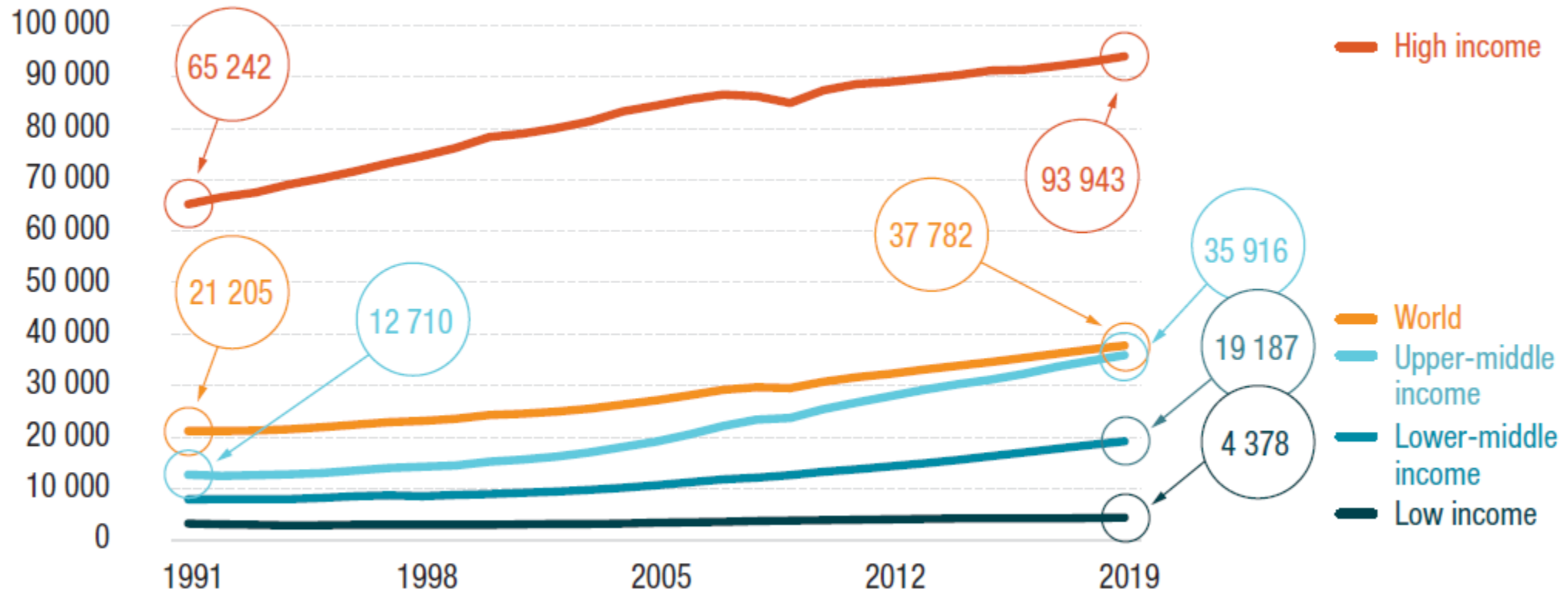
Change in population between 2020 and 2050, billions



Source: UNCTADStat.

TECHNOLOGICAL GAP

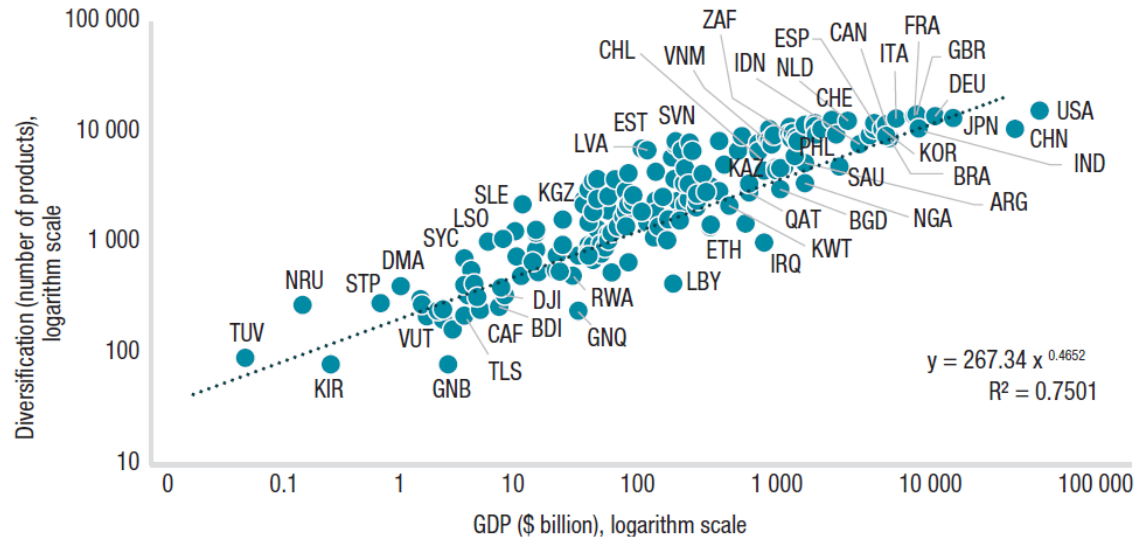
Output per worker, income groupings, \$constant international 2011 prices



Source: UNCTAD based on data from ILOStat.

SLOW DIVERSIFICATION

Association between total GDP and diversification and complexity of economies, 2019



Source: UNCTAD based on UN COMTRADE data.

Note: Based on the number of product categories exported, at the SITC 5-digit level, further disaggregated by unit value using the methodology presented in Freire (2017).

Products connected to each other based on the likelihood of being exported together, selected clusters of products identified



Source: UNCTAD based on The Atlas of Economic Complexity (2020).

Note: Each dot represents a product using the HS 4-digit data classification. Products that are connected have a higher probability of being exported together. Selected clusters of products are indicated for illustrative purposes.

WEAK FINANCING MECHANISMS

R&D expenditures by subgroups

	R&D expenditures (average annual growth rate, 2007-2017, percentage)	GDP (average annual growth rate, 2007-2017, percentage)	R&D expenditures as a percentage of GDP, 2017
Landlocked Developing Countries	5.0	5.8	0.21
Small Island Developing States	2.5	0.9	0.96
Sub-Saharan Africa	4.4	4.4	0.38
Least Developed Countries	6.2	5.1	0.20
Low income countries	7.2	4.0	0.29
Lower middle-income countries	4.5	5.5	0.43
Upper middle-income countries	10.2	5.0	1.48
High income countries	2.3	1.4	2.42
World	4.3	2.6	1.72

Source:

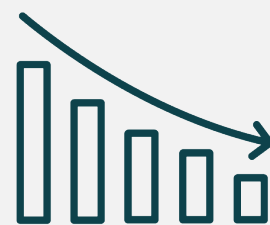
UNCTAD based on UNCTAD (2020), UNESCO (2020).



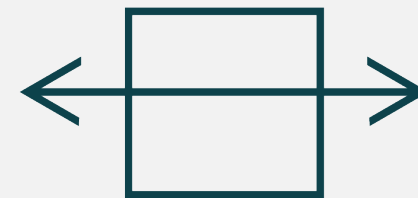
CHALLENGES FOR DEVELOPING COUNTRIES



Demographic changes



Low economic diversification



Existing technological gaps



Weak financing mechanism



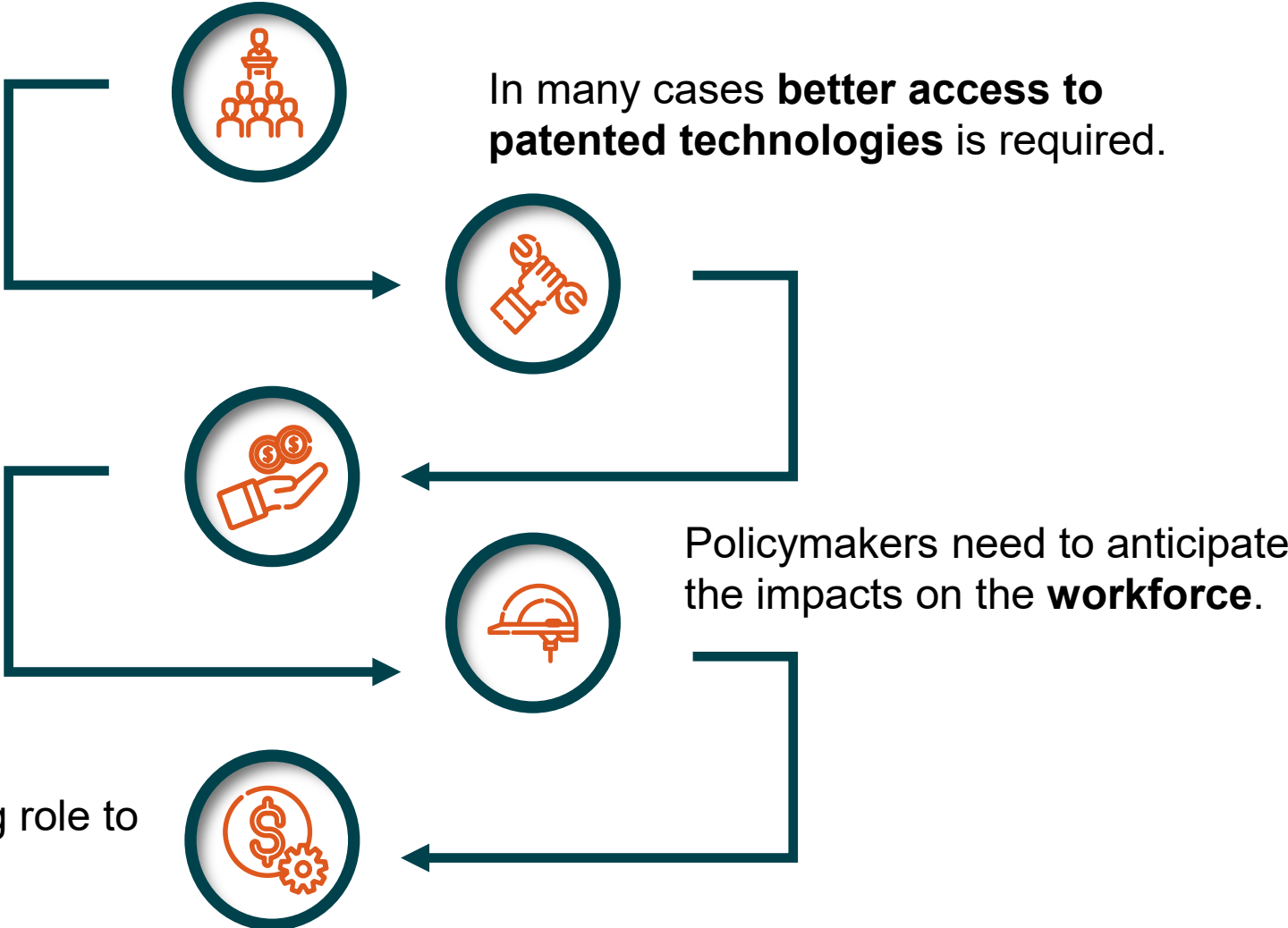
Stringent intellectual property rights

ACCELERATING TOWARDS INDUSTRY 4.0

National innovation policies need to align with industrial policies.

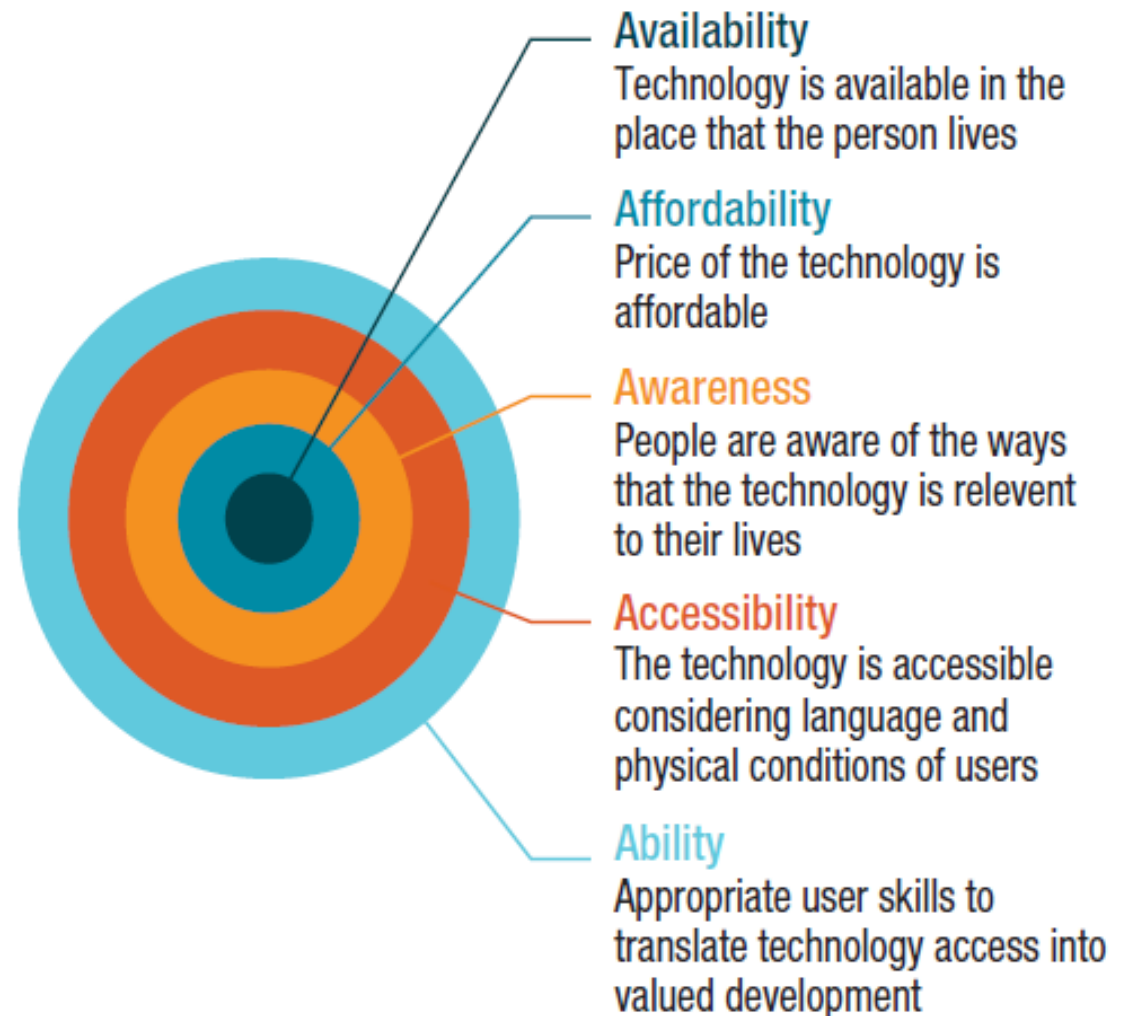
Finance source include official sources, impact investment, venture capital, crowdfunding, and Innovation and technology funds.

Labour unions will also have a big role to play to protect workers



TECHNOLOGIES AFFECTING INEQUALITIES THROUGH ACCESS & DESIGN

Five as of technology access



Source: UNCTAD based on Roberts (2017) and Hernandez and Roberts (2018).

CHALLENGES FOR DEVELOPING COUNTRIES



Higher levels of poverty

Average share of the population living in extreme poverty:
upper-middle-income 2%
low-income countries 45%.



Digital divide

Almost half of the world's population remains offline

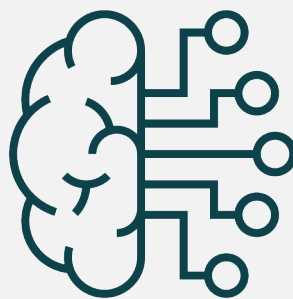


Shortage of Skills

in developing countries, the basic computer skills are on average 20 percentage points lower than in developed countries



RISKS OF BIAS AND DISCRIMINATION



AI algorithms with built in bias



Genomic inequalities



Gene editing and intellectual property



Ethical questions in gene editing

THE TIR 2021 COVERS 11 FRONTIER TECHNOLOGIES

Frontier technologies are new and rapidly developing technologies that take advantage of digitalization and connectivity. This report covers 11 of these technologies:

Artificial Intelligence (AI)



The Internet of Things (IoT),



Big Data



Blockchain



5G



3D printing



Robotics



Drones



Gene Editing



Nanotechnology



Solar Photo-voltaic (Solar PV)

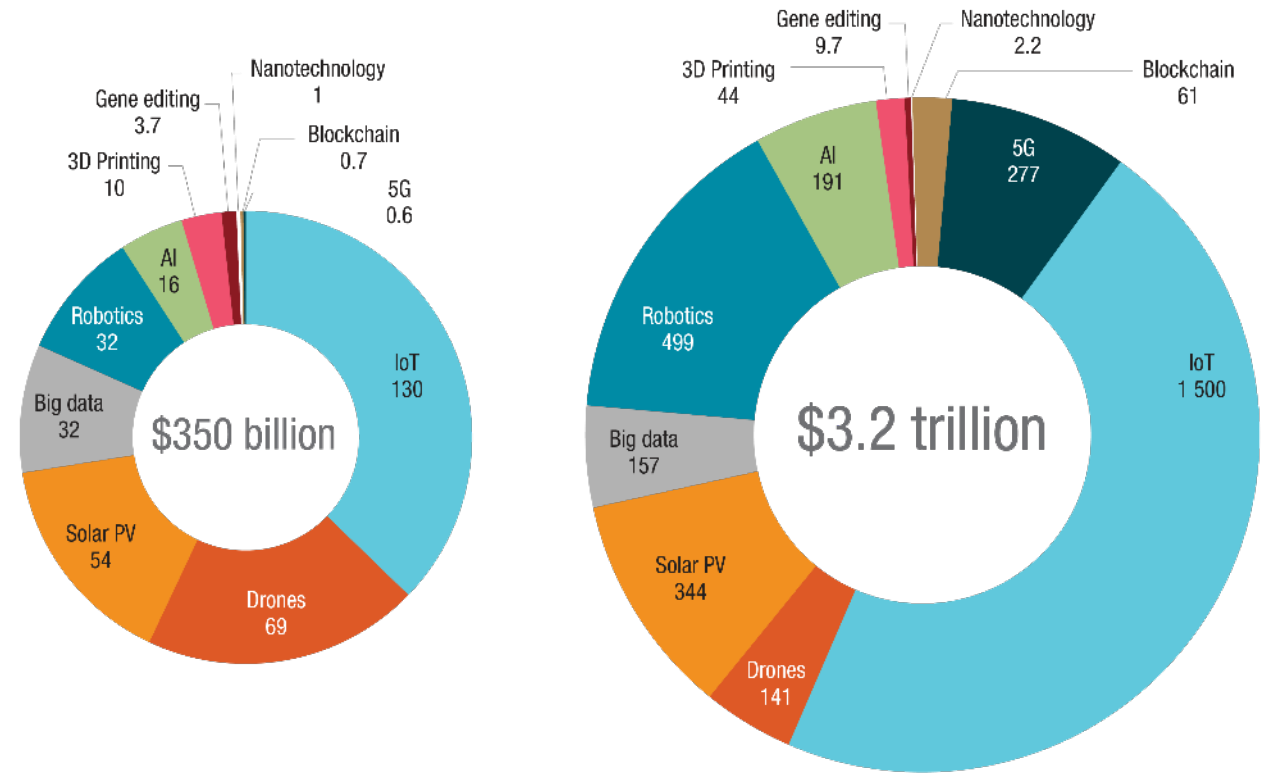


Market size estimates of Frontier technologies, \$billions

2018

2025

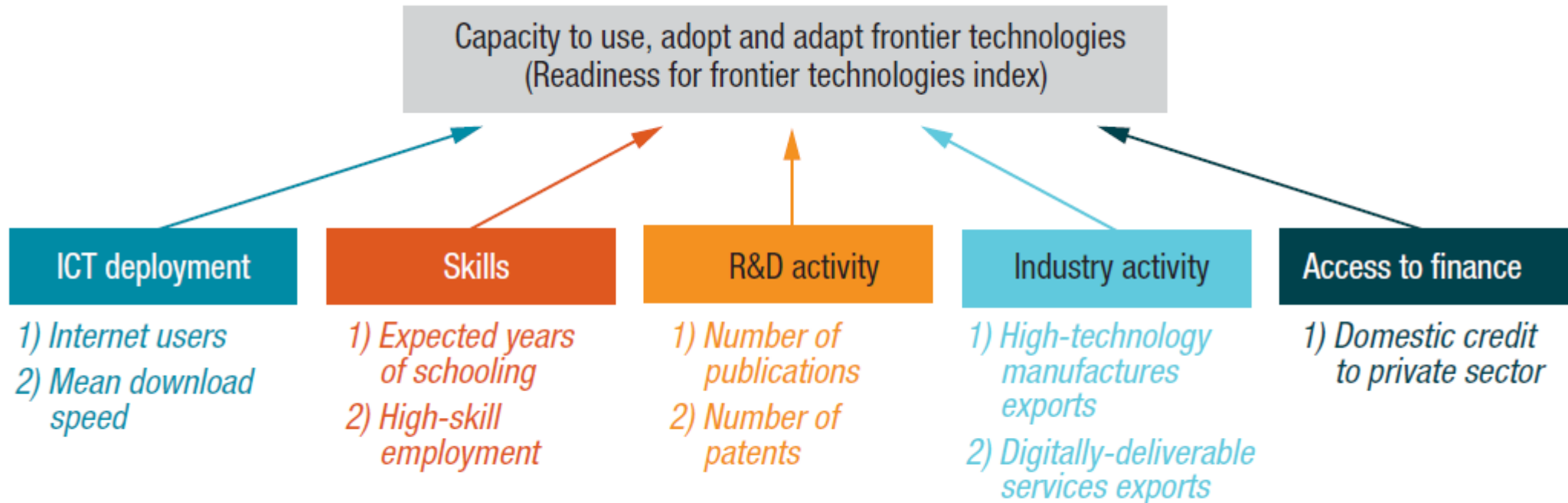
FRONTIER TECHNOLOGY MARKETS ARE EXPECTED TO GROW RAPIDLY



Source: UNCTAD based on data estimates from Froese (2018), MarketsandMarkets (2018), Sawant and Kakadee (2018), Business Wire (2019), Chaudhary et al. (2019), GlobeNewswire (2019b), MarketsandMarkets (2019), MarketWatch (2019a), MarketWatch (20191), Raza (2019), Tewari and Baul (2019), Wagner (2019b), Mordor Intelligence (2020a).

A COUNTRY READINESS INDEX

Structure of the readiness index



Source: UNCTAD.

A COUNTRY READINESS INDEX

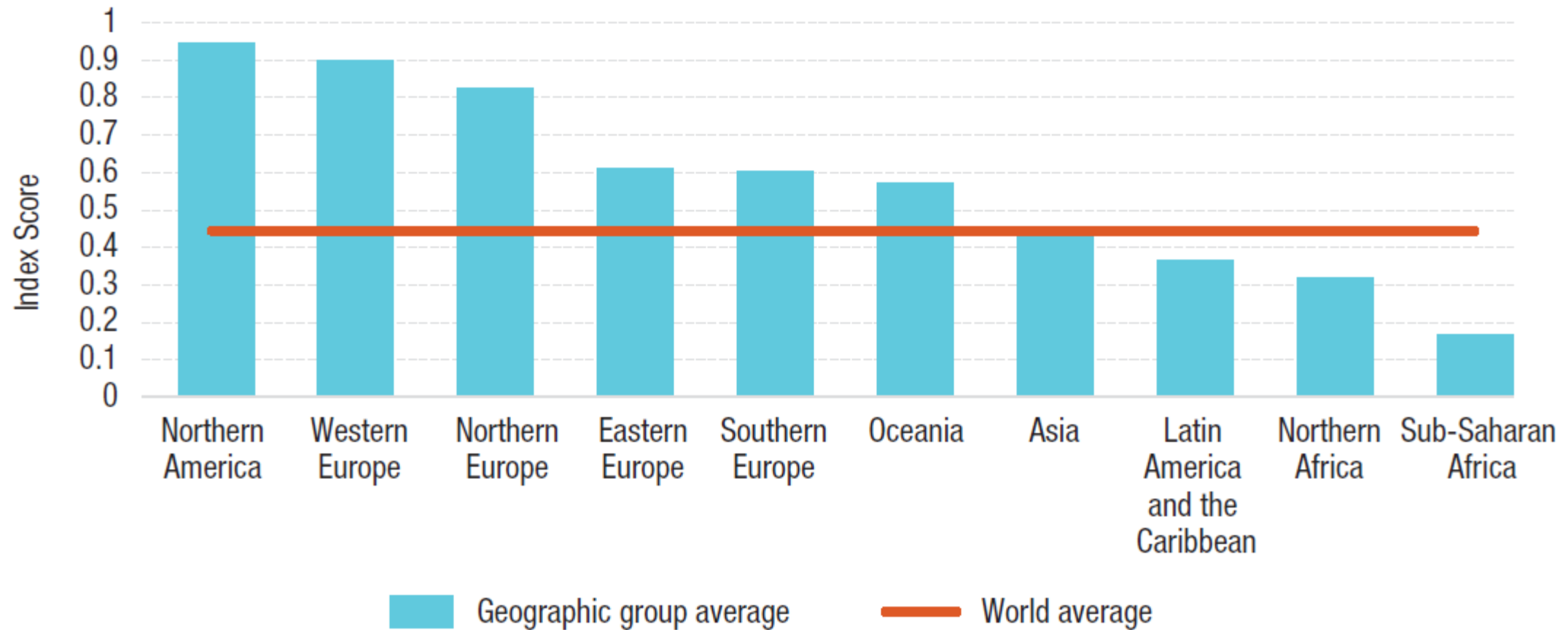
Readiness towards the use, adoption and adaptation of frontier technologies, selected countries

Country name	Total ranking	ICT ranking	Skills ranking	R&D ranking	Industry ranking	Finance ranking
Top 10						
United States of America	1	14	17	2	20	2
Switzerland	2	7	13	13	3	3
United Kingdom	3	17	12	6	11	14
Sweden	4	1	7	16	15	16
Singapore	5	4	9	18	4	18
Netherlands	6	6	10	15	8	23
Korea, Republic of	7	19	27	3	9	8
Ireland	8	24	6	21	1	87
Germany	9	23	16	5	10	39
Denmark	10	2	4	25	21	5
Selected transition and developing economies						
China	25	99	96	1	7	6
Russian Federation	27	39	28	11	66	45
Brazil	41	73	53	17	42	60
India	43	93	108	4	28	76
South Africa	54	69	84	39	71	13

Source: UNCTAD (see the complete table in Statistical Appendix. Readiness for frontier technologies index).

A COUNTRY READINESS INDEX

Average index score by geographical group



Source: UNCTAD.

COUNTRIES OVERPERFORMING RELATIVE TO PER CAPITA GDP

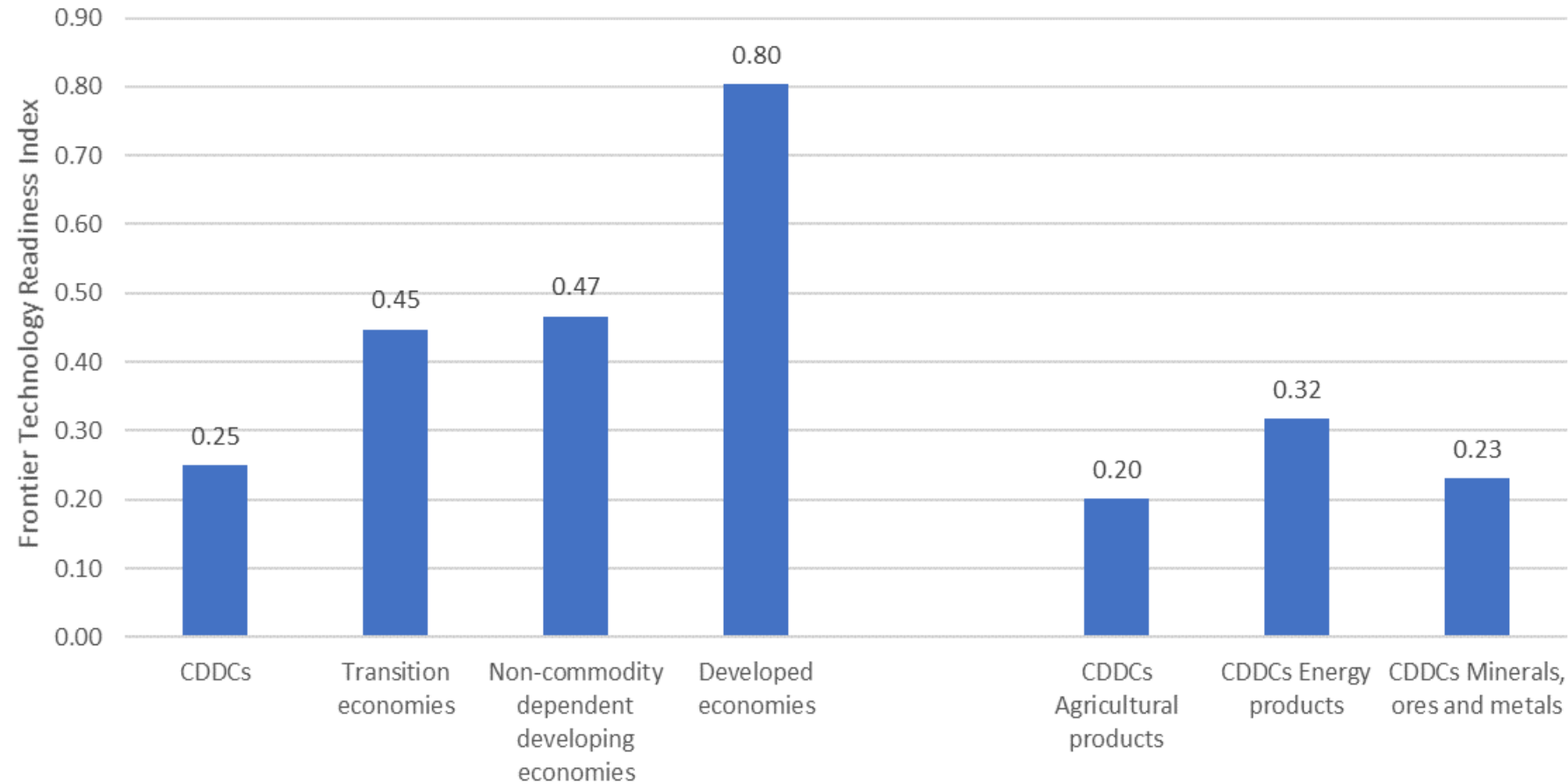
Gain in ranking position.

	Country	Overperformance (positions)		Country	Overperformance (positions)
1	India	65	11	Morocco	29
2	Philippines	57	12	Kenya	28
3	Ukraine	47	13	Nepal	28
4	Viet Nam	45	14	Serbia	25
5	China	40	15	Korea, Republic of	24
6	Jordan	34	16	Russian Federation	24
7	Brazil	33	17	Lebanon	24
8	Republic of Moldova	33	18	Togo	23
9	South Africa	29	19	United Kingdom	21
10	Tunisia	29	20	Ghana	20

Source: UNCTAD calculations based on GDP data by the World Bank (World Bank, 2020).

Note: Overperformance by gain in ranking position are measured taking the difference in positions between the actual index rankings and the estimated index rankings based on per capita income. For instance, India's actual index ranking was 43 while the estimated index ranking based on per capita income was 108. Hence, India overperformed by 65 ranking positions.

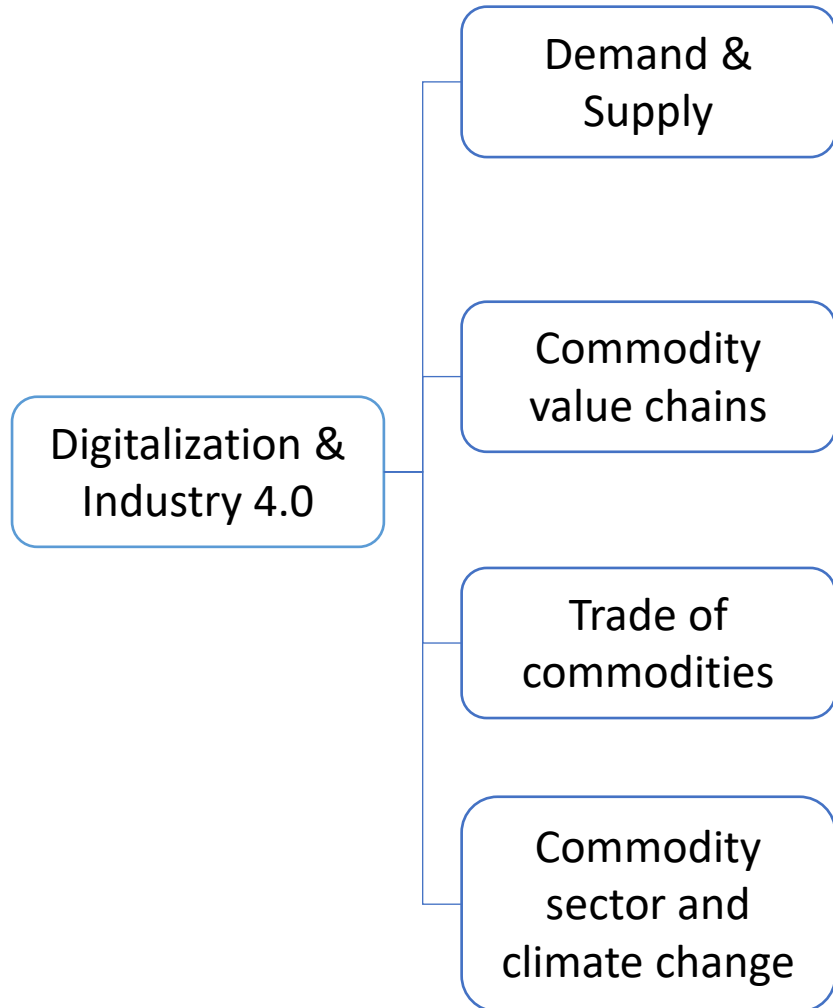
CDDCs are less prepared to adopt and adapt frontier technologies



Source: UNCTAD based on the frontier technology readiness index in the Technology and Innovation Report 2021.

Note: The frontier technology index is computed based on indicators in five dimensions: ICT deployment, skills, R&D activity, industry activity, and finance access.

The potential impact of digitalization and Industry 4.0 on commodity sectors and related GVCs

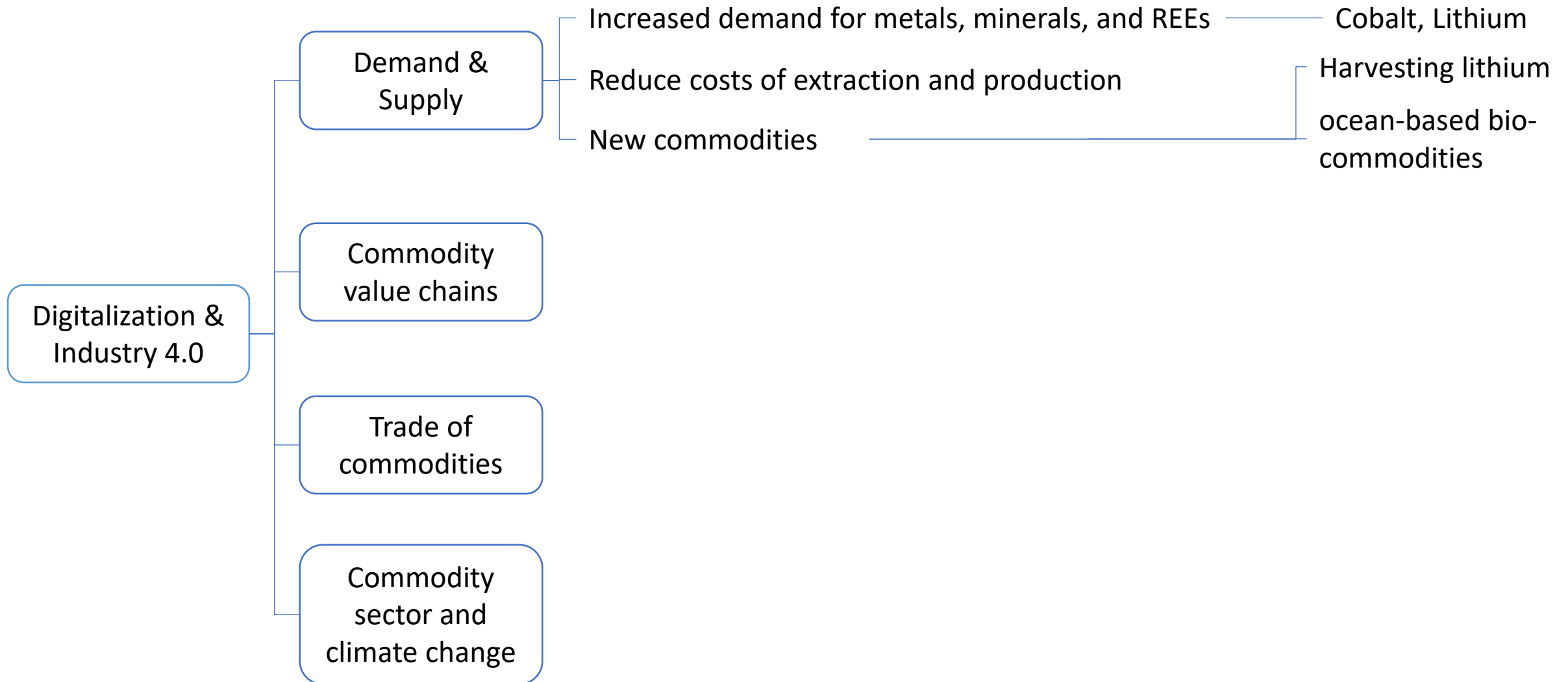


A more renewable-energy-intensive economy will result in greater overall demand for metals

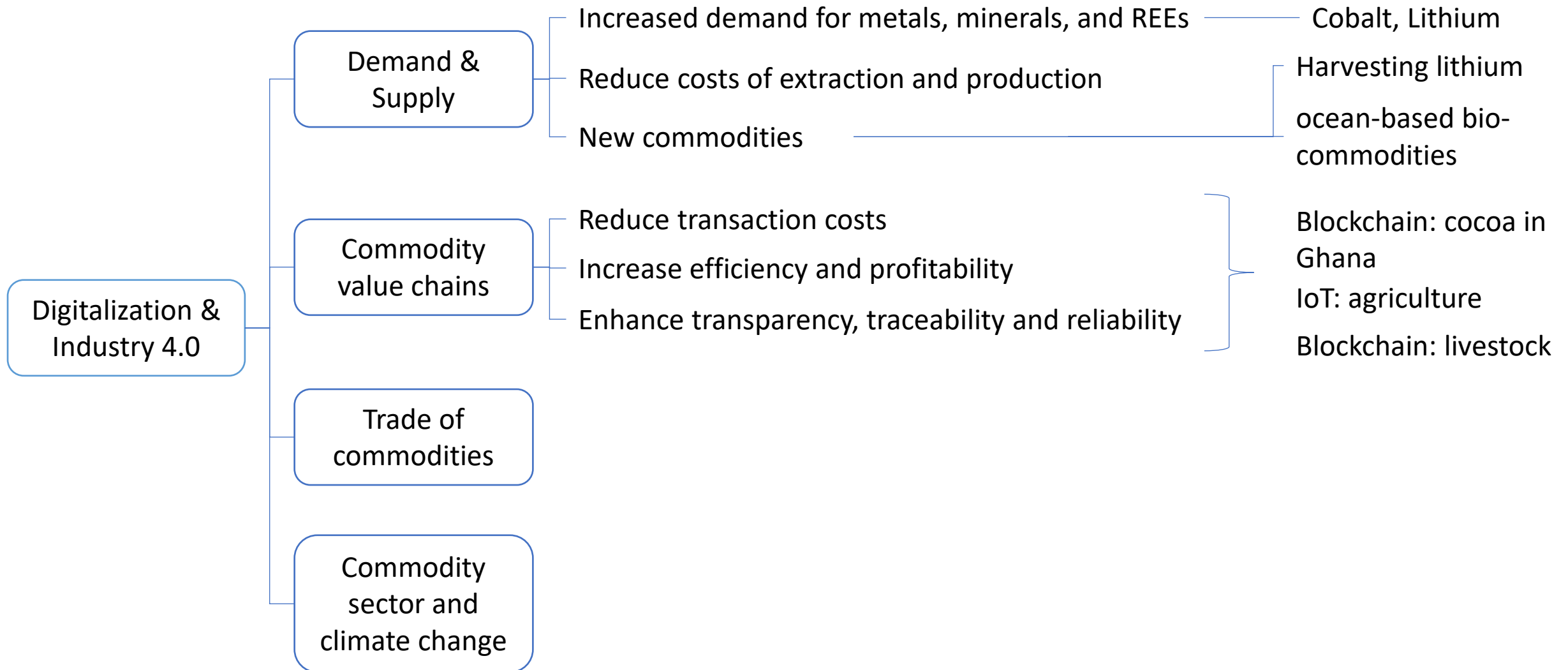
Peak annual demand from renewable energy and storage compared to current production (2017 data)

	Tonnes	% of annual production	Year of peak demand	Top reserve countries (global share)
Cobalt	1 966 469	1788	2050	Congo, D.R.(71,39%), Canada (3,58%), Russia(3,41%), Cuba(3,39%),Australia(3,12%)
Dysprosium	11 524	640	2050	China (99%)
Lithium	4 112 867	8 845	2050	Australia (60,58%), Chile(20,48%), Argentina(7,28%), Canada(4,61%), China(3,45%)
Neodymium	94 687	592	2050	China (86%), USA (6%), Australia (2%), Russia (2%)
Nickel	6 581 326	313	2050	Indonesia (24,16%), Philippines (15,29%), Russia (9,66%), New Caledonia (9,58%), Canada (7,98%)
Tellurium	834	199%	2035	China (74,19%), Japan (8,96%), Sweden (6,96%), Russia (5,41%), Canada (3,86%)

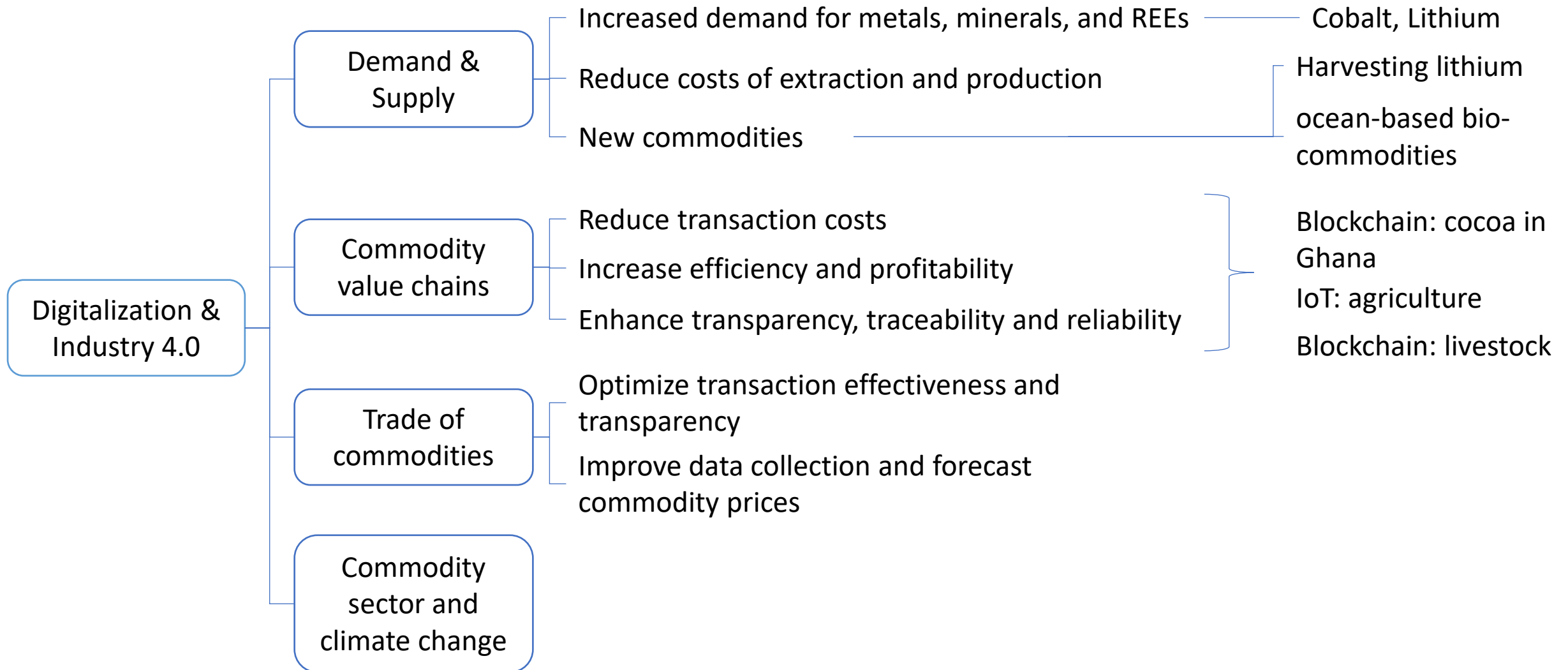
The potential impact of digitalization and Industry 4.0 on commodity sectors and related GVCs



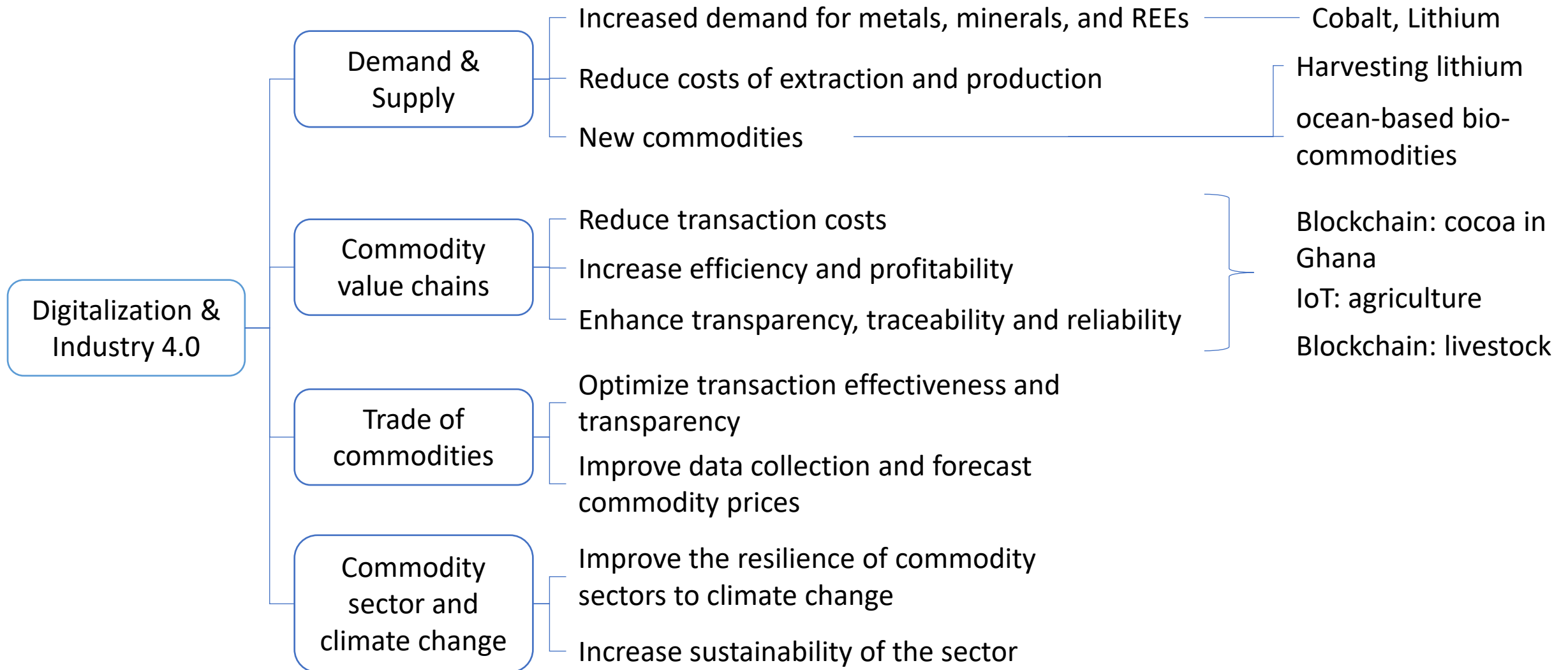
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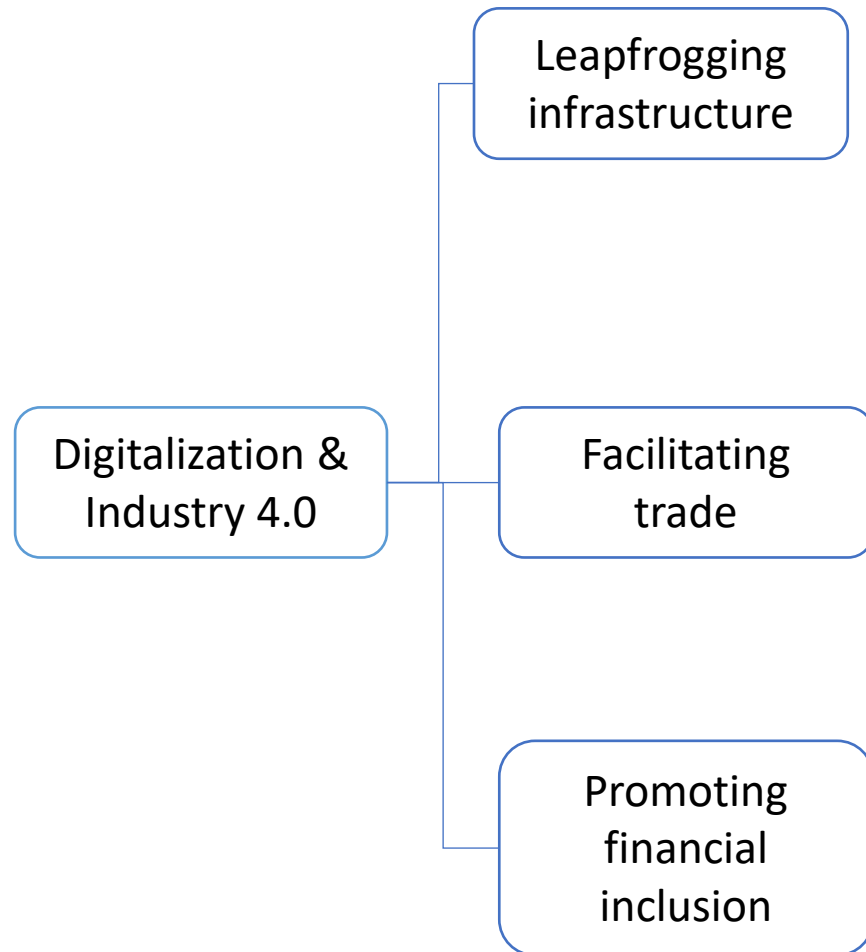
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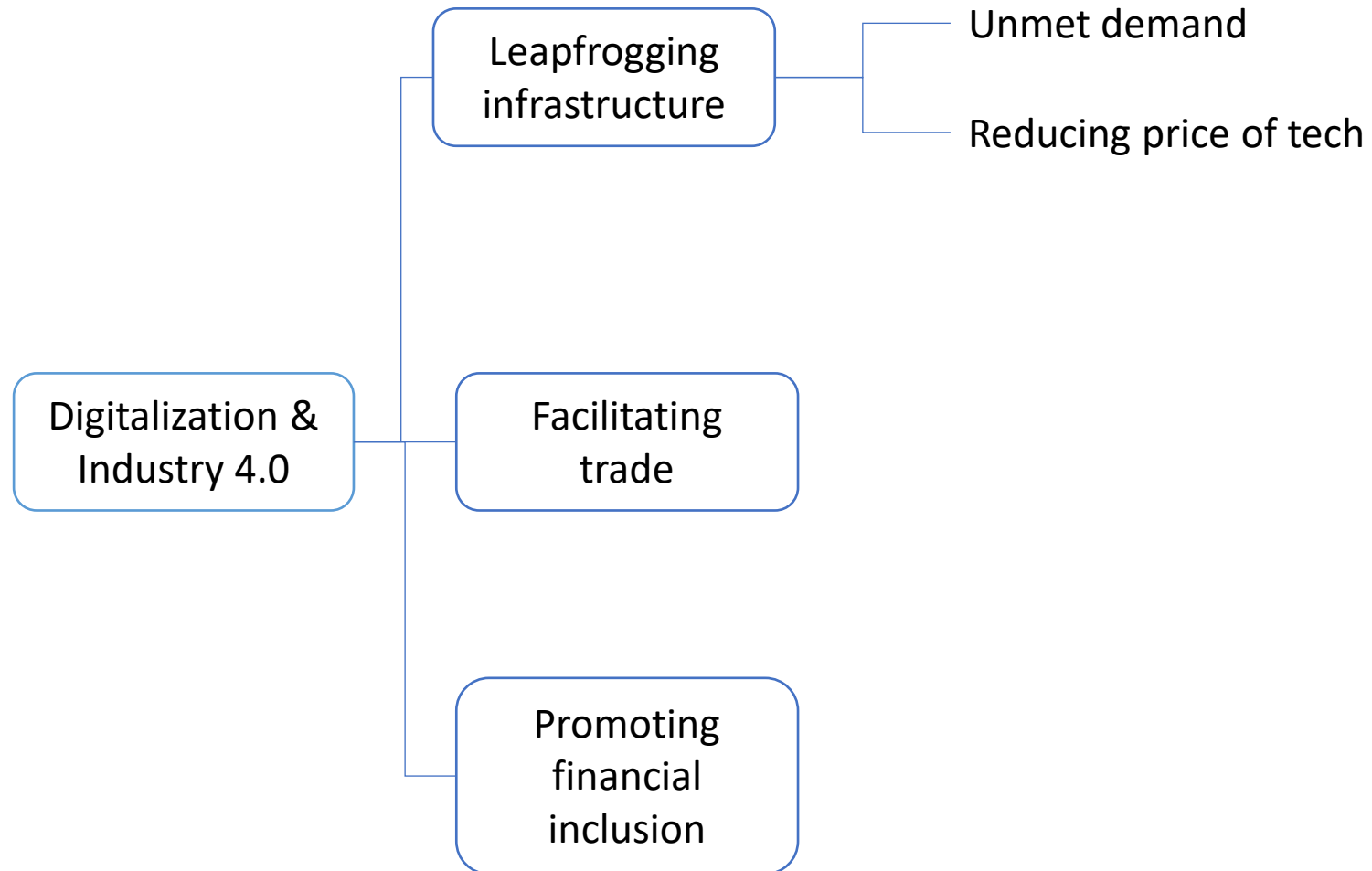
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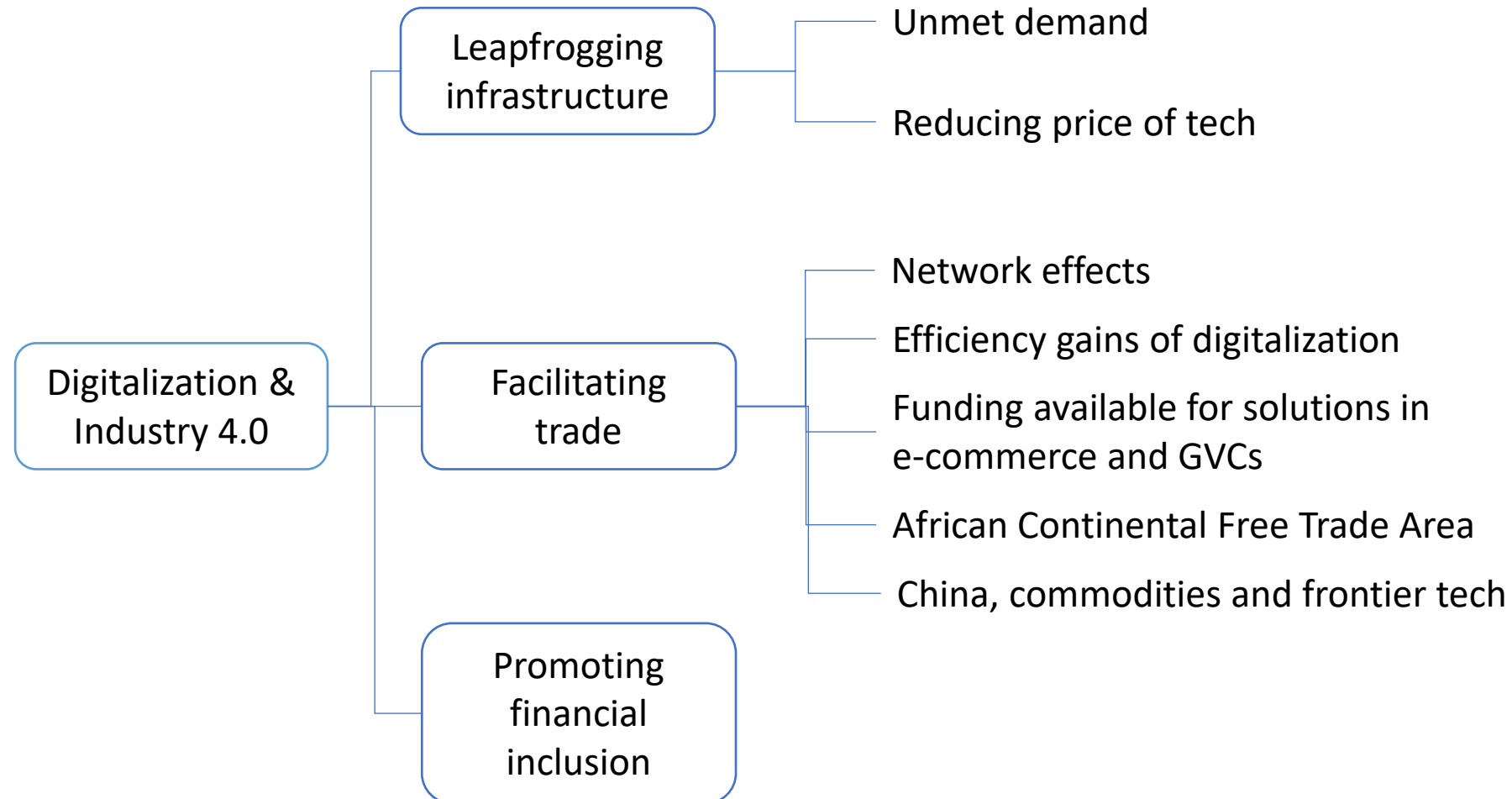
Windows of opportunity on deploying digital technologies and preparing the ground for the 4th Industrial revolution in CDDCs



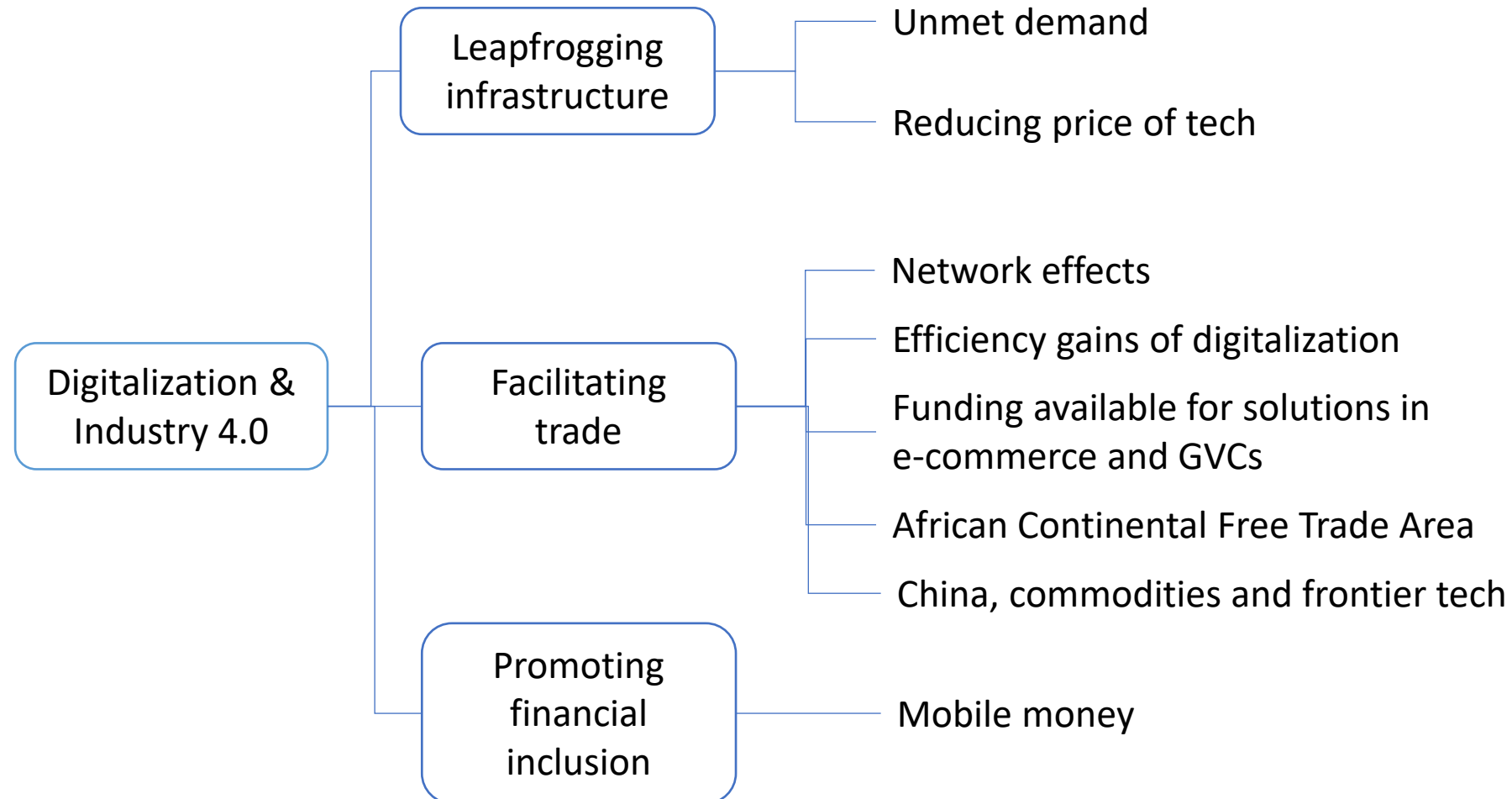
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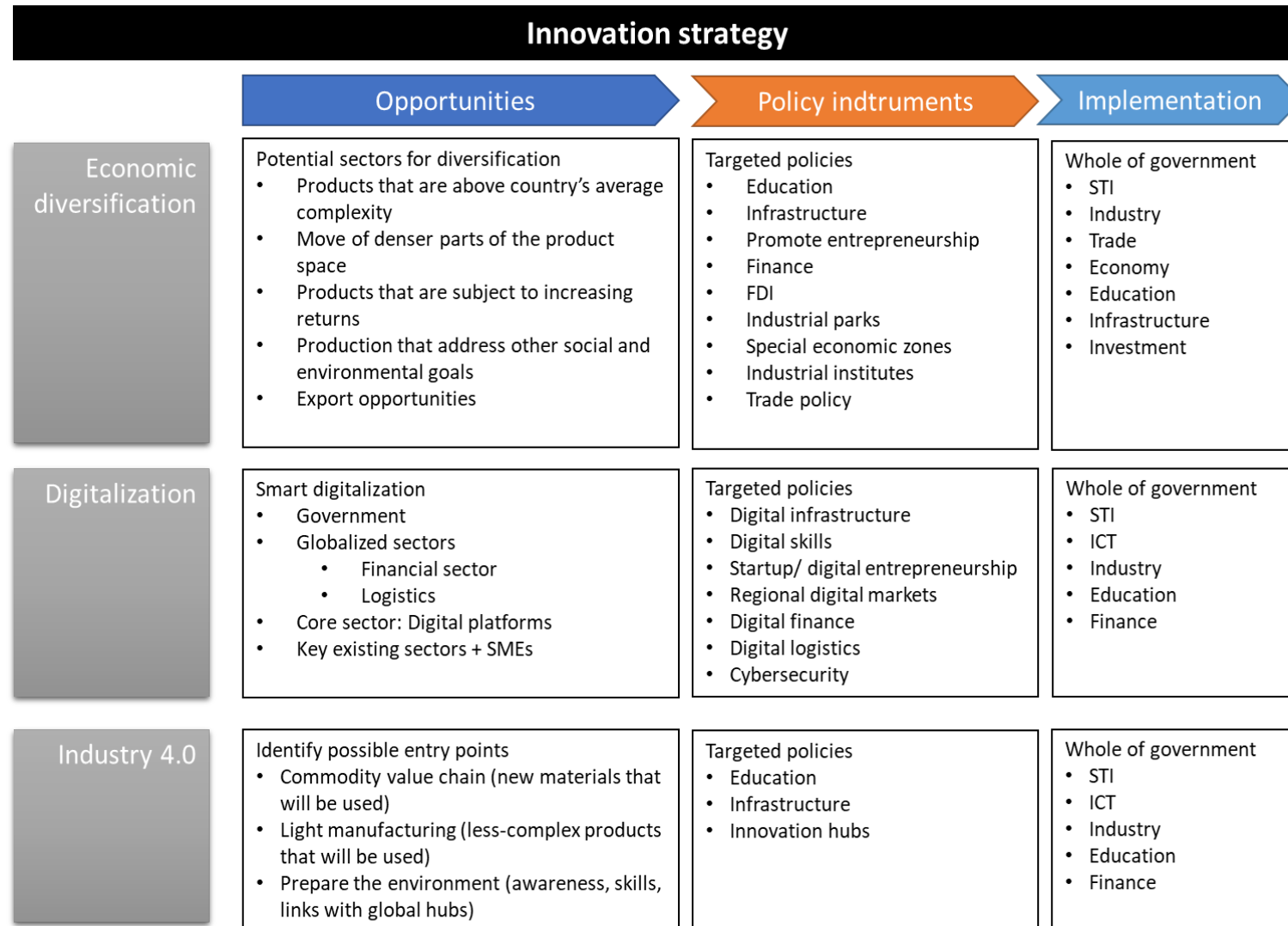


Windows of opportunity on deploying digital technologies and preparing the ground for the 4th Industrial revolution in CDDCs

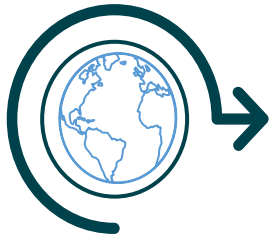


Promoting structural transformation through economic diversification and technological upgrading

National Development Strategy



DIRECTED TO SUSTAINABLE DEVELOPMENT



International community needs to **guide new and emerging technologies**



Outcomes should be **fair, transparent, accountable, and inclusive**



It's important to **establish ethical frameworks, particularly for the deployment of AI**



For human germline gene editing there needs to be a **broad consensus on ethical and societal issues**

GUIDING INNOVATION TOWARDS REDUCING INEQUALITIES

Extend frontier technologies to the poor

Set strategic directions using the SDGs

Support inclusive innovation systems

Use frontier technologies in the public sector



THE ROLE OF CIVIL ACTIVISM



Continuously fight for reducing social-economic and digital inequalities

Break societal and institutional inertia

Keep governments, business, and financial sectors accountable

Raise awareness about unintended consequences

Drive behavioral changes to align technological development with societal goals

DEPLOYING AT SCALE



Guided by a
vision



Engage
the
users



Plan for
deployment



Pass the
baton



Generate
incomes



Critical role of inclusive and sustainable businesses in deploying frontier technology to support the SDGs



PATTERNS OF BUSINESS MODELS

Digitally enabled for new customers.

CHARACTERISTICS

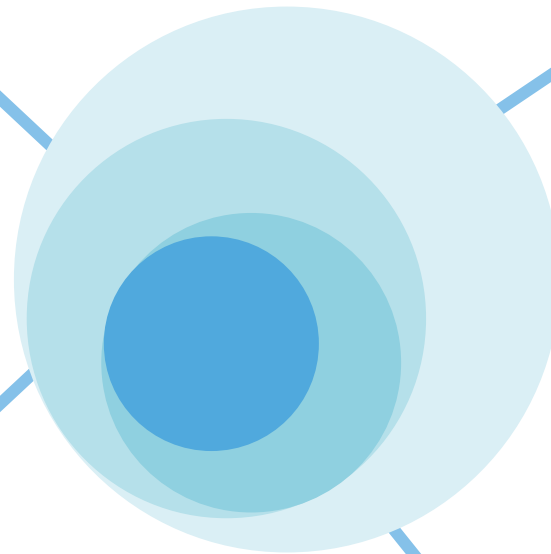
Supply and demand side.

SUSTAINABILITY

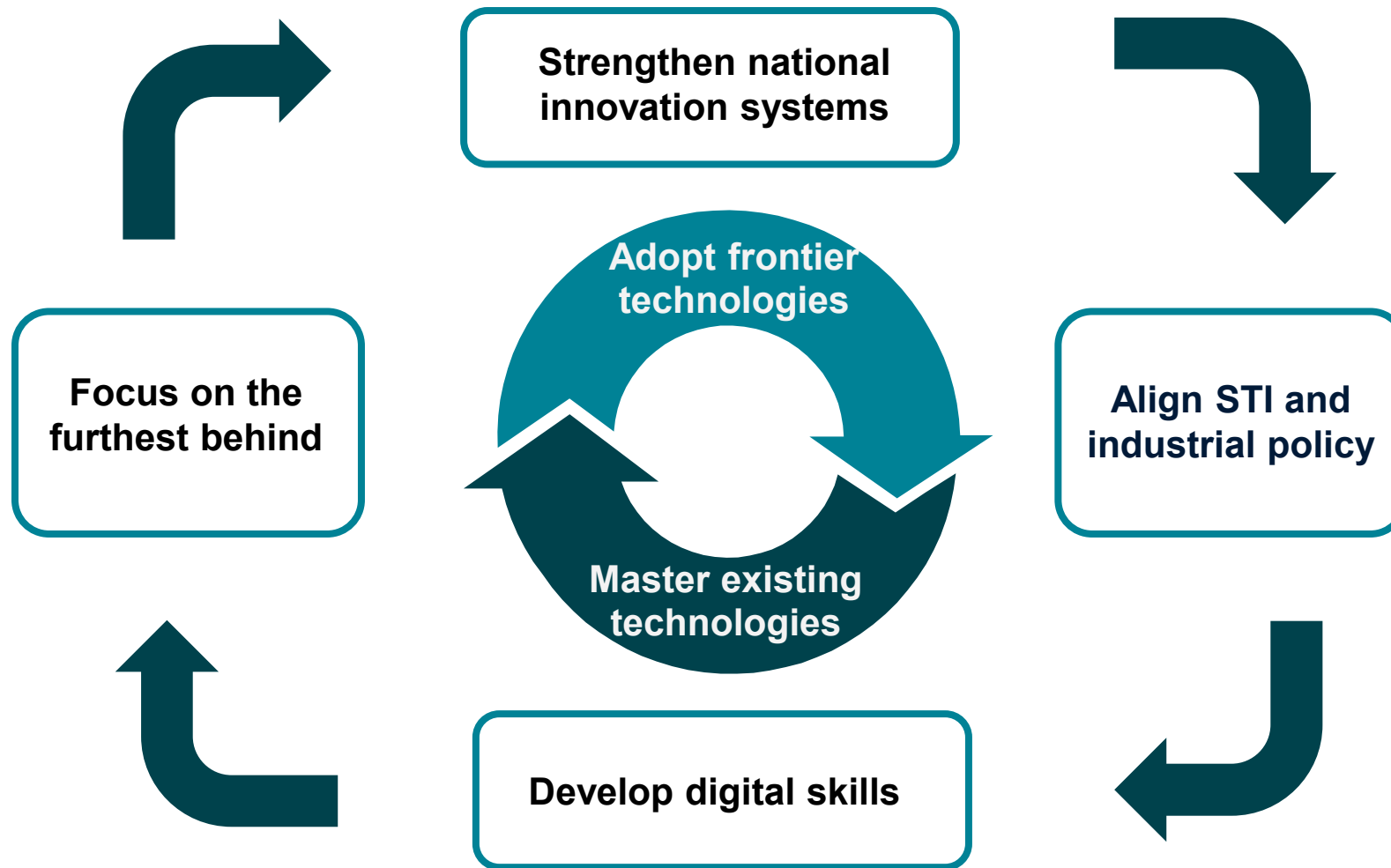
Aligning businesses with the 2030 Agenda.

REACHING THE EXTREME POOR

Policy challenges.



TWIN TECHNOLOGY TARGETS



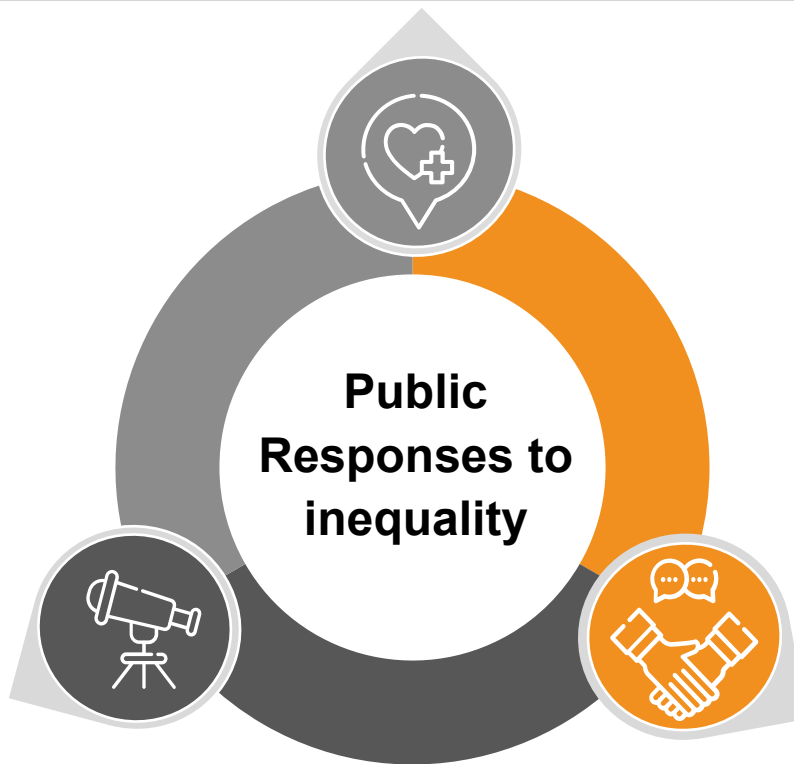
MITIGATING RISKS

Strengthen social protection

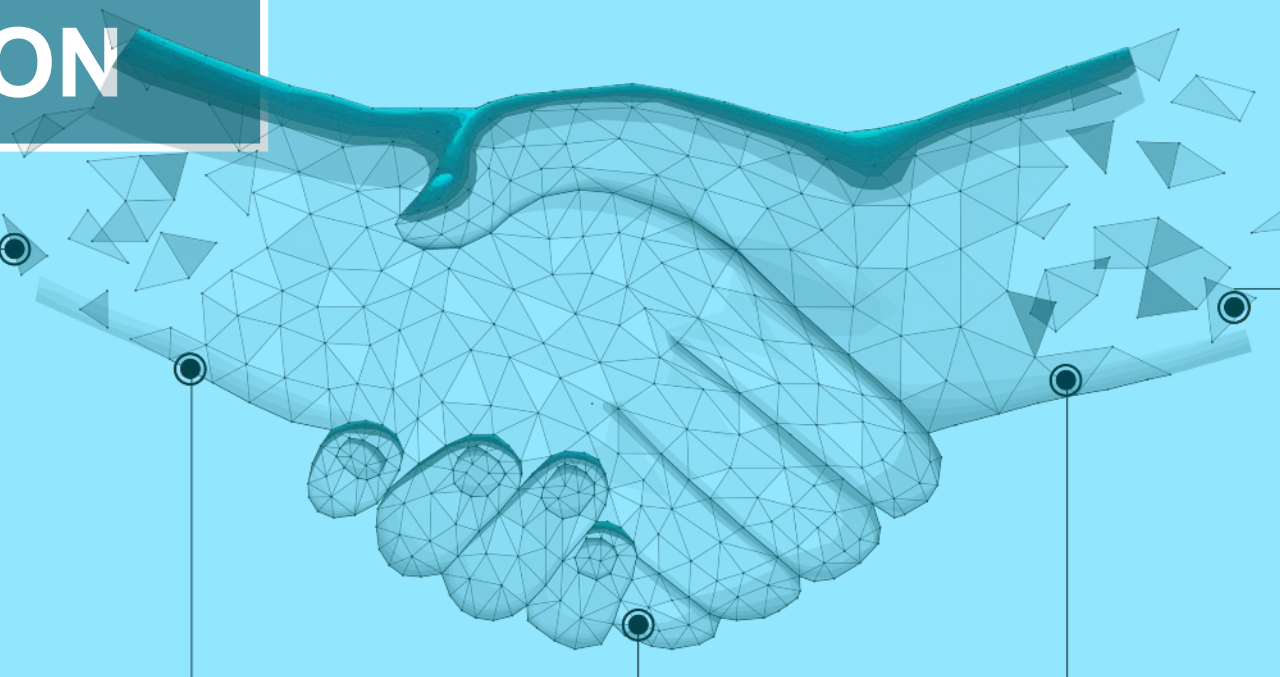
**Public
Responses to
inequality**

Anticipate the future

Ease workforce transitions



PRIORITIES FOR INTERNATIONAL COOPERATION



Build stronger national capacities in STI

Smooth technology transfer

Increase women participation in STEM

Improve foresight and technological assessment

Promote inclusive debate on frontier technologies

CATCHING TECHNOLOGICAL WAVES



- Strong leadership needed
- Frontier technologies need to be steered
- This concerns all countries, but not all are equally prepared for it
- Governments should take the lead, but all stakeholders must bear responsibility
- Developing countries cannot afford to miss this new wave of technological change.
- Appropriate STI policies to building a robust industrial base and promoting frontier technologies that can help deliver the 2030 Agenda



Catching the waves



UNITED NATIONS
UNCTAD