IN4ACT WEBINAR SERIES

MANAGEMENT AND POLICY CHALLENGES IN INDUSTRY 4.0

MARCH 5th, 1pm

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Overview

- Industry 4.0 in historical perspective: is there a Fourth Industrial Revolution underway?
- The historical setting of Industry 4.0: VUCA
- A note on method and anchor concepts
- Industry 4.0 in the pre-Covid-19 world: three future trajectories
- Industry 4.0 in a Covid-19 world: Phases: 1) Survival, 2) Recovery, 3) a new paradigm (?)

Part I: Micro-level – The 4IR at the level of the firm, functions and phases of production

I. 1. The decomposition / re-composition of production and the changing value composition of Global Value Chains

I. 2. AI, the cloud, big data, algorithmic models and the Internet of Everything

I. 3. The "platform economy" and associated business models: the changing form of the corporation

Part II: Meso-level – The 4IR at the level of regional economic and innovation ecosystems

II. 1. Centralization vs. decentralization in Industry 4.0

II. 2. The changing economic geography in Industry 4.0

II. 3. The challenges of commoditization and "smart specialization"

Part III: Macro-level – The 4IR at the level of governance systems and innovation strategy

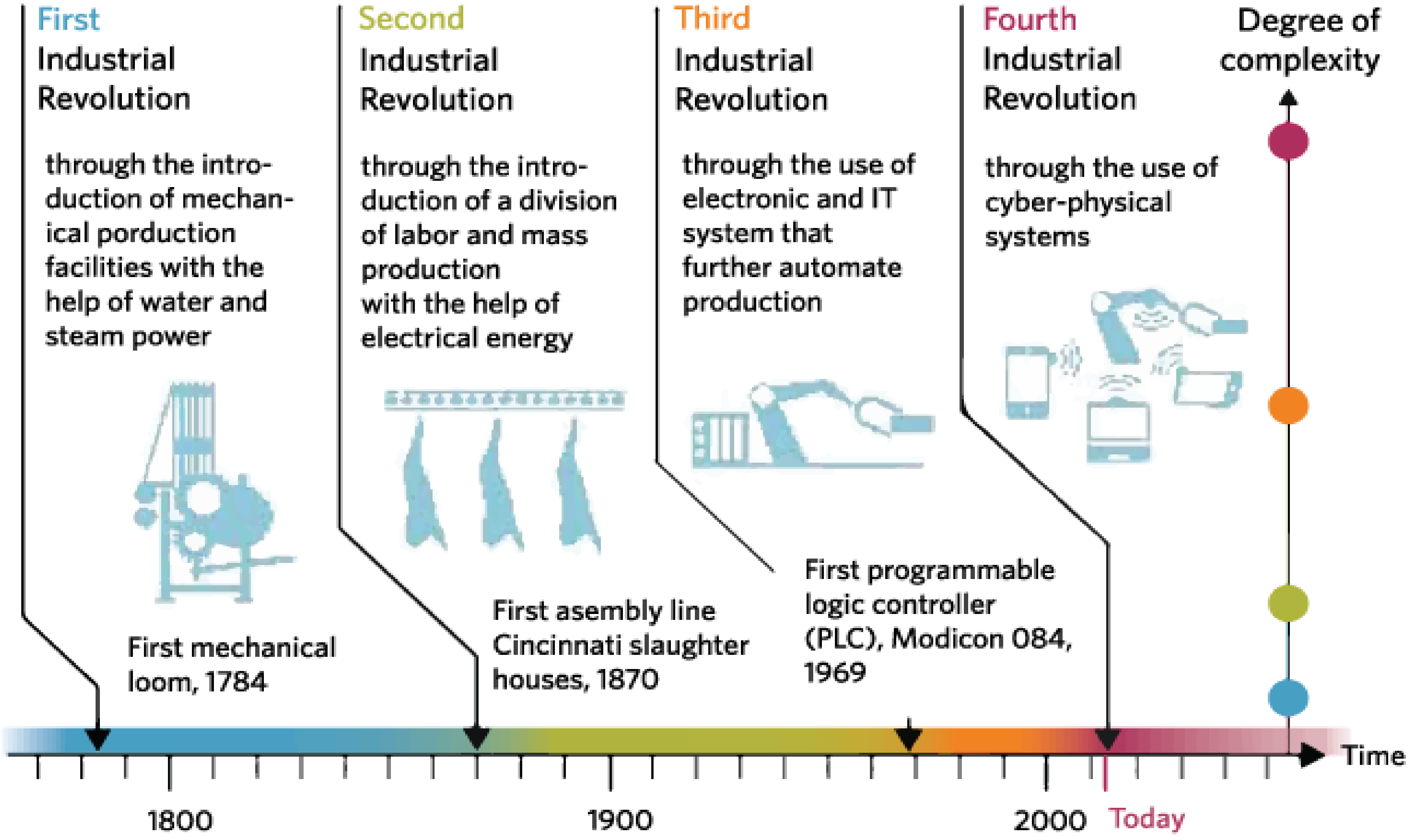
III. 1. Methods and approaches for assessing comparative readiness for Industry 4.0

III. 2. Employment and skillset challenges in Industry 4.0

III. 3. Systems of business and innovation governance: regulation, innovation and sustainability in Industry 4.0

In lieu of a conclusion: considering future scenarios

A Fourth Industrial Revolution?



Source: Deutsches Forschungszentrum für Künstliche Intelligenz, (DFKI), 2011.

Why a “Fourth Industrial Revolution”?

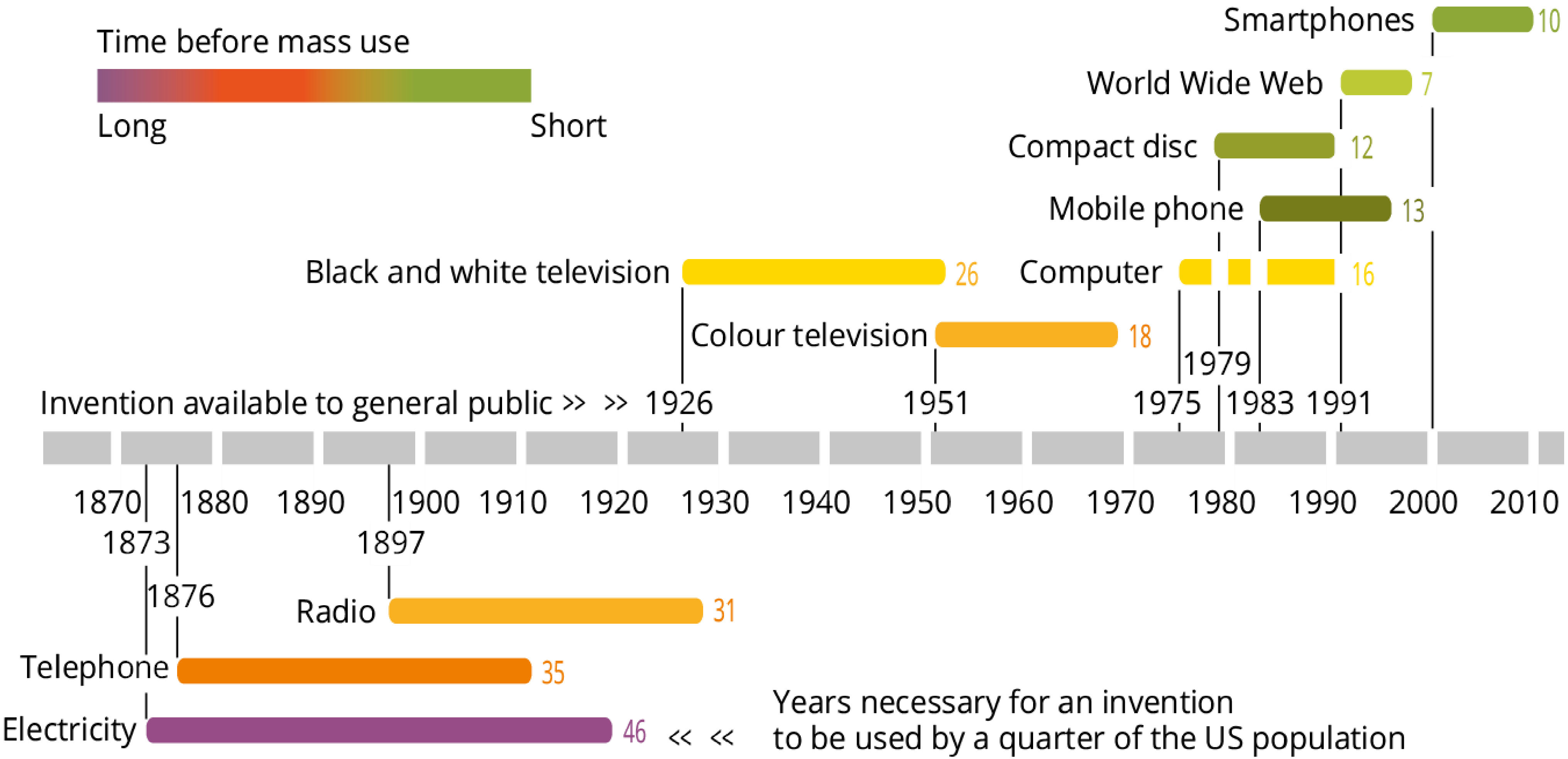
The origins of the Fourth Industrial Revolution can be traced to the beginning of this century and builds on and amplifies the impact of the digital revolution. So why not call it a more intense phase, a phase of maturation, of the computer or digital revolution? There are mainly three reasons why not:

- ***Velocity and scale*****:** In contrast to the previous industrial revolutions, the Fourth Industrial Revolution has the potential to evolve at an exponential rather than linear pace;

- ***Breadth and depth*****:** the Fourth Industrial Revolution builds on the digital revolution and combines multiple technologies from across various fields that have the potential to lead to unprecedented paradigm shifts in established practices in the domains of business, the economy, and society;

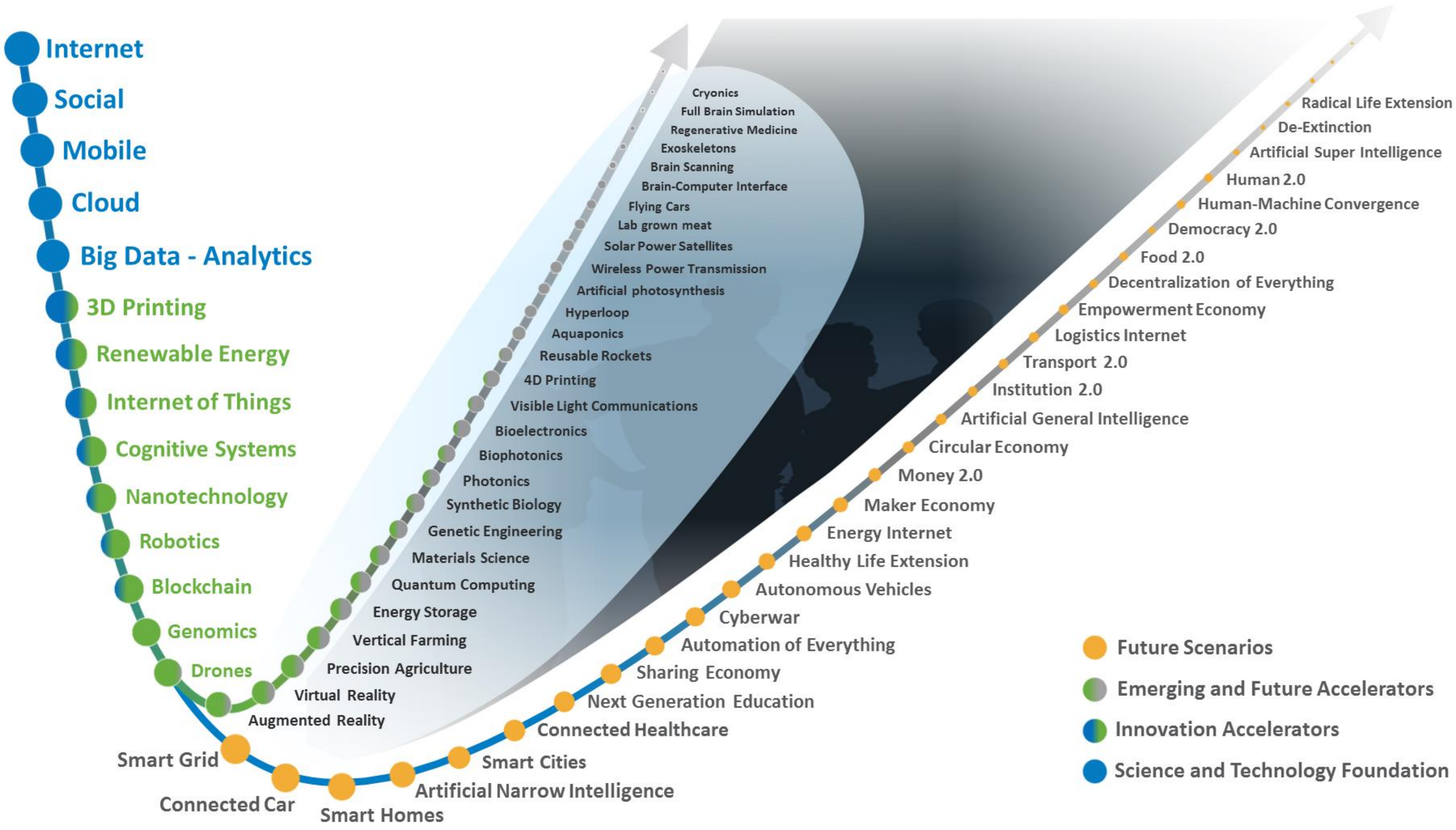
- ***Systemic Impact*****:** the Fourth Industrial Revolution presents the real possibility of transforming entire systems, across and within countries, companies, industries and civil society as a whole and the structures of the state.

Velocity: Shortening Time Lapse before Mass Adoption of New Technologies



Source: World Economic Forum, *Mitigating Risks in the Innovation Economy*, 2017.

Breadth and depth: systemic impact



VUCA – Volatility, Uncertainty, Complexity, Ambiguity

There is “something big on the horizon”: Three perspectives

- *Perspective 1:* ***Inflection Point*** of exponential growth unlike anything experienced before. Dominant manifestations of the Fourth Industrial Revolution are clusters of technologies that generate profound shifts across all industries, business models, disruption of incumbents, and the reconfiguration of production, consumption, transportation, logistics and delivery systems. *Result?* A positive transformation more comprehensive than anything seen before.

- *Perspective 2:* ***Entropy*** Entropy, in the context of economy and society, refers to the lack of order or predictability; gradual decline into disorder. Its dominant characteristics are secular stagnation, coupled to socially and politically debilitating high levels of unemployment, the end of middle class work, unsustainable levels of inequality within and across countries, social fragmentation, polarization, corruption and shrinking bases of political legitimacy. *Result?* A prolonged period of social and political instability within and across countries and growing tensions and conflicts in uncharted international political waters.

- *Perspective 3:* ***Interregnum*** A mid-point between “installation” and “deployment” of technologies in economic and social processes. During deployment new possibilities are diverse and often unconnected; they represent potentialities because they can be shaped in various ways to create alternative cost and profitability structures, new forms of demand, skills, and synergies along supply chains, distribution networks and consumption modes. *Result?* A techno-economic and socio-technical paradigm shift that leads to a profound transformation in the modes of work and consumption, as well as ways of living across society.

- **A note on method and anchor concepts:**
  - **Technology**
  - **Globalization**
  - **The state**

A note on method and anchor concepts

The 4IR and the possible futures it holds is not a historical inevitability. The clusters of technologies associated with the current transformations in economy and society do not in themselves point to a “direction”. Instead, they represent a “potential” whose realization and actual implementation will be determined by the exercise of social and political options.

These options will be shaped by the dynamic interactions of three forces:

- ***Technological advances*** and the specific ways they will be deployed across economy and society;
- ***The future of globalization***, specifically the degree of its compatibility with socially and environmentally sustainable development;
- ***The role of the state***, specifically in mediating and taking an active role in the creation of “enabling frameworks” for the diffusion and adoption of the technologies, the management of globalization, and their collective disruptive and destabilizing consequences for economic and social systems.

Reconsidering anchor concepts

Technology as biology: *beyond functionalism* – technology as a "tool" – and toward more synthetic evolutionary conceptions. Novel technologies arise by combinations of existing technologies, through a process of *combinatorial evolution*. As we adopt and use new technologies, we are moving from using nature to intervening directly within nature. We are entering a period where, conceptually at least, biology itself is becoming technology, and physically, technology is becoming biology, an open "living system". But as the economy becomes more combinatorial and technology more open, new operating principles are being introduced into the foundations of economies. Order, closedness, and equilibrium as ways of organizing explanations are giving way to open-endedness, indeterminacy, and the emergence of perpetual novelty.

Globalization as a phase of time-space compression or global "computation": the "end of geography"? Though it is important to remain focused on the quantitative aspects of globalization (levels of economic integration, velocity of financial transactions, etc.), it is equally important to focus on its qualitative aspects. This means adopting a perspective that grasps globalization as a phase of 'time-space compression' which has given rise to the contested and uneven development of a system of planetary (geographical) and digital "spatial" reach that has the technological, organizational, institutional and decision-making ability to act as a coordinated system in real or chosen time. Or globalization as global "computation": it does not just denote machinery; it is planetary-scale infrastructure that is changing not only how economies operate and governments govern, but also what governance even is in the first place.

The State and innovation: time to dispense with the popular mythology that innovation is a phenomenon set in motion exclusively by entrepreneurs and garage tinkerers under the encouraging eye of the state. Since WW II the state has been a – if not *the* – decisive force behind all the major innovations of our time, not only in organizing the "enabling frameworks'" that foster innovation but also undertaking the necessary high-risk greenfield investments that private business and certainly venture capital typically would forgo. The state, especially in the US, where most of the post-war leading technologies trace their origins, has taken not only an active role in the development of critical technology fields, it has also taken an active role in building the physical environments, what have been called "cities of knowledge" within which innovations have been developed. The state is also central on the design and application of the 'legal code' of capital.

Industry 4.0 in a Covid-19 world: Phases: 1) Survival, 2) Recovery, 3) a new paradigm

Part I: Micro-level – The 4IR at the level of the firm, functions and phases of production

I. 1. The decomposition / re-composition of production and the changing value composition of GVCs

The iPhone: "Made in the World"

Manufacturing Network

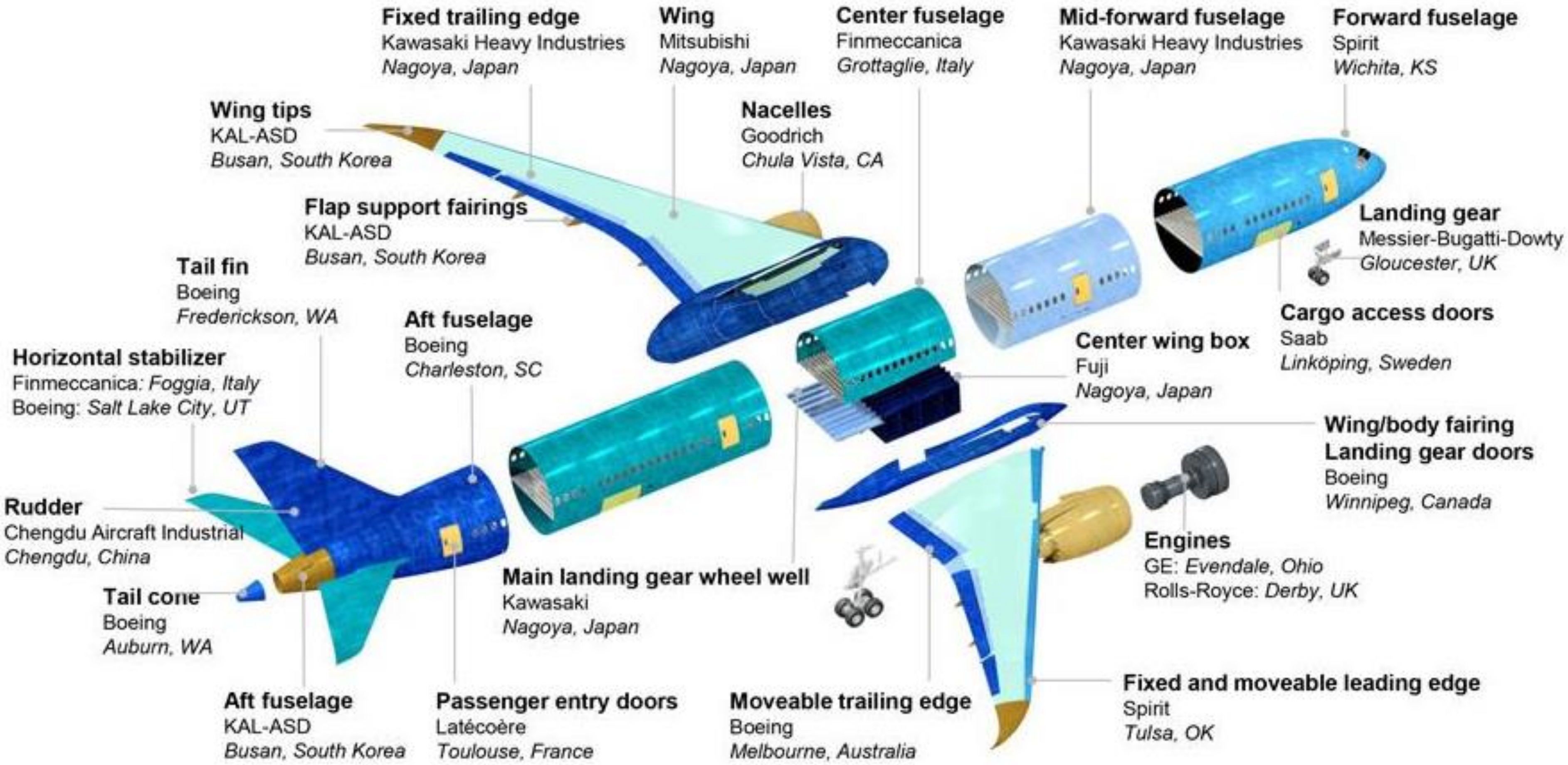
Accelerometer: Bosch Sensortech (Germany)
Audio chipsets: Cirrus Logic (US)
Baseband processor: Qualcomm (US)
Battery: Samsung (Korea)
Battery: Huizhou Desay Battery (China)
Camera: Qualcomm (US)
Camera: Sony (Japan)
Chips for 3G/4G/LTE networking: Qualcomm (US)
Compass: AKM Semiconductor (Japan)
Glass screen: Corning (US)
Gyroscope: STMicroelectronics (France, Switzerland)
eCompass: Alps Electric (Japan)
Flash memory: Toshiba (Japan), Samsung (Korea)
DRAM: TSMC (Taiwan)
LCD screen: Sharp (Japan), LG. (Korea)
A-series Processor: Samsung (Korea), TSMC (Taiwan)
Touch ID: TSMC (Taiwan), Xintec (Taiwan)
Touchscreen controller: Broadcom (US)
Wi-Fi chip: Murata (US)
Fingerprint authentication: Authentec (China, Taiwan)

Assembly Network

Hon Hai Precision Industry Co. Ltd. or Foxconn (its trading name) (Taiwan, with locations in China, Thailand, Malaysia, the Czech Republic, South Korea, Singapore, and the Philippines)

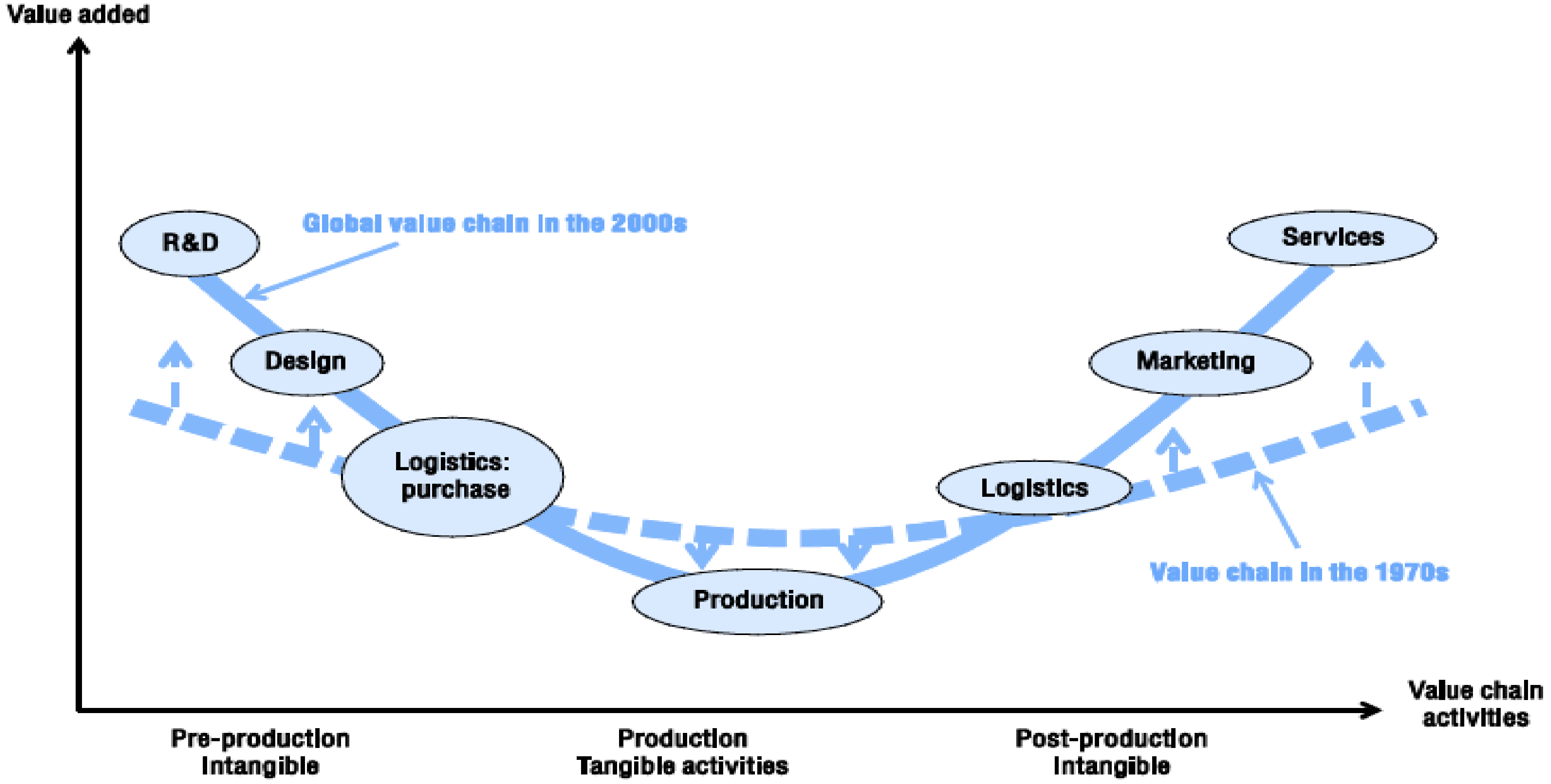
Pegatron (Taiwan)

The Boeing 787 Dreamliner: “Made in the World”



Source: Boeing, 2015.

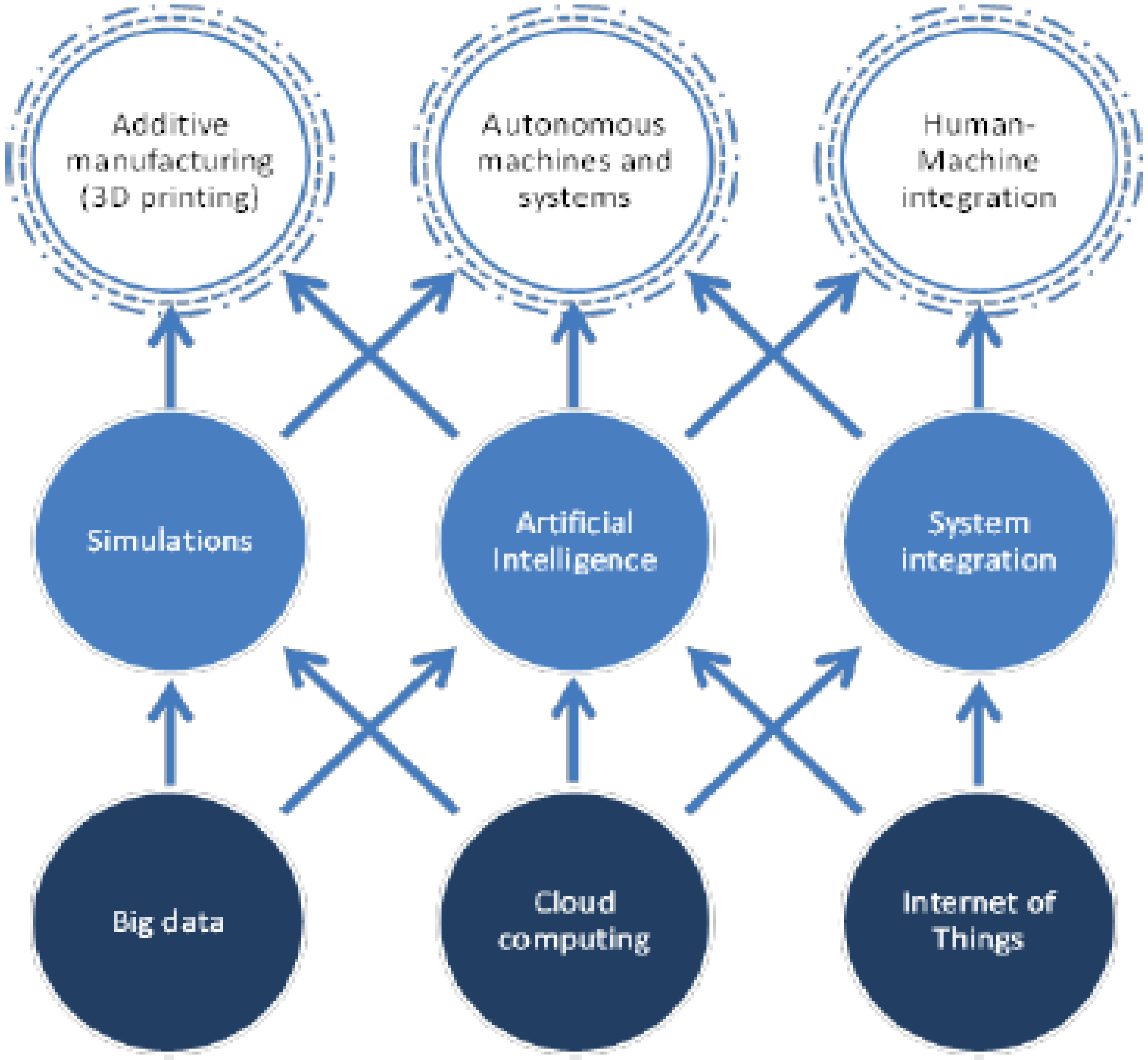
Global Value Chains: qualifying the “global”



Source: OECD, *Interconnected Economies: Benefiting from Global Value Chains*, Paris 2013.

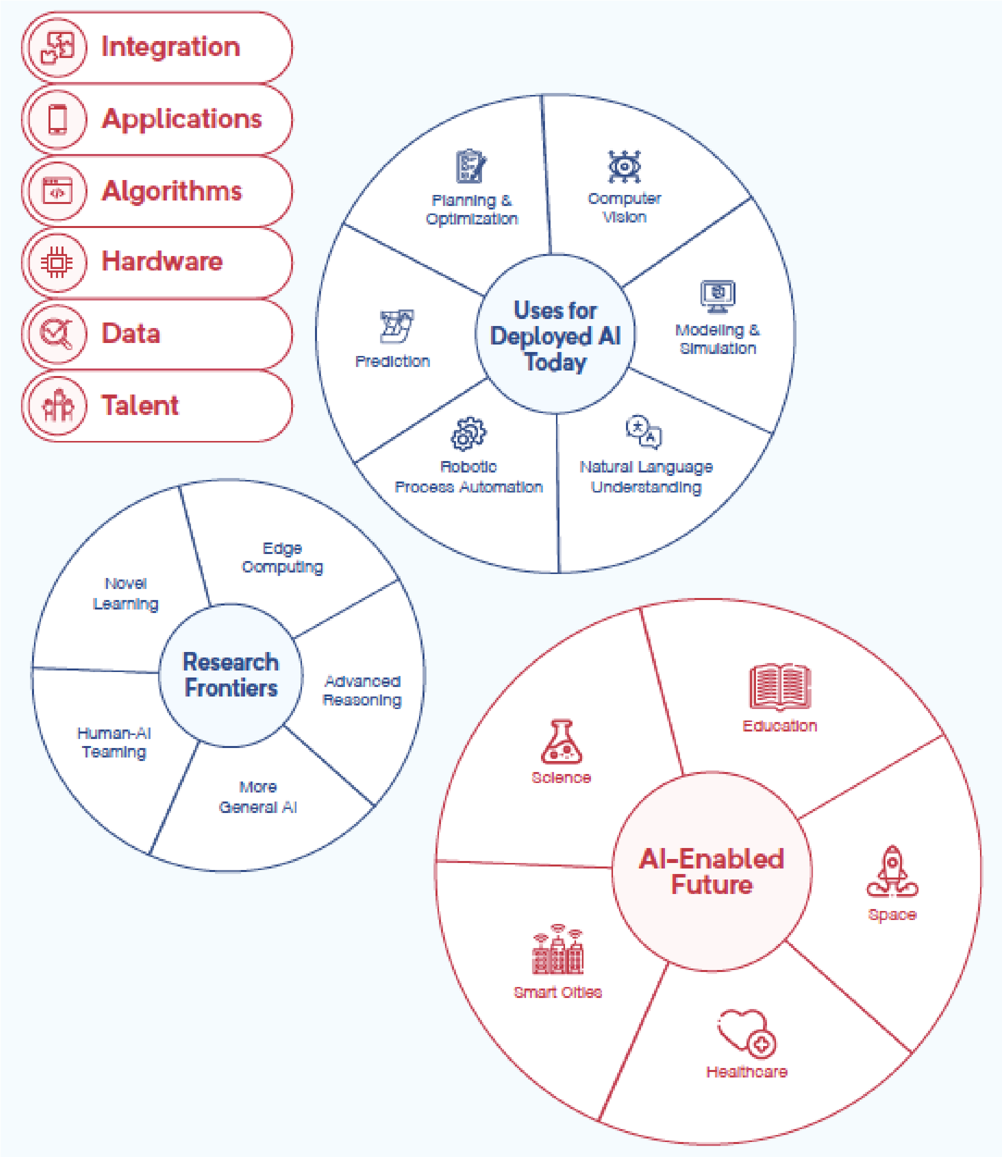
I. 2. AI, the cloud, big data, algorithms, and the Internet of Everything

The confluence of key technologies enabling the digital industrial transformation



Source: OECD, *The Future of Global Value Chains: Business as Usual or "A New Normal"?*, 2017.

The ‘stack’ of Artificial Intelligence



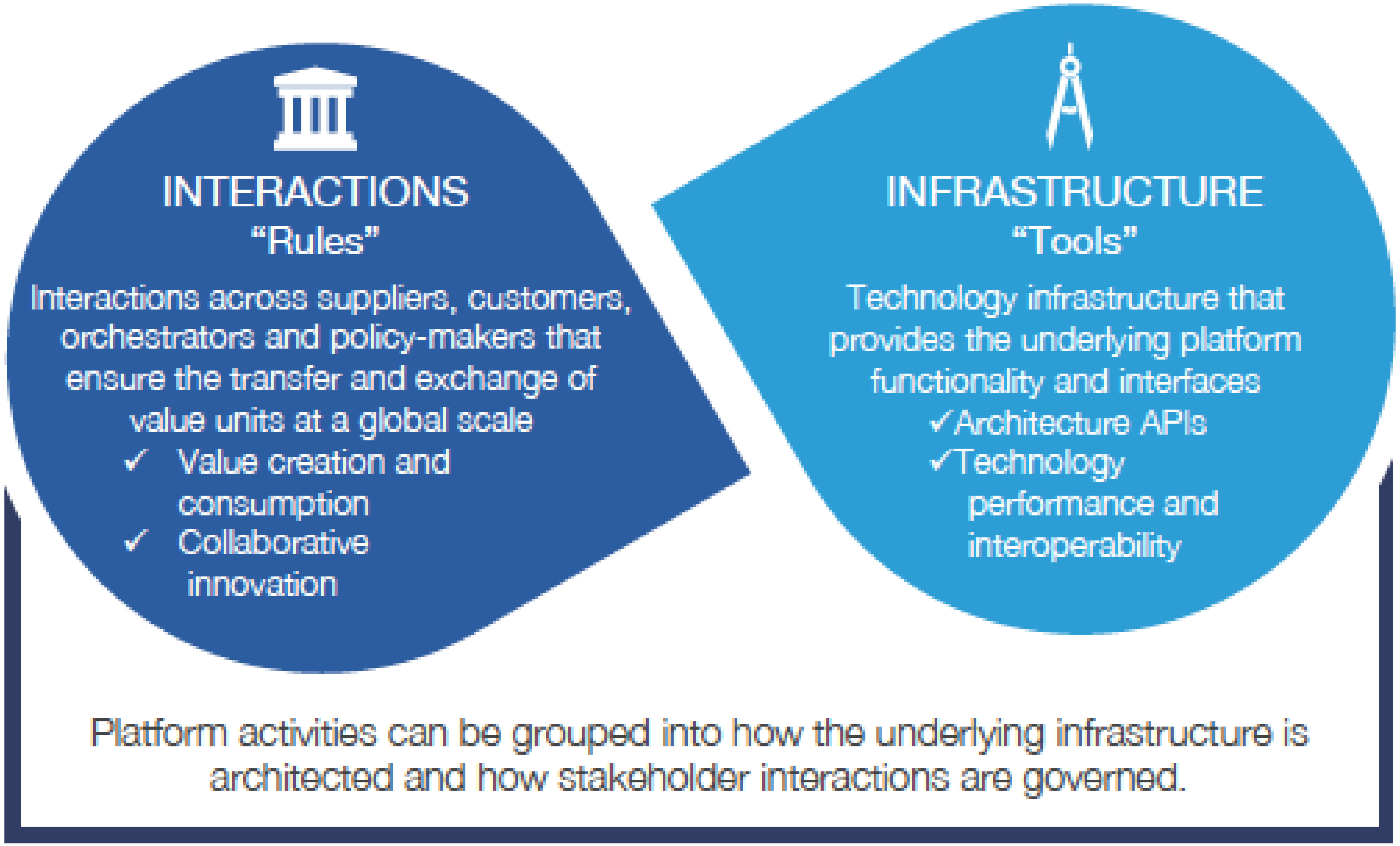
Source: Nation. al Security Commission on Artificial Intelligence, (2021), *Final Report.*.

AI: the cloud, big data, algorithms and the Internet of Everything

- If GVCs are reconfiguring the **where** of production/services, big data, algorithms, the cloud, and the Internet of Everything are redefining the **how**. Their integration into the production process is transforming the structure of the economy and the nature of work by facilitating the growth of the “platform economy”.
- Computing power is increasingly converted into economic tools using algorithms that operate on vast reservoirs of the raw material of big data.
- The Internet of Everything signifies a transition from a period where the types of products that were produced were mechanical – made manually through various value-chain activities – to one where products and production itself are becoming “smart”.
- Smart, connected products enable new categories of capabilities and new types of functionalities. These include: monitoring, control, optimization, and autonomy.
- Unlike the previous waves of ICT transformation that boosted firm productivity, this one will affect companies’ strategies and how companies differentiate themselves, create value, and compete, and will change the structure of industries.
- Taken together, big data, algorithmic models and the Internet of Everything embody considerable transformative potential as they are changing the basis of competition, redrawing industry boundaries and creating openings for new waves of disruptive companies just as the current internet has given rise to the likes of Amazon, Google, Uber, Airbnb, and Netflix.

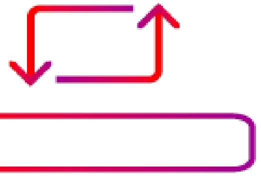
I. 3. The “platform economy” and associated business models: the changing form of the corporation

The two functional elements of platforms

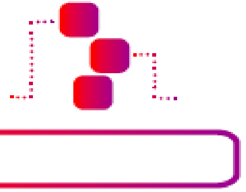


Source: World Economic Forum, *Digital Transformation Initiative: Unlocking B2B Platform Value*, 2017.

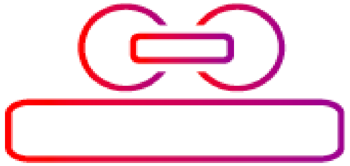
Platform types



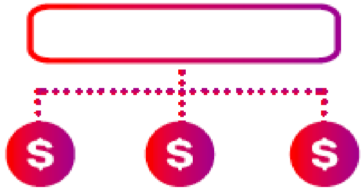
Transaction platforms: A transaction platform is a technology, product or service that acts as a conduit (or intermediary) facilitating exchange or transactions between different users, buyers, or suppliers.



Innovation platforms: An innovation platform is a technology, product or service that serves as a foundation on top of which other firms (loosely organized into an innovative ecosystem) develop complementary technologies, products or services.



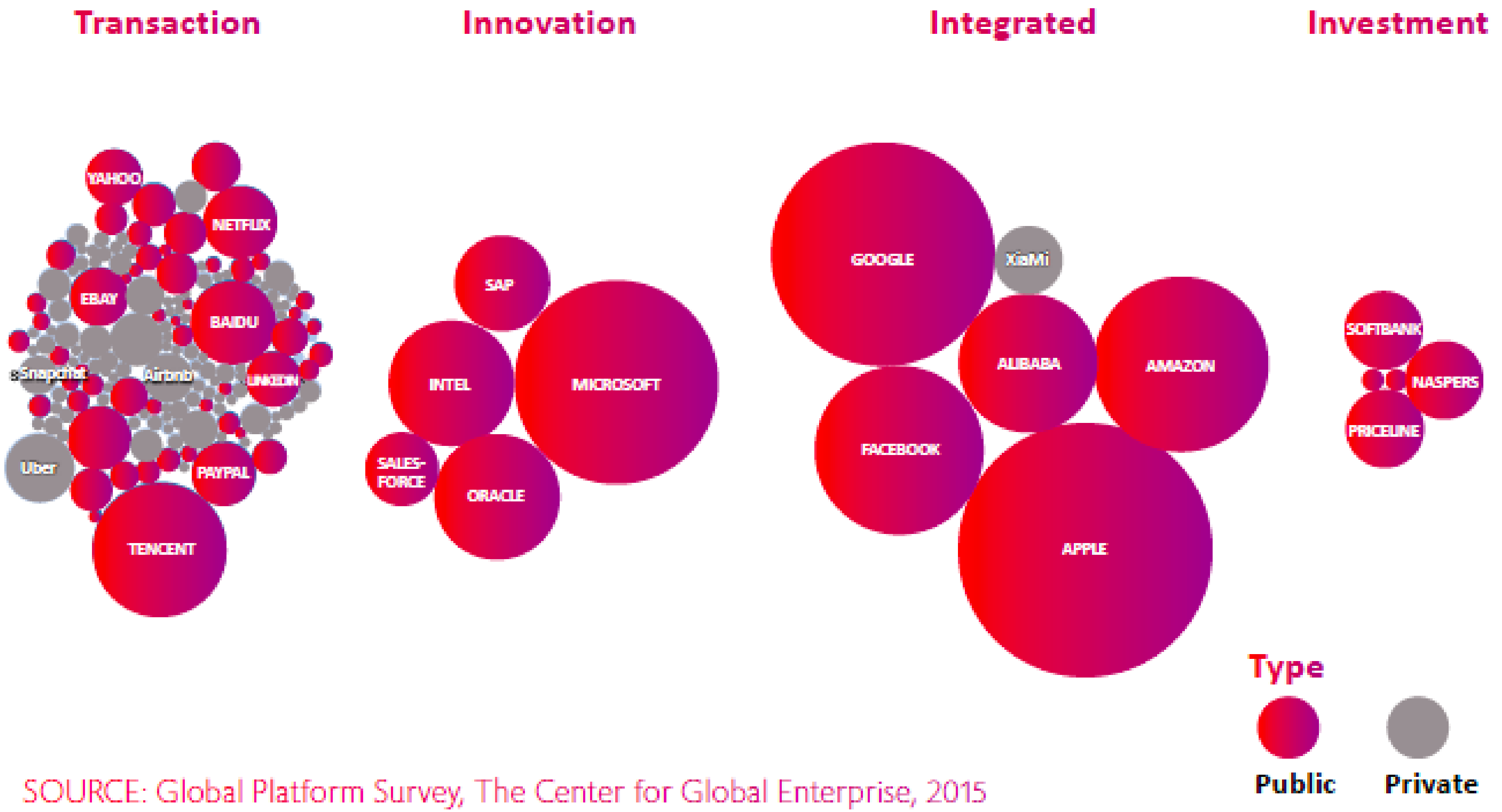
Integrated platforms: An integrated platform is a technology, product or service that is both a transaction platform and an innovation platform. This category includes companies such as Apple, which has both matching platforms like the App Store and a large third-party developer ecosystem that supports content creation on the platform.



Investment platforms: Investment platforms consist of companies that have developed a platform portfolio strategy and act as a holding company, active platform investor or both.

Source: The Centre for Global Enterprise, *The Rise of the Platform Enterprise: A Global Survey*, 2016.

Platform companies by type



Source: The Centre for Global Enterprise, *The Rise of the Platform Enterprise: A Global Survey,* 2016.

Top 10 Cities by platform Headquarters

RANK	HQ CITY 2	Country	Region	No. of Platform Companies	Company Market Cap
1	San Francisco Bay Area	Country	N. America	44	$2,229B
2	Seattle	US	N. America	4	$767B
3	Beijing	US	Asia	30	$246B
4	Hangzhou	China	Asia	6	$242B
5	Shenzhen	China	Asia	5	$191B
6	Tokyo	Japan	Asia	5	$109B
7	Walldorf	Germany	Europe	1	$97B
8	Cape Town	S. Africa	Africa	1	$63B
9	Norwalk	US	N. America	1	$62B
10	Shanghai	China	Asia	14	$55B

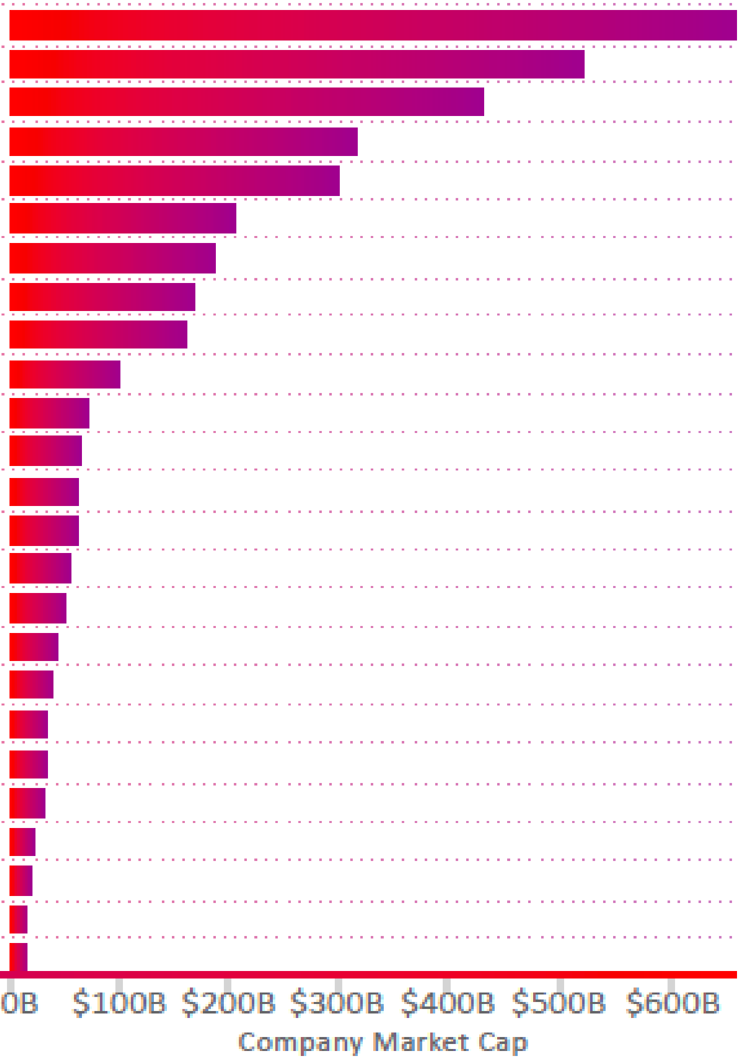
$0T $1T $2T $3T

Company Market Cap

Source: The Centre for Global Enterprise, *The Rise of the Platform Enterprise: A Global Survey*, 2016.

Top 25 Publicly Traded Platforms

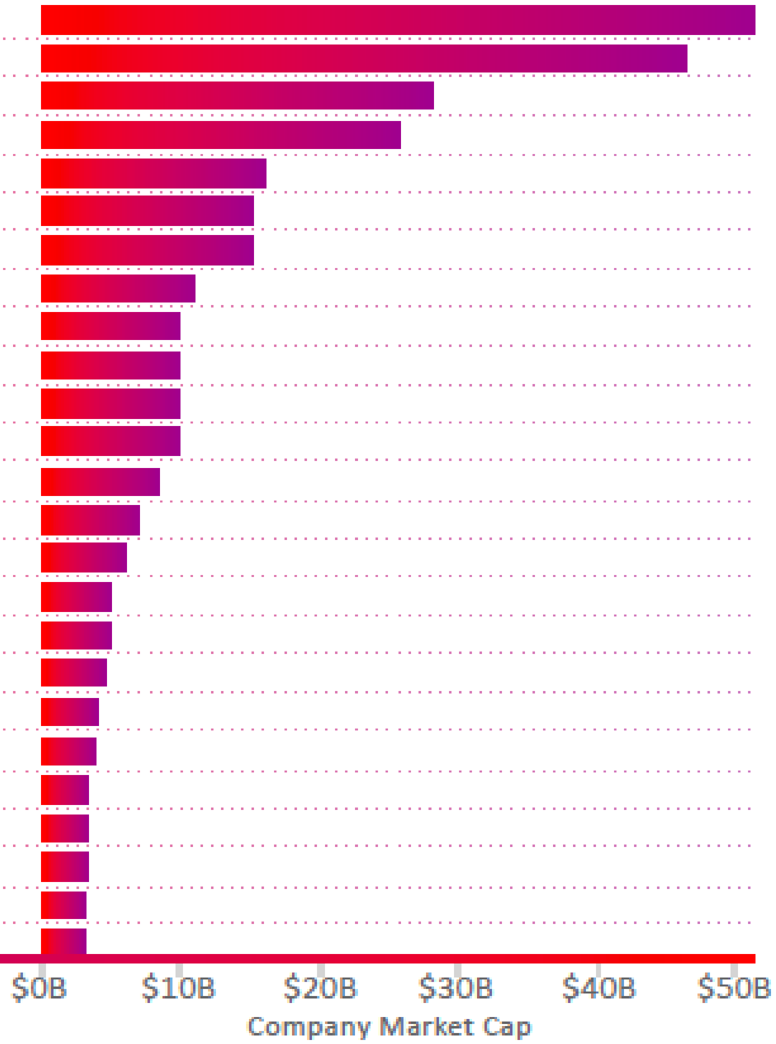
RANK	Company	Country	Type	Platform Type
1	APPLE	US	Public	Integrated
2	GOOGLE	US	Public	Integrated
3	MICROSOFT	US	Public	Innovation
4	AMAZON	US	Public	Integrated
5	FACEBOOK	US	Public	Integrated
6	ALIBABA	China	Public	Integrated
7	TENCENT	China	Public	Transaction
8	ORACLE	US	Public	Innovation
9	INTEL	US	Public	Innovation
10	SAP	Germany	Public	Innovation
11	BAIDU	China	Public	Transaction
12	SOFTBANK	Japan	Public	Investment/Holding
13	NASPERS	S. Africa	Public	Investment/Holding
14	PRICELINE	US	Public	Investment/Holding
15	NETFLIX	US	Public	Transaction
16	SALESFORCE	US	Public	Innovation
17	PAYPAL	US	Public	Transaction
18	JD.COM	China	Public	Transaction
19	EBAY	US	Public	Transaction
20	LINKEDIN	US	Public	Transaction
21	YAHOO!	US	Public	Transaction
22	YAHOO JAPAN	Japan	Public	Transaction
23	RAKUTEN	Japan	Public	Transaction
24	NAVER	South Korea	Public	Transaction
25	TWITTER	US	Public	Transaction



Source: The Centre for Global Enterprise, *The Rise of the Platform Enterprise: A Global Survey*, 2016.

Top 25 Privately Owned Platforms

RANK	Company	Country	Type	Platform Type
1	UBER	US	Private	Transaction
2	XiaMi	China	Private	Transaction
3	AliPay	China	Private	Transaction
4	Airbnb	US	Private	Transaction
5	Snapchat	US	Private	Transaction
6	Didi Kuaidi	China	Private	Transaction
7	Flipkart	India	Private	Transaction
8	Pinterest	US	Private	Transaction
9	Dropbox	US	Private	Transaction
10	Lu.com	China	Private	Transaction
11	Lufax	China	Private	Transaction
12	WeWorK	US	Private	Transaction
13	Spotify	Sweden	Private	Transaction
14	Meituan	China	Private	Transaction
15	Meizu.com	China	Private	Transaction
16	Olacabs	India	Private	Transaction
17	Stripe	US	Private	Transaction
18	Zenefits	US	Private	Transaction
19	Dianping	China	Private	Transaction
20	Shanghai Han Tao	China	Private	Transaction
21	Beijing Feixiangren	China	Private	Transaction
22	Credit Karma	US	Private	Transaction
23	Atlassian	Australia	Private	Transaction
24	Delivery Hero	Germany	Private	Transaction
25	Fanatics	US	Private	Transaction



Source: The Centre for Global Enterprise, *The Rise of the Platform Enterprise: A Global Survey*, 2016.

Selected B2B platform companies

FINANCIAL SERVICES
rippleLabs, fidor BANK, SWIFT, PayPal, VISA, Biz2Credit, Paytm, Dataminr, SYMPHONY, Bloomberg

PRODUCTS
Audi, Tencent, Ctrip, GM, Mercedes-Benz, MICHELIN, Sabre, amazonbusiness, BMW, ebay, EBATES, Flipkart, Alibaba, DHgate.com, carbon3D

HEALTHCARE
KAISER PERMANENTE, DSM, GE Healthcare, PHILIPS HealthSuite Digital Platform, COHEALO

AGRICULTURE
BAYER, JOHN DEERE, MONSANTO, CATERPILLAR

RESOURCES
klöckner & co multi metal distribution, Blue Pillar, WELLAWARE, e.on, CLEARBLADE, NOKIA Connecting People, IoT

ANALYTICS / AI
Goldman Sachs, ALPINE DATA, mixpanel, DataRobot, Paxata, UPTAKE, ARIMO, TRIFACTA, BeyondCORE, thingworx

PUBLIC SECTOR
World Health Organization, Geofeedia, esri, ORGANICITY

SOCIAL MEDIA
slack, GitHub, MindLink Enterprise Chat, LINE

INDUSTRIAL
PREDIX, Telit, DATARPM, Schneider Electric, Ayla Networks, SIEMENS, Honeywell, Rockwell Automation, carriots

LOGISTICS
DHL, OPEN PORT, COYOTE, KÜHNE+NAGEL

TALENT
ProFinder, upwork, OnForce, 猪八戒 ZBJ.COM, AT&T FOUNDRY WHERE IDEAS ARE MADE, ZENEFITS, workmarket, kaggle, HourlyNerd

TELECOMMUNICATIONS AND INFRASTRUCTURE
AT&T, Google, TELESP, paloalto, Microsoft Azure, murano, amazon web services, Jasper, Greenplum, ERICSSON, Google Cloud Platform, HUAWEI, Cloudant, Hortonworks, salesforce, heroku

Macroeconomic Transformation – The Platform Economy

Industrial Era Changed every aspect of life	**Digital Economy Era** Transforming every dimension of life
Products	Platforms
Value chains (linear)	Ecosystems (non-linear)
Power of controlling supply chain	Coordination of supply chain
Supply-side economies of scale	Demand-side economies of scale
Physical assets and capital depreciation	Digital assets and innovation capital
Diminishing returns	Distribution power law and network effects
Market valuations driven by return on assets	Market valuations driven by ecosystems
Growth organic or via mergers & acquisitions	Growth driven by asymmetric network effects
GDP as economic measurement	New measures, digital density & ‘free goods’

Macroeconomic Transformation – The Platform Economy

The Business Model of the Industrial Era	The ‘platform economy’ business model

❑ Centered on the corporate imperative for growth
❑ Scale and asset-heavy
❑ Vertical integration
❑ Asset-heavy
❑ Hierarchy attached to “job ladders”
❑ Performance measured by industrial “territory” and market “footprint”
	❑ Centered on big data and algorithms
	❑ Finance-heavy in the sense that “size” relates predominantly to market capitalization value
	❑ Asset-light (but variations apply)
	❑ Labor-light (minimal employment commitments disappearance of ‘job ladders’)
	❑ Oriented toward market capture through:
	  ❑ Monopoly (Google, Facebook) or
	  ❑ Monopsony (Amazon)

Detroit (February 2018)

GM
Market capitalization; $57,06 bn
Revenue: $166,3 bn
Employees: 209,000

Ford
Market capitalization; $42,16 bn
Revenues: $151,8 bn
Employees: 201,000

FCA FIAT CHRYSLER AUTOMOBILES
Market capitalization; $32,65 bn
Revenue: 111 bn (2016)
Employees: 225,587

Totals:
Market cap: $131,87 bn
Revenues: $429,10 bn
Employees: 635,587

Silicon Valley (February 2018)

Market capitalization; $905,15 bn
Revenue: $ 229,2 bn
Employees: 123,000 (global)

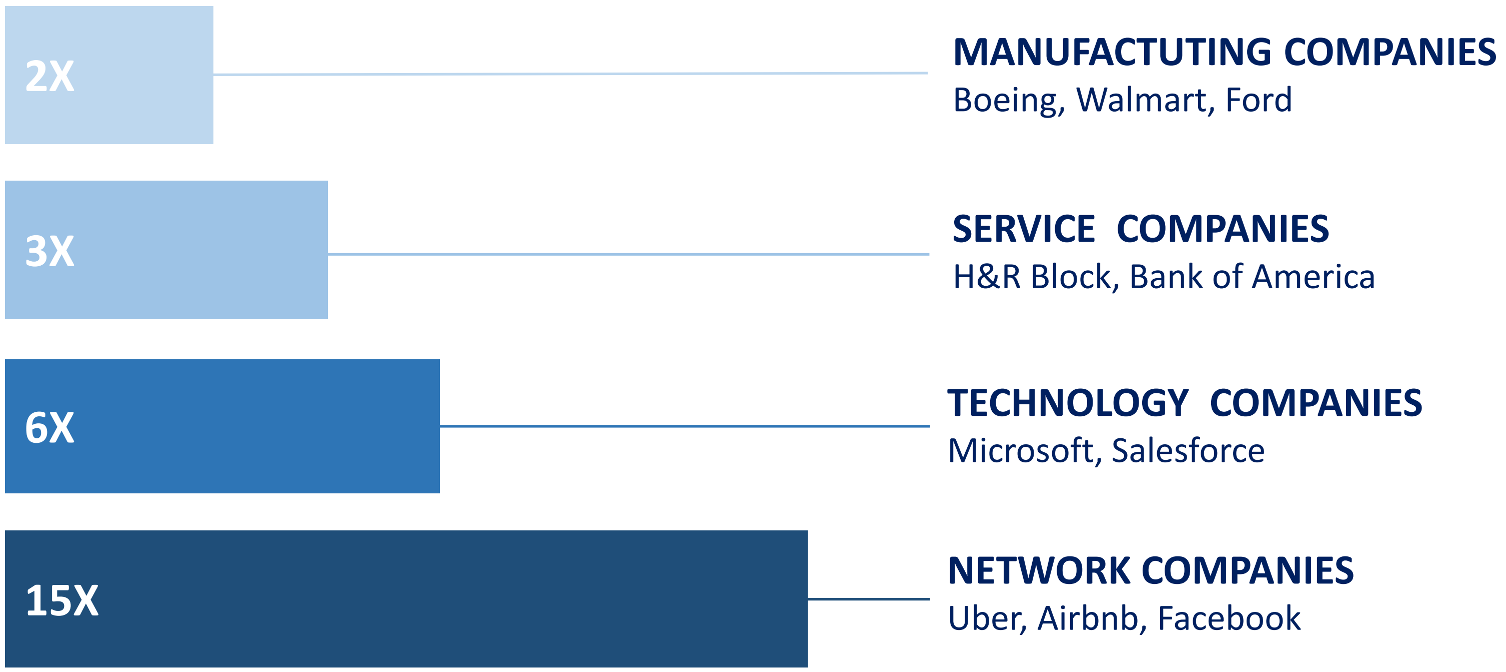
Market capitalization; $776,61 bn
Revenues: $109,65 bn
Employees: 73,992

Market capitalization; $527,14 bn
Revenue: 40,65 bn
Employees: 25,105

Totals:
Market cap: $2,20 trillion
Revenues: $379,40 bn
Employees: 222,209

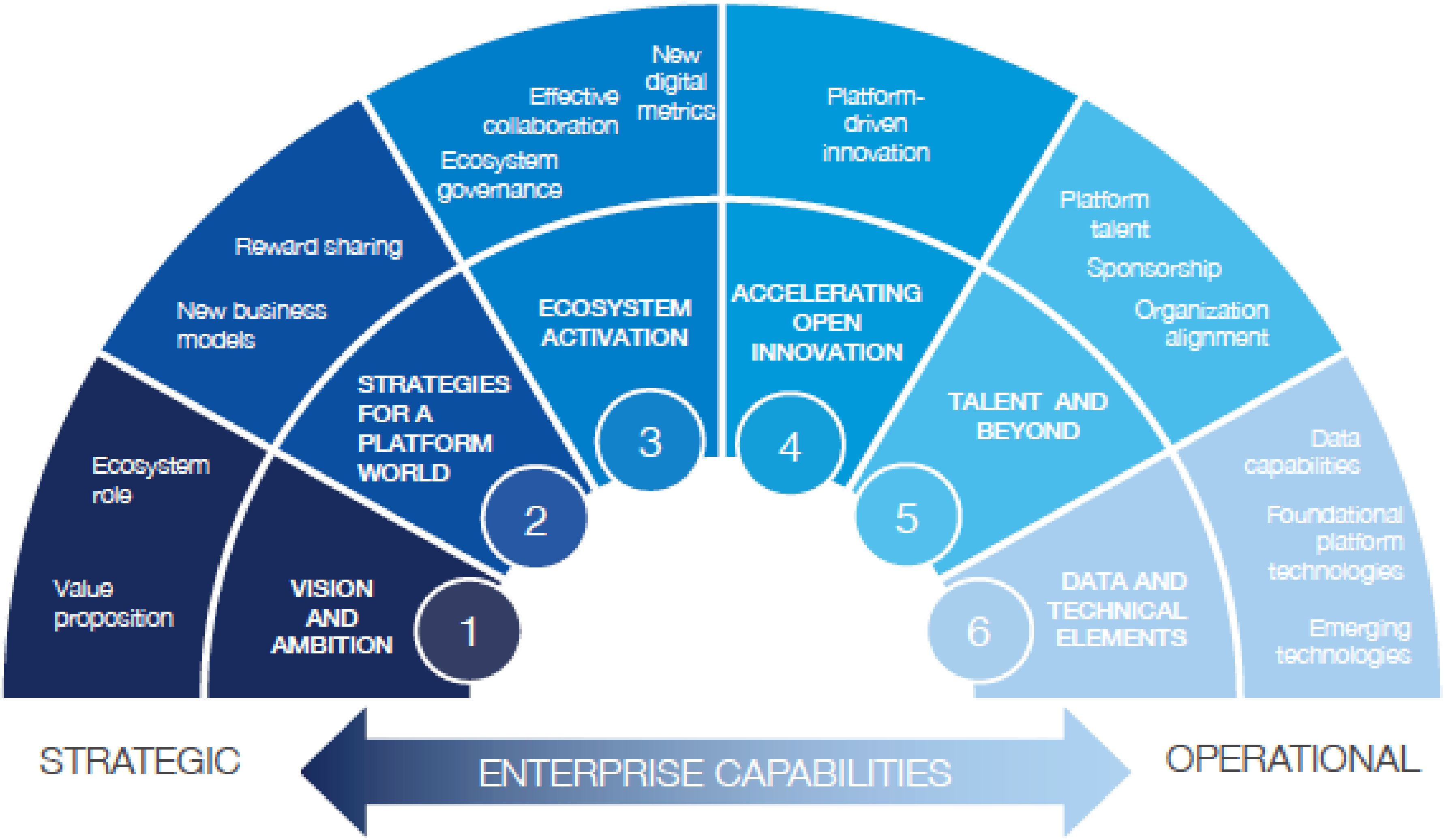
The ROI value genome

In 1975, 83% of all assets were made up of tangible things. Over the next four decades the allocation of capital shifted dramatically. By 2013, only 15% of the world economy was in tangible items.



Sources: MIT Platform Strategy Summit, 2017; *Haskel and Westlake, Capitalism without Capital*, 2018.

New strategies and operational capabilities are critical for success in the platform economy



Source: World Economic Forum, *Digital Transformation Initiative: Unlocking B2B Platform Value*, 2017.

Part II: Meso-level – Industry 4.0 at the level of regional economic and innovation ecosystems

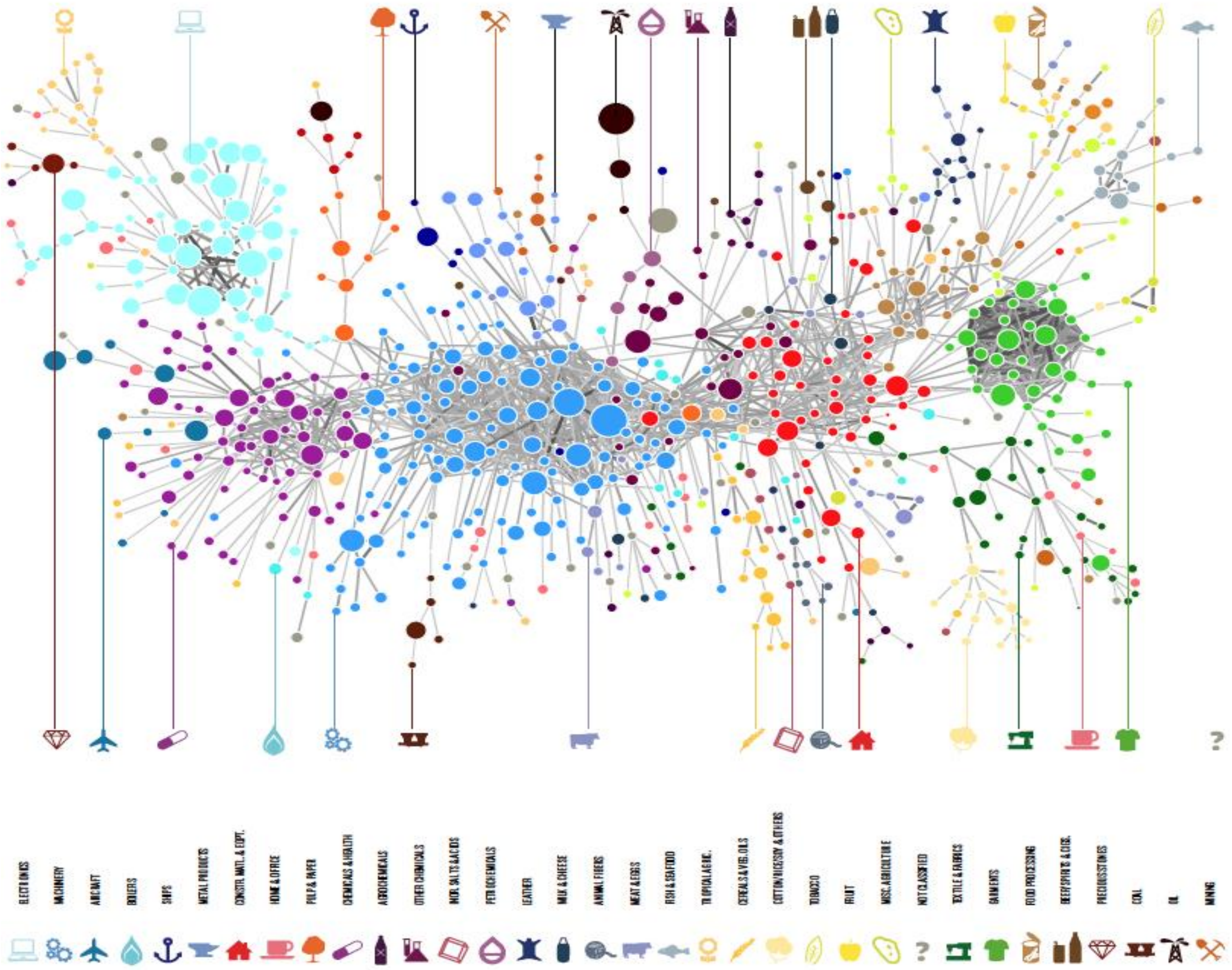
II. 1. Centralization vs. decentralization in Industry 4.0

- The platform economy presents a series of challenges and opportunities for regional economies and innovation ecosystems. These hinge on whether “domain expertise”, that is deep knowledge about a single industry, which tends to concentrate in specific cities or regions, will continue to hold competitive advantage in the foreseeable future.

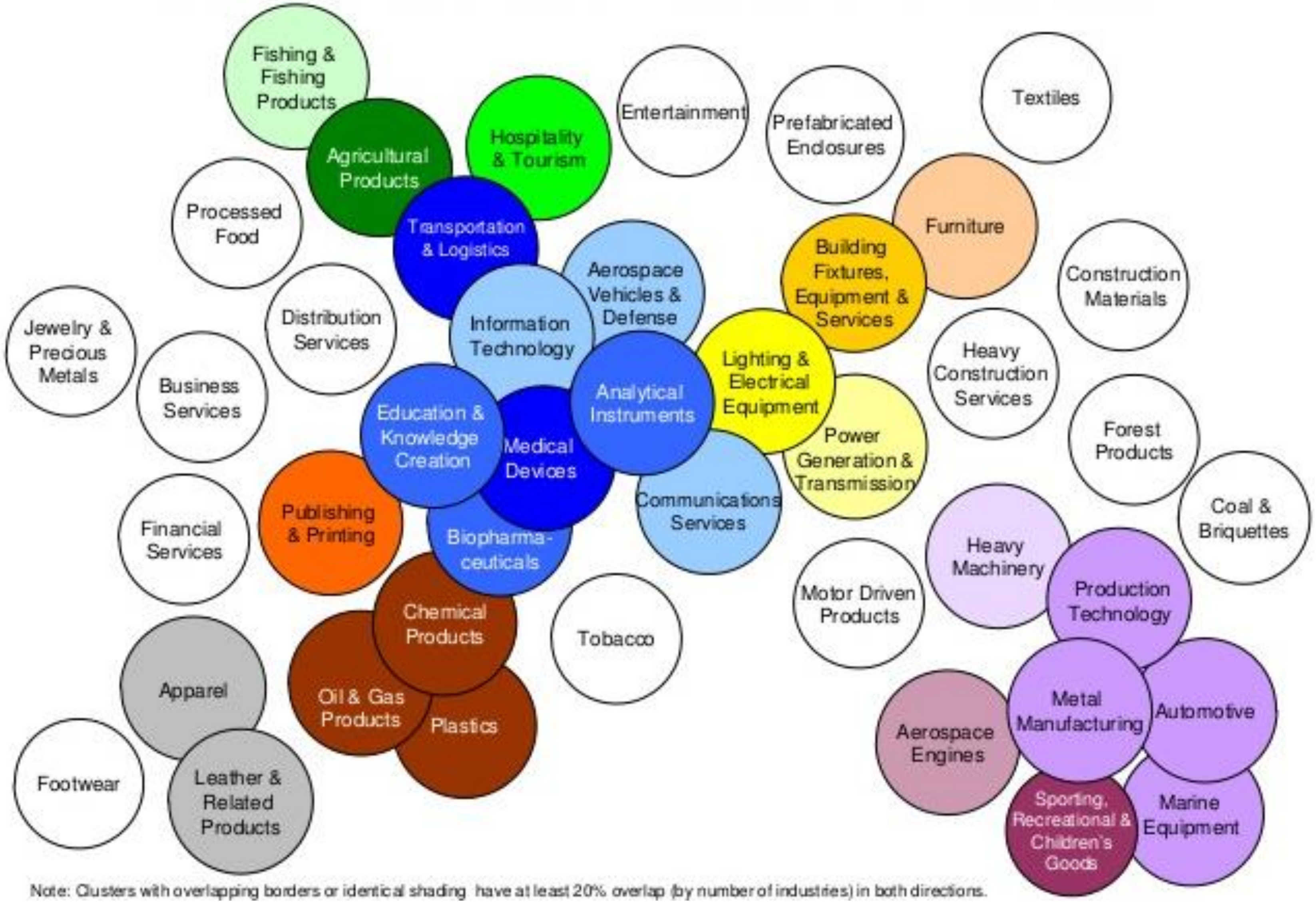
- One issue of fundamental importance, in this context, concerns the dynamics of centralization vs. decentralization of the platform economy and their locational implications for existing as well as emerging industries. Two questions are of importance:

  1. Are existing concentrations of advanced computing power, cloud scale, access to Big Data and algorithmic expertise likely to lead to further concentration of economic power organized around places like Silicon Valley?

  2. Will the growth of big data become sufficiently usable and scalable so instead of absorbing and supplanting other industries, serve as a broad tool that every existing industry can use to spur growth and revitalization for old industrial centers where local domain expertise exists?



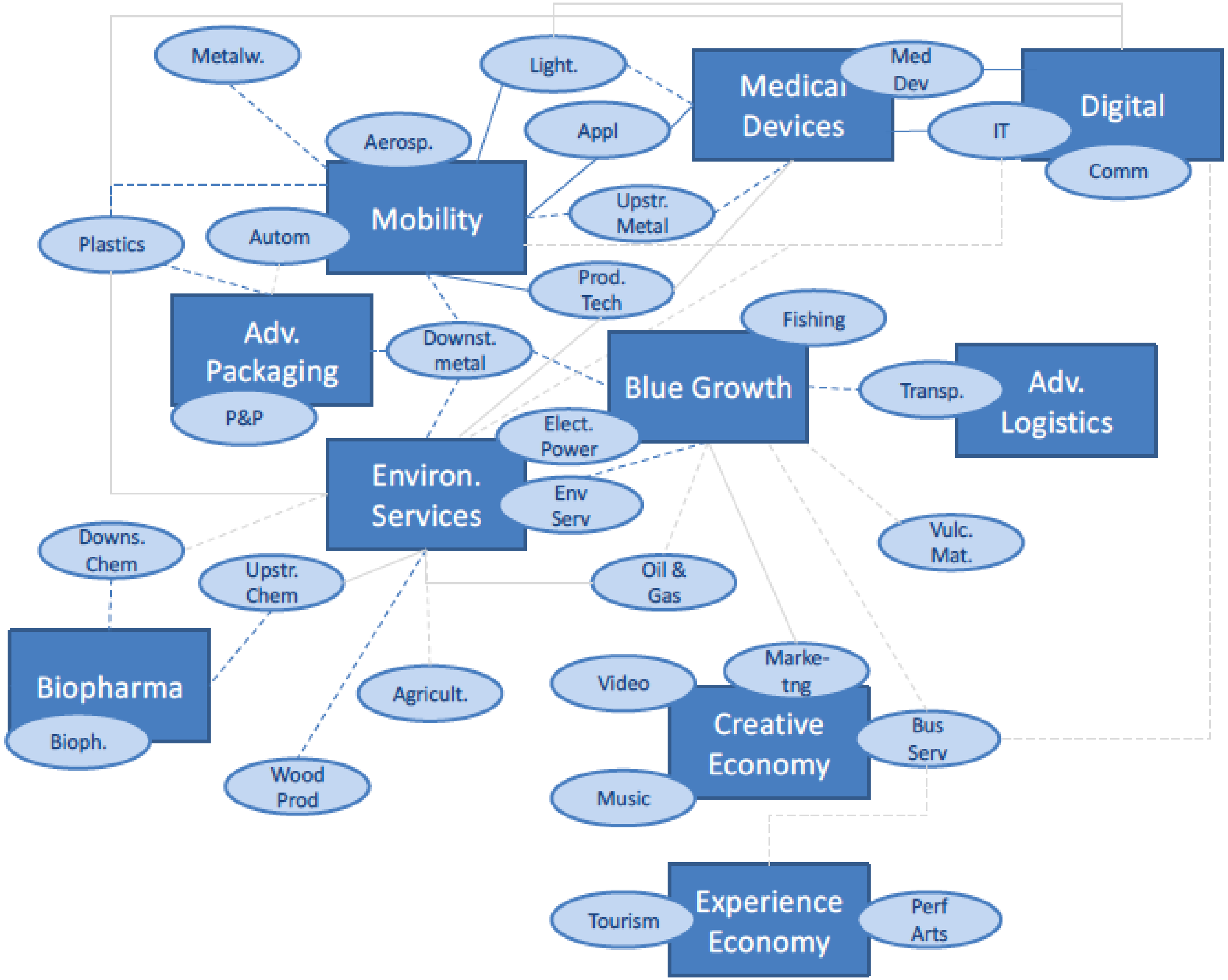
Source: *The Atlas of Economic Complexity*, MIT, 2019.



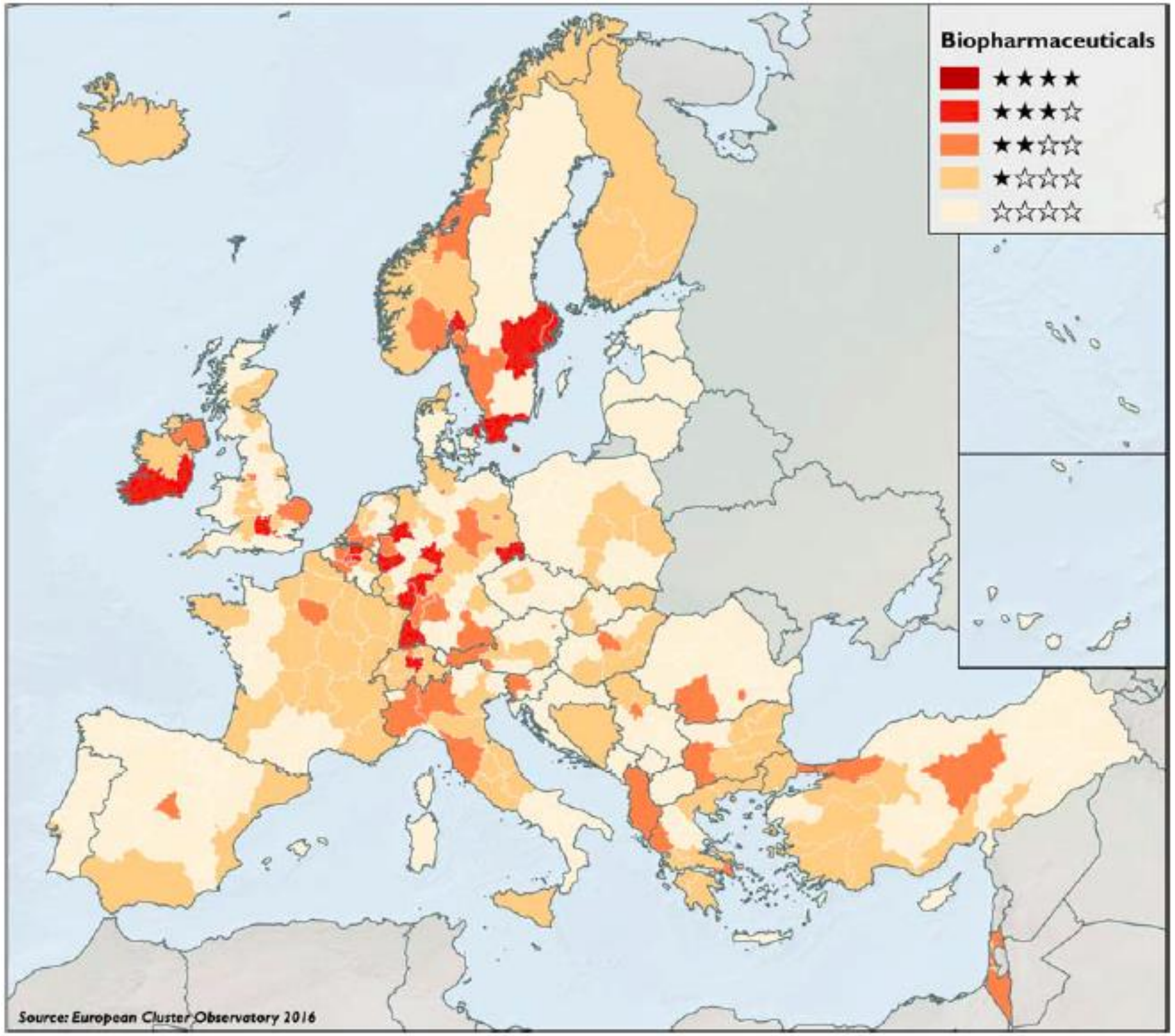
Note: Clusters with overlapping borders or identical shading have at least 20% overlap (by number of industries) in both directions.

Source: Michael Porter, 2014.

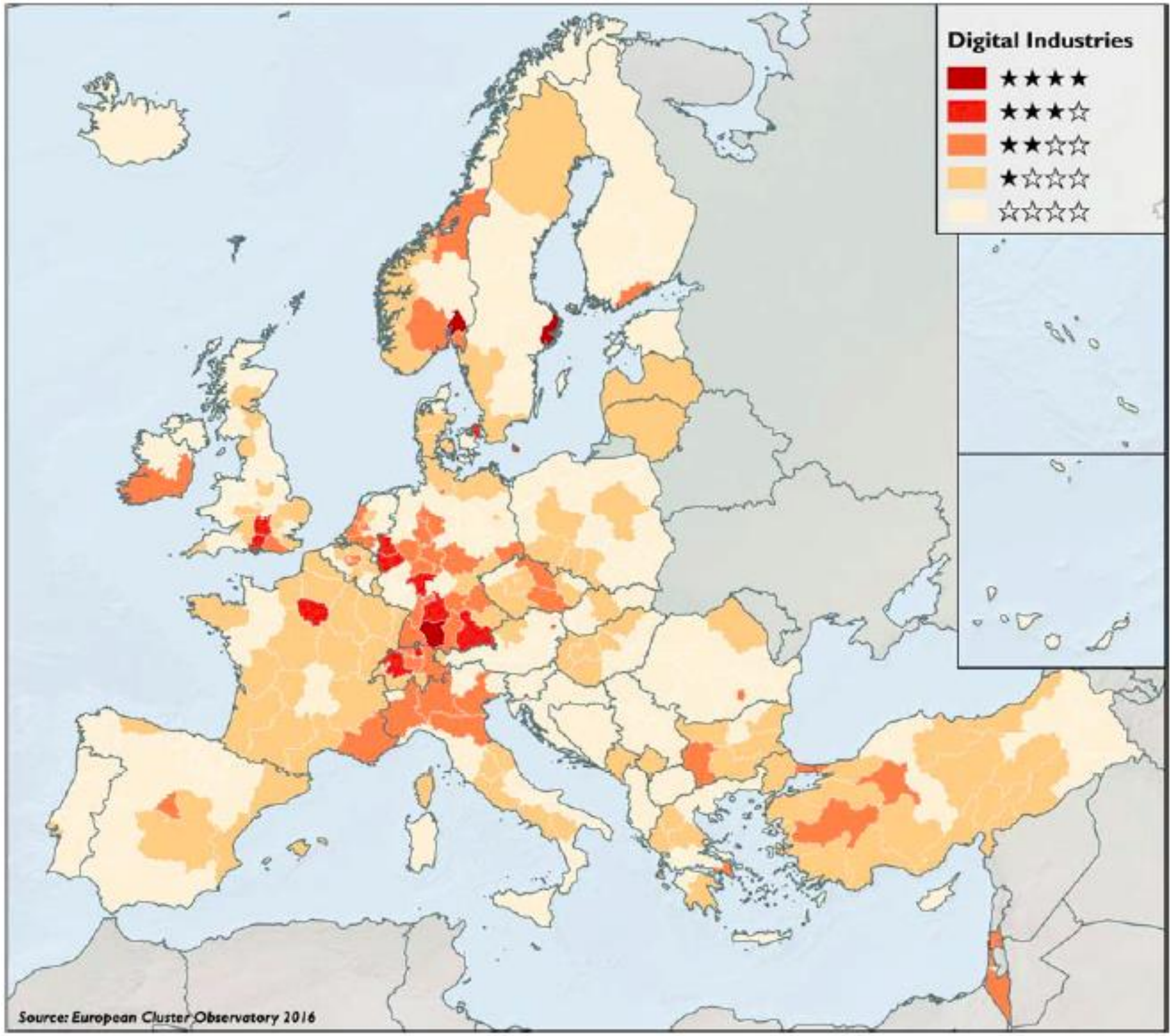
EU: emerging industries and clusters



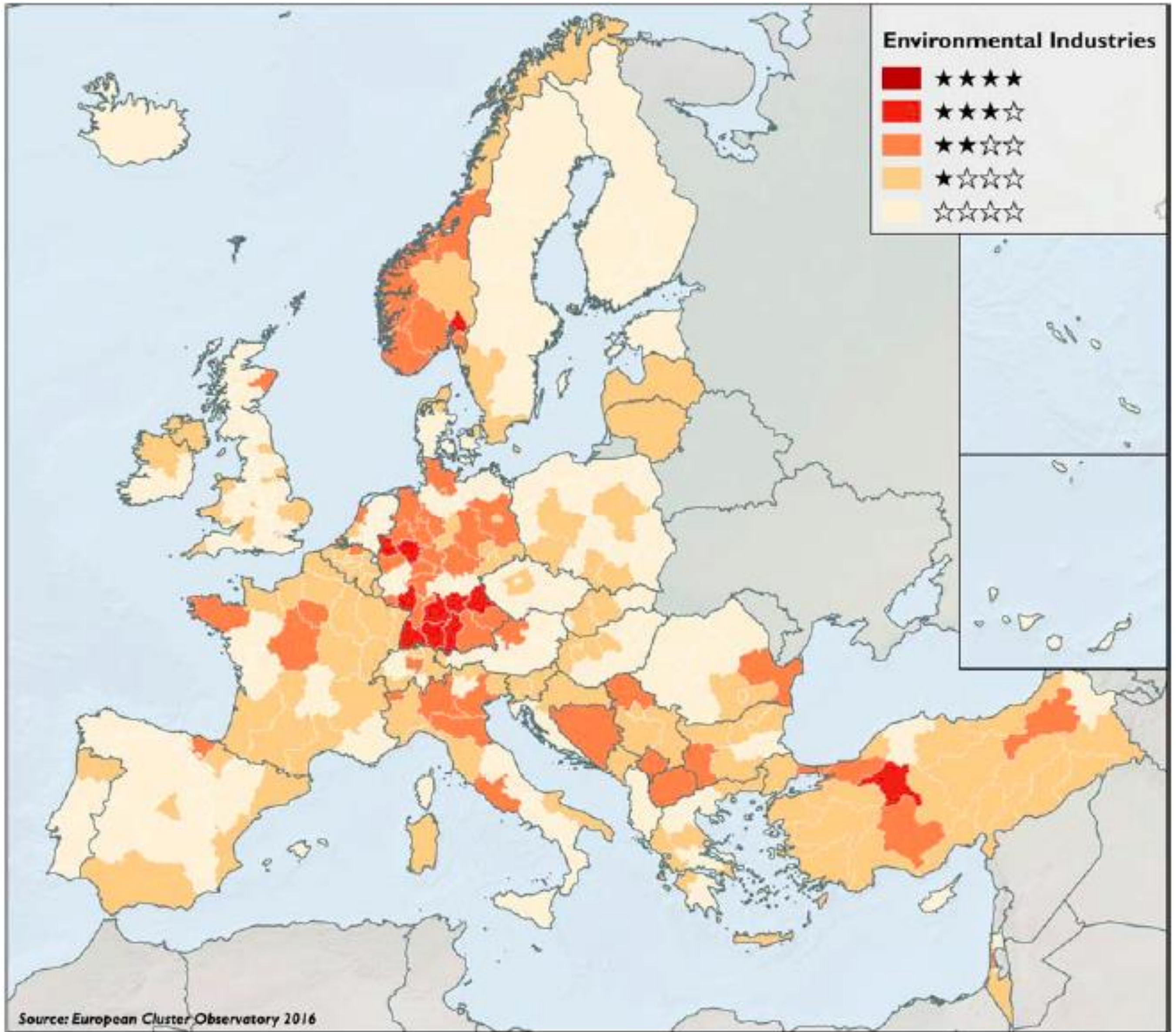
Leading regions in Biopharmaceuticals



Leading regions in Digital Industries



Leading regions in Environmental Industries



II. 2. The changing economic geography of Industry 4.0

The changing economic geography: reshuffling

- Recent research indicates that the technologies and economic activities the Fourth Industrial Revolution brings in its path are reshuffling the ranks of cities and regions across the globe. The dominant trend is concentration. Indeed, the extent to which economic activity has become concentrated in the world’s cities and metropolitan areas is astonishing. The fifty largest metropolitan areas across the globe house just 7% of the world’s total population but generate 40% of global economic activity.

- Just forty mega-regions – constellations of cities and metros like the Boston-New York-Washington corridor – account for roughly two-thirds of the world’s economic output and more than 85% of its innovation, while housing just 18% of its population.

- Even though it is probably too early to confidently predict specific patters of change, research shows that as capitalism’s spatial division of labor – the distribution of economic activities across geographical locations – becomes more finely honed, fewer and fewer cities are able to hold on to the most economically valuable activities and niches.

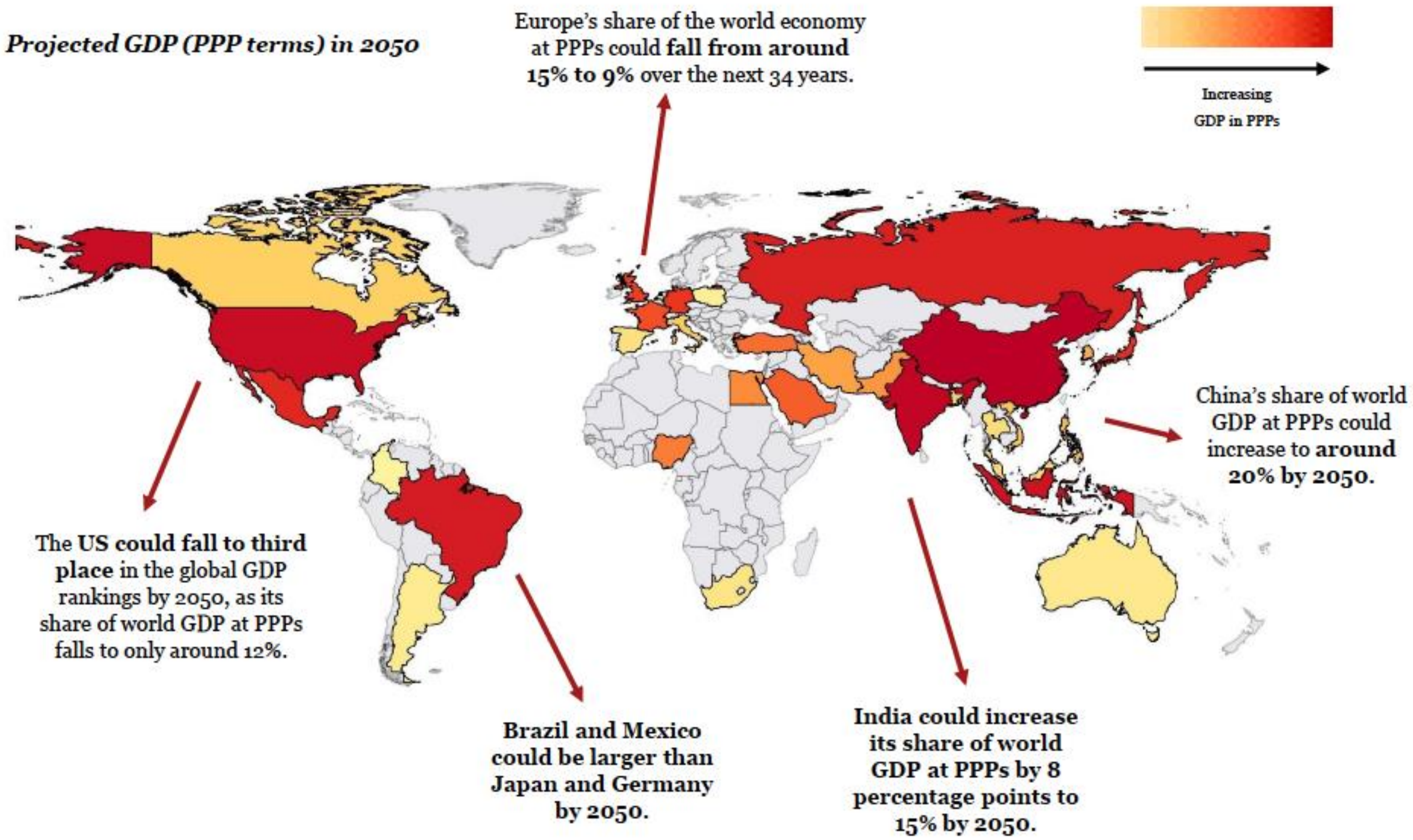
The changing economic geography: reshuffling

Top-tier World Cities
London
New York
Tokyo

2nd-tier World Cities
Brussels
Chicago
Frankfurt
Los Angeles
Paris
São Paulo
Singapore
Washington, DC
Zürich

3rd-tier World Cities
Amsterdam
Bangkok
Berlin
Buenos Aires
Hong Kong
Houston
Johannesburg
Madrid
Manila
Mexico City
Miami
Milan
Mumbai (Bombay)
Osaka
Rio de Janeiro
San Francisco
Seoul
Sydney
Taipei
Toronto
Vancouver

US and Europe will steadily lose ground to the Asian giants



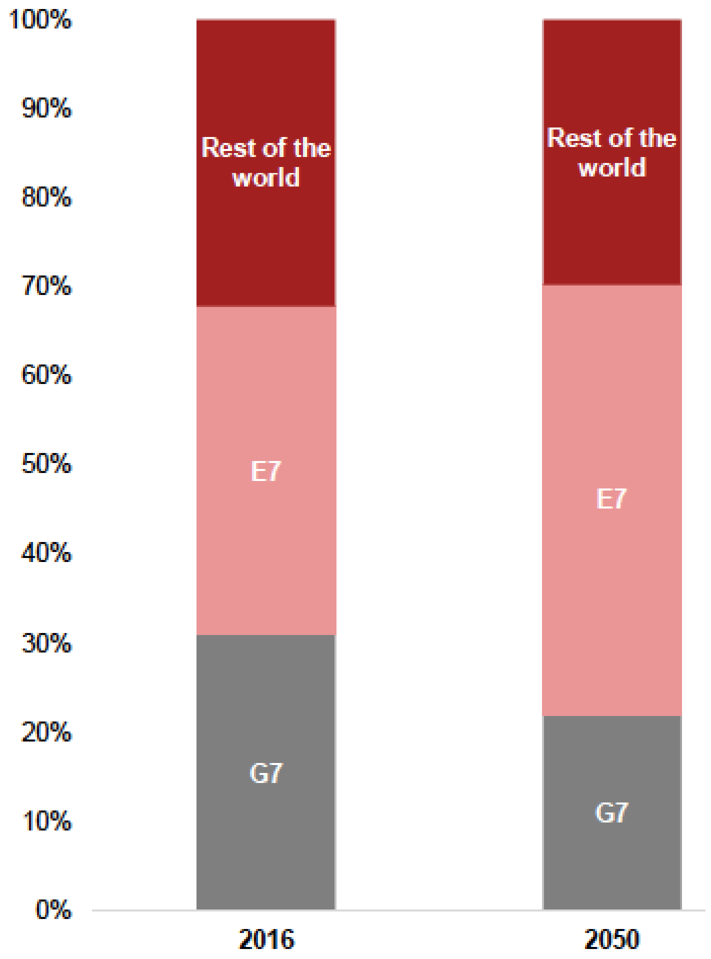
Source: PWC, *The World in 2050*, 2015; OECD, *Perspectives on Global Development,* 2019.

Emerging economies will dominate the list of the world's largest economies by 2050

Rankings of GDP at PPPs

2016			2050
China	1	1	China
US	2	2	India
India	3	3	US
Japan	4	4	Indonesia
Germany	5	5	Brazil
Russia	6	6	Russia
Brazil	7	7	Mexico
Indonesia	8	8	Japan
UK	9	9	Germany
France	10	10	UK

Share of world GDP at PPPs

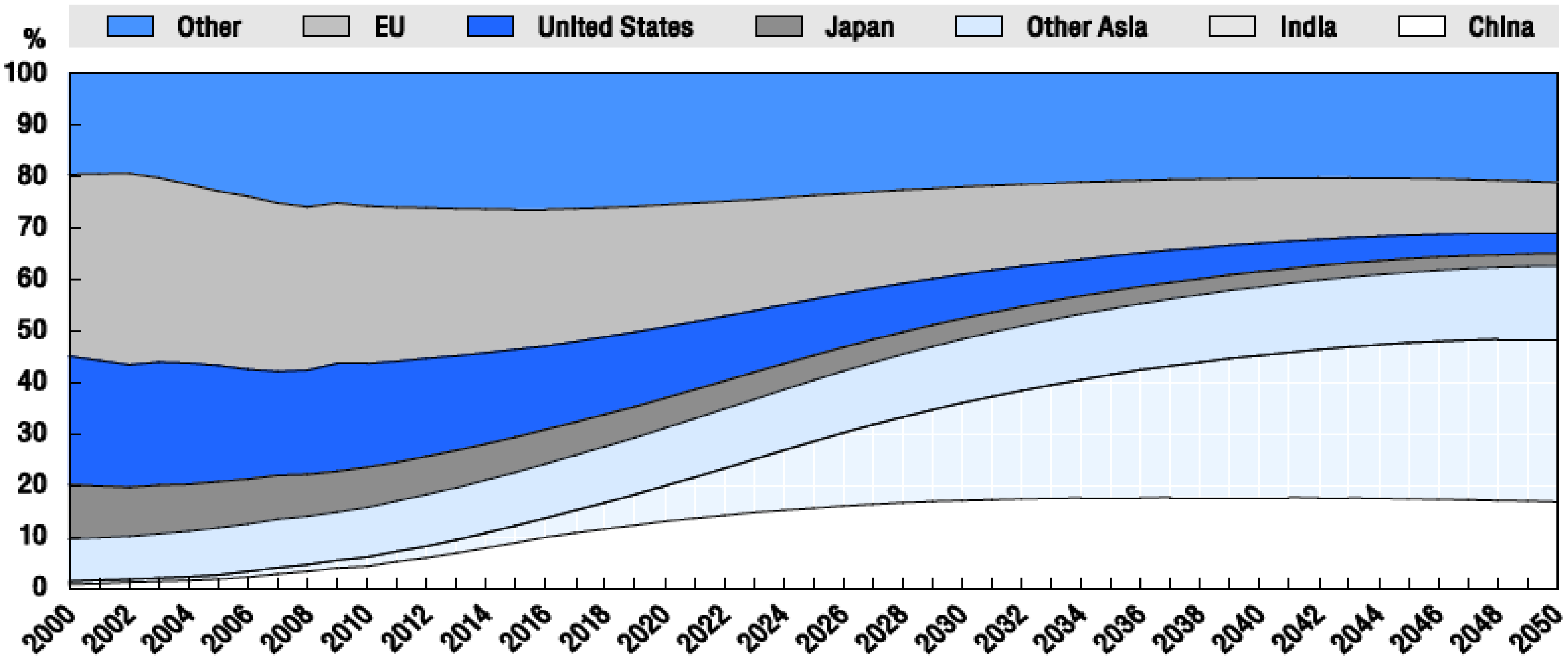


Source: PWC, *The World in 2050*, 2015; OECD, *Perspectives on Global Development*, 2019.

The changing economic geography: reshuffling

Production activities go where the markets are… While global consumer demand had previously been concentrated in (rich) OECD economies, a new middle class is emerging in China and India. While the middle class worldwide could rise from 1.8 billion to 3.2 billion people by 2020 and to 4.9 billion by 2030, almost 85% of this growth is expected to come from Asia. In 2000, Asia (excluding Japan) only accounted for 10% of the global middle-class spending; this could reach 40% by 2040 and almost 60% in the long term.

The Global Middle Class, by country, 2000-50

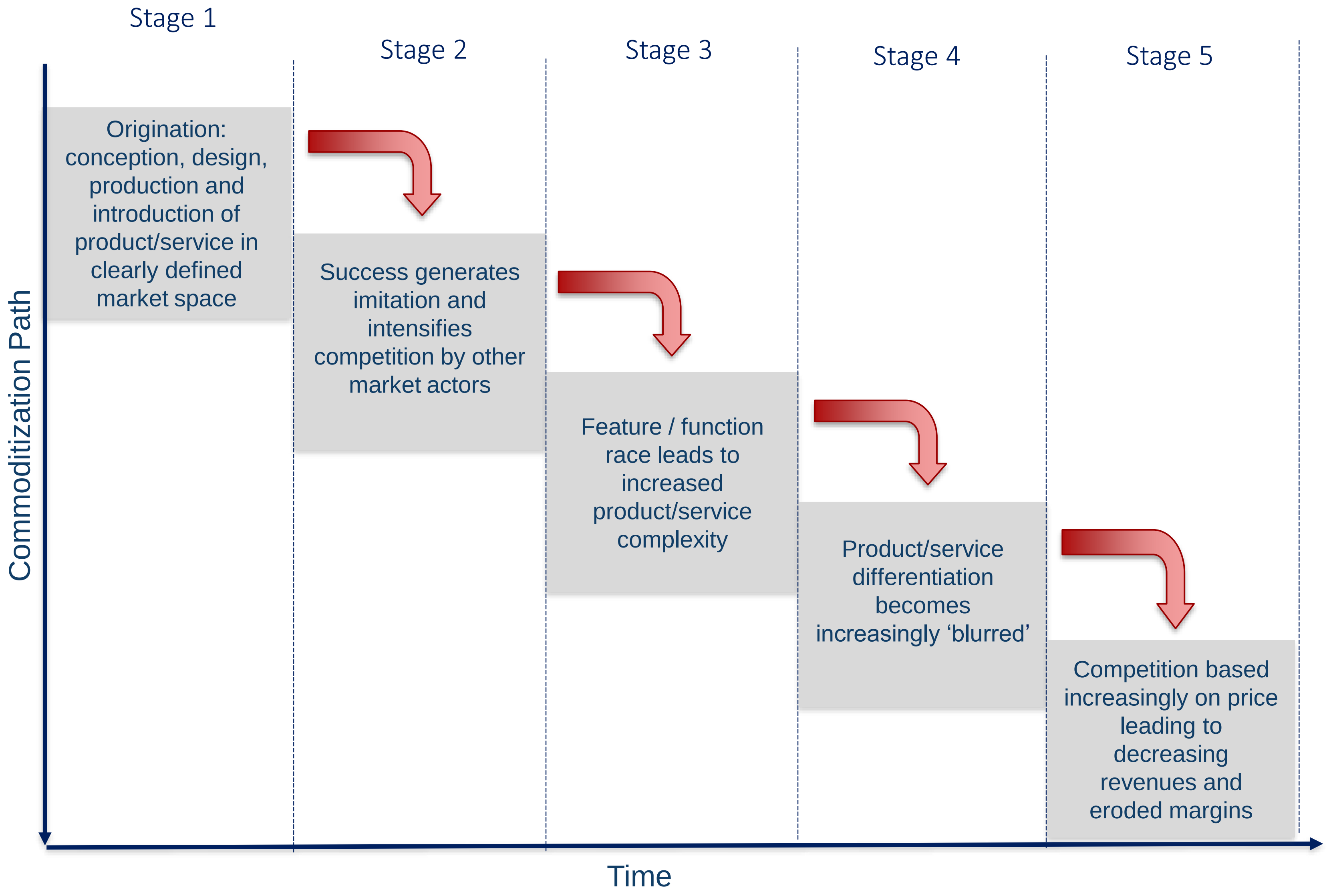


II. 3. The challenges of commoditization and “smart specialization”

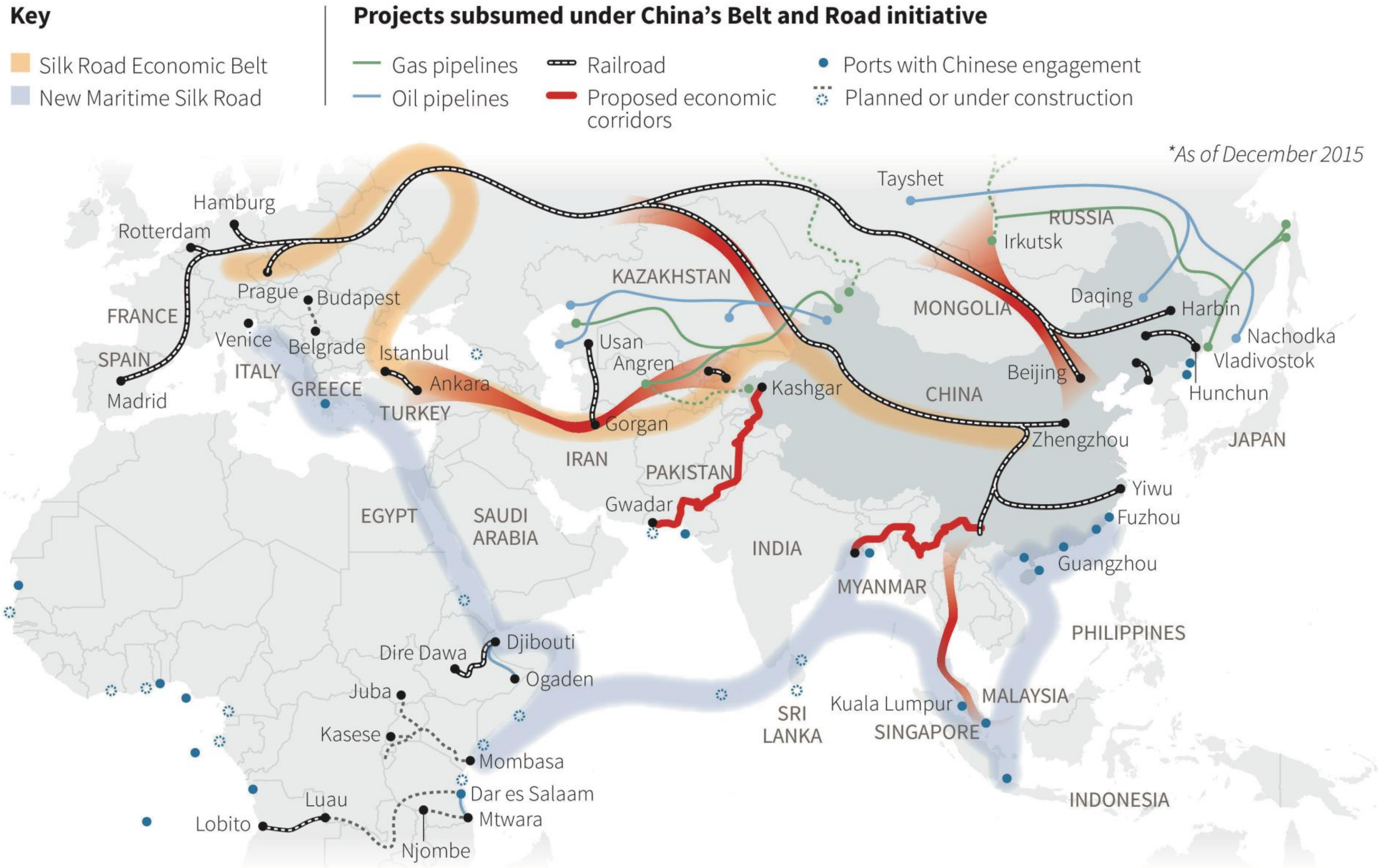
Commoditization and “smart specialization”

- If the highest portions of the GVCs lead to concentration and centralization of high value-added activities anything below is becoming subject to varying degrees of commoditization. The decomposition of manufacturing and services, outsourcing, and the spatial distribution of production activities around the globe, coupled now to Big Data, algorithms and the Internet of Everything have unleashed a process of commoditization across the countries of advanced capitalism.
- The functional and geographical decomposition/re-composition of production and services has been accompanied by the dispersion of skills and knowhow to competing geographical locations undermining in the process regional clusters of capacities in the advanced countries as similar clusters have been built elsewhere.
- The result? Increasing difficulty of value-added differentiation in the GVCs, price-based competition throughout markets for standard goods and services, and pressure on wages and profit margins alike, not only for companies but for entire regional economies and innovation ecosystems across advanced countries.

The commoditization process

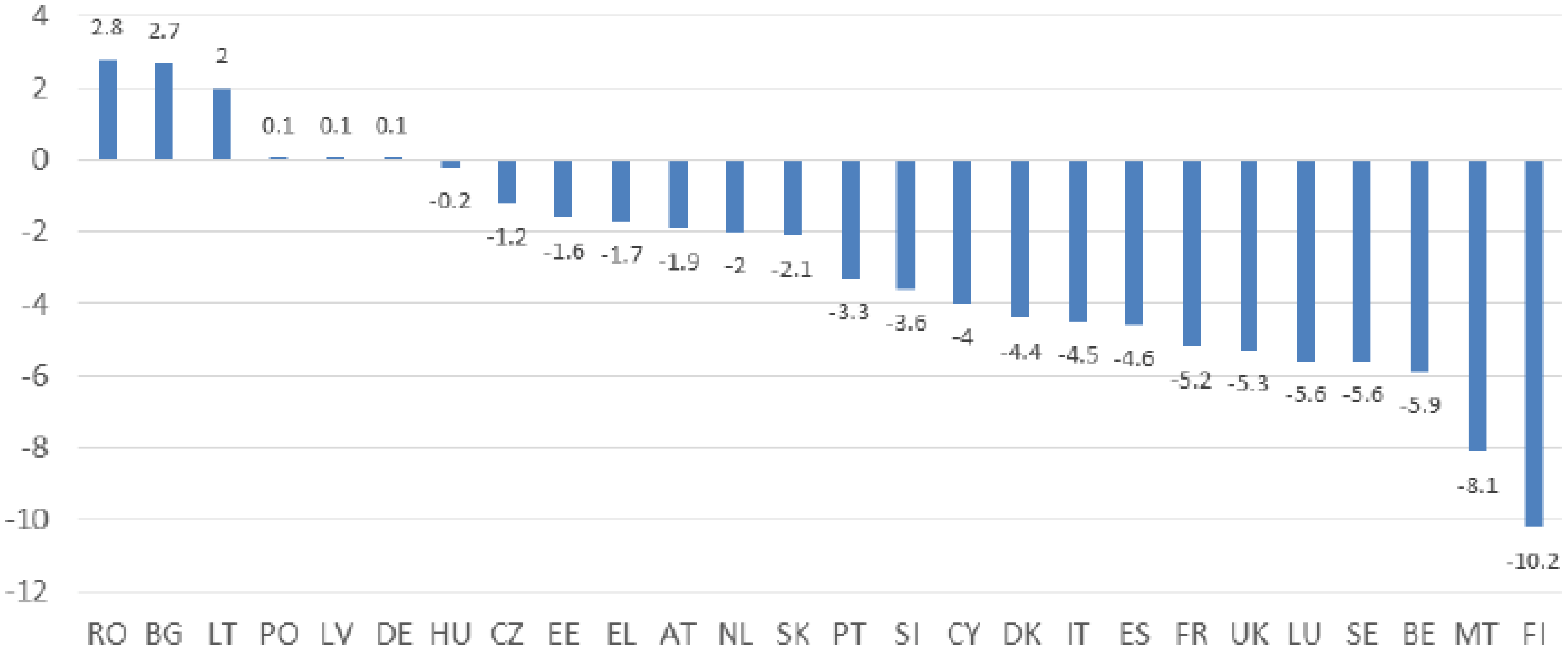


China: Reviving the Silk Road



Source: Mercator Institute for China Studies, 2017.

Change in share of manufacturing as a percentage of gross added value at basic process 2000-2016 (%)



Source: European Parliament – Directorate General for Internal Policies, *Industry 4.0*, 2016.

SMART SPECIALISATION PLATFORM

WHAT IS SMART?

1. Place **evidence based**
2. Not top-down decision, but **bottom-up partnership approach**
3. A **Global perspective** on potential advantage and potential cooperation
4. Source in **knowledge, technologies, services, talent and investors**

WHAT IS SPECIALIZATION?

1. **Priority setting** in times of scarce resources
2. **Excellence** in a specific economic activity
3. Accumulation of **critical mass**
4. Not necessarily focus on a single sector but **cross-sectoral approach**

a. Best way to leverage territorial potential through innovation
b. Foster international comparative advantage

Source: European Parliament – Directorate General for Internal Policies, *Industry 4.0*, 2016.

Smart Specialization

Regional Competitiveness Turbine

Critical questions on "smart specialization"

Three questions regarding the adequacy of smart specialization as a framework supporting sustainable innovation in the context of the Fourth Industrial Revolution. The main point is to differentiate among different modes of financing innovation and distinguish between 'symbiotic' and 'parasitic' ecosystems.

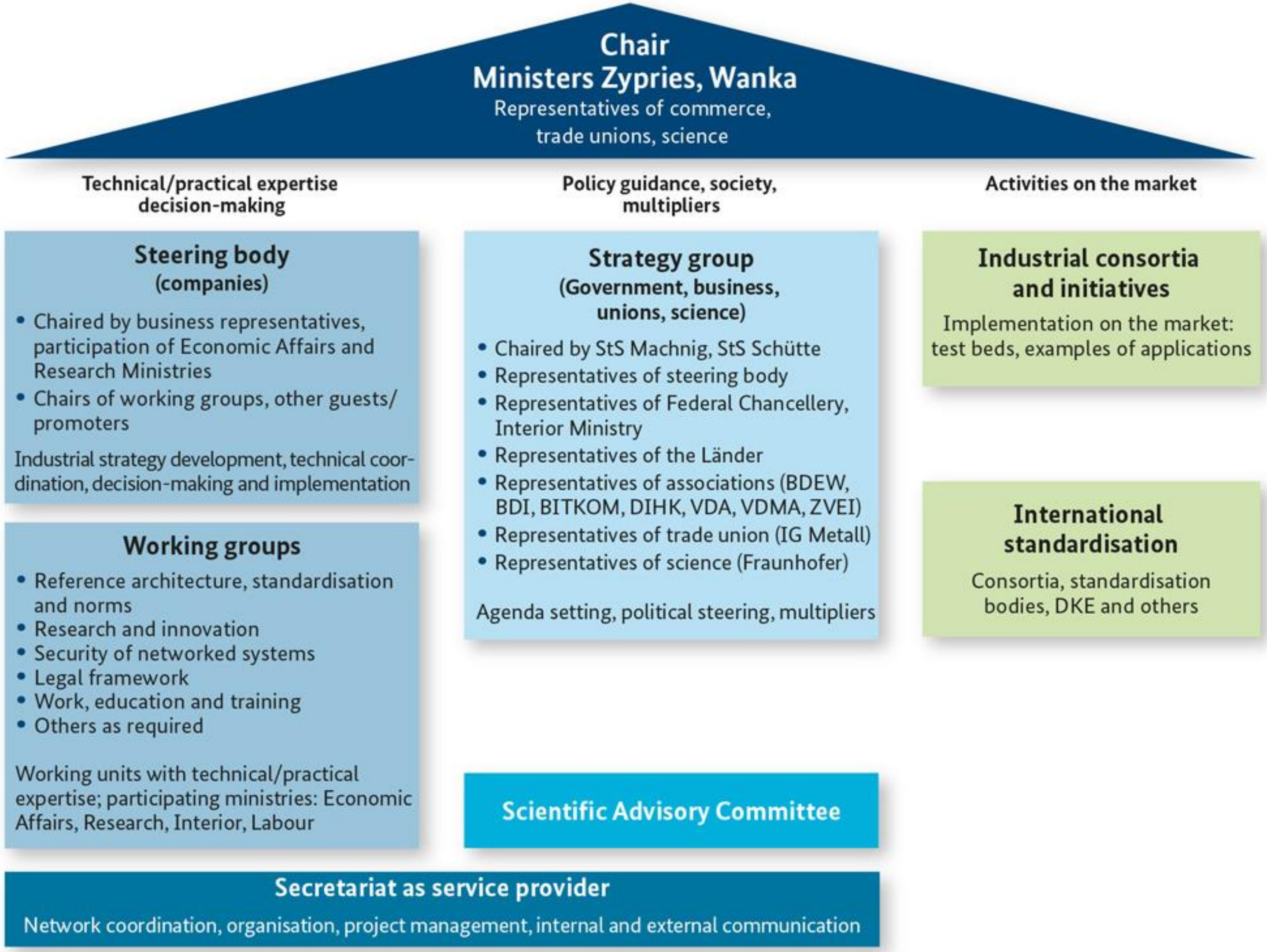
- Is smart specialization likely to provide a sustainable counterweight to the 'expertise domain' agnosticism of the platform economy exhibited by the likes of Uber or Amazon?
- Smart specialization stresses, correctly, that innovation is an ecosystem phenomenon. However, it does not specify the exact role each actor plays in the risk landscape of innovation. Many errors of current innovation policy are due to placing actors in the wrong part of this landscape – both in time and space. For instance, is venture (private) capital the appropriate form of finance for all types of innovation in the emerging technologies? Or is it the case that "patient" (public) investment is more appropriate in some critical technology areas with longer maturation cycles?
- How can smart specialization ensure that increased investments by the state in the innovation ecosystem will not result in the private sector investing less, and using its retained earnings to extract short-term profits instead of in riskier areas like human capital formation and R&D, to promote long-term growth? This raises the question of whether the "open innovation" model officially adopted by the European Commission as a way to foster innovation is becoming dysfunctional.

Why? Because, as large companies are increasingly relying on alliances and collaborations with SMEs and the public sector within regional innovation ecosystems, the indication is that large players invest more in short-run profit gains than long-run investments, i.e., parasitic ecosystems.

Part III: Macro-level – Industry 4.0 at the level of governance systems and innovation strategy

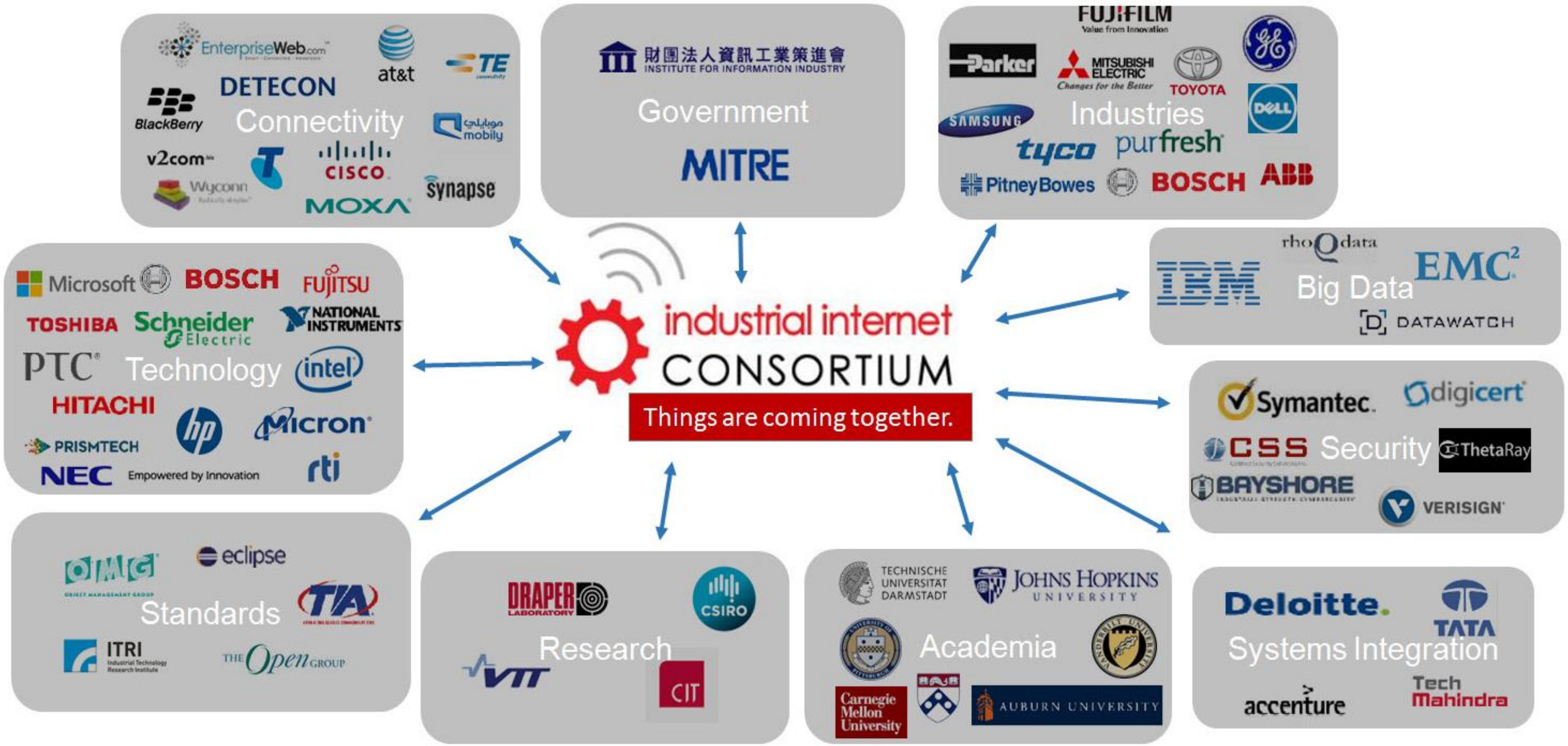
III. 1. Methods and approaches for assessing comparative readiness for Industry 4.0

Germany: The Industrie 4.0 Platform



Source: Plattform Industrie 4.0, 2017.

United States: The US-led Industrial Internet Consortium



Source: https://www.iiconsortium.org .

Made in China 2025: Strategic sectors, priorities and support mechanisms

Industry 4.0 across the globe

EU	US	Asia
Industrie 4.0 Östereich	Industrial Internet Consortium	Made in China 2025
Factory of the Future 4.0	Smart Manufacturing	Robot Revolution Initiative
Prùmysl 4.0	Smart Planet	Society 5.0
MADE	Internet of Everything	Smart Nation
e-estonia		
FIMECC PPP Programs		
L'Industrie du Futur		
Industrie 4.0		
IPAR 4.0		
Industria 4.0		
Industry 4.0		
Smart Industry		
INNOMOTO / INNOLOT		
Industria 4.0 / Produtech		
Industria Conectada 4.0		
Smart Industry / Production 2030		
Industry 4.0 / IR4		
Industry 4.0 Coordination Plans		

Framework requirements of Industry 4.0 within and across national industrial structures

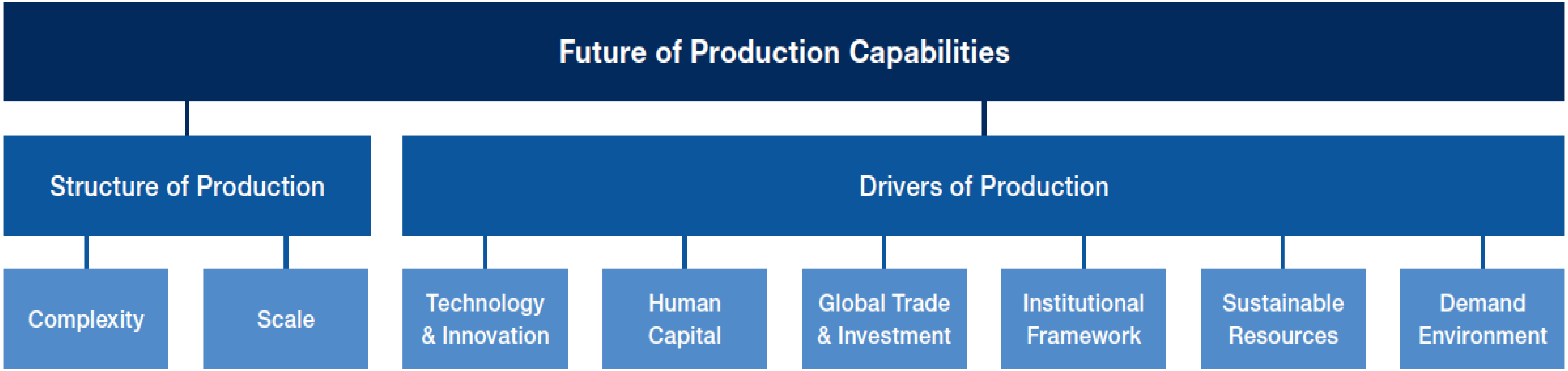
- Standardisation of systems, platforms, protocols, connections, interfaces seem is crucial and a reference architecture to provide a technical description of these standards and facilitate their implementation to help business implement Industry 4.0 processes.
- *Security / protection of know-how* in a global competitive situation is critical. Will companies/ governments be prepared to invest if their innovations can be readily duplicated by others that have not had to bear the investment in R&D (including those based in Third countries? Will the costs of investing in safety of equipment to protect workers be proportionate to the potential gains?
- *New business models* have to be developed and implemented – what are the costs involved, and who will bear the risks and costs for initiatives that fail?
- *Work organization* will have to change reflecting changes in business models. Complex systems will have to be managed with the help of planning and explanatory models. Real-time oriented control will transform work content and processes & environment, resulting in increased responsibility and continued development required for individuals. This will require a concerted effort amongst stakeholders in order to be successful
- The *availability of skilled workers* that can design and operate Industry 4.0 establishments. Who will invest in their skills and training? What are the implications in terms of employment for those without such skills?
- Who will carry out the *research* required to further develop Industry 4.0 (public/ private)**?**
- How can *a common EU legal framework* to enable the digitalisation of industry be developed and implemented? This is a precondition for companies to implement Industry 4.0 in the Single Market as it would allow them to pool resources to undertake the investments needed to integrate their production systems.

Industry 4.0: Differentiated impact across industries

- Industries with a high level of product variants such as the automotive and food-and-beverage industries will benefit from a higher degree of flexibility whereas industries with a focus on high quality such as semiconductors and pharmaceuticals may benefit from reduced error rates. Some companies are well positioned to serve new markets.
- The key businesses that will increase in importance include technology suppliers, infrastructure providers (cloud computing, big data storage and processing, telecoms, SAP) and industrial users (e.g. Siemens, VW or BASF) In each category, new players may emerge or established European economies may gain a lead.
- *Impact may also differ by company size:* start-ups and small businesses may develop and provide downstream services and further integrate themselves into value chains or on the contrary may face prohibitive entry barriers to participating in the digital transformation of manufacturing.
- Currently, the highest adoption, maturity levels and potential for future implementation are observed in industries like machinery, electrical, electronics and automotive, each of which are classified as either medium-high tech or high-tech intensity industry. This can be attributed to the high-levels of virtualization already employed in these industries resulting in disruption in their business.
- The next best promise for adoption is demonstrated by auto-components, aviation and aerospace, construction, logistics, food processing, chemicals, rubbers, plastics, industrials, metals, engineering, etc. In such industries, there appear fewer prospects of disruptions that might result in significant changes in business models and processes. However, these industries are expected to undergo improvement in resource efficiency with implementation of industry 4.0. In industries such as textiles, pharmacy, beverage and agriculture – predominantly the low-tech industries (not withstanding pharma), there has been limited adoption at this stage.

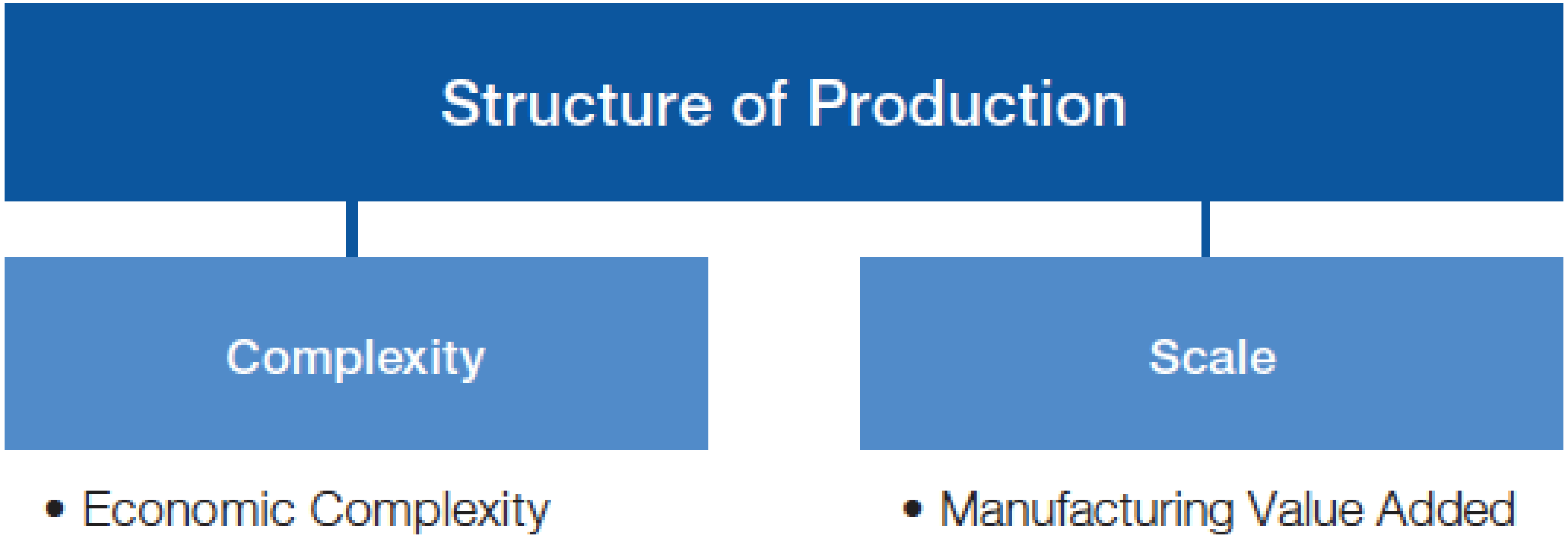
Industry 4.0: Differentiated impact and potential across countries

Industry 4.0: Readiness Diagnostic Model Framework



Source:. World Economic Forum, *Readiness for the Future of Production Report 2018.*

Structure of Production: Concepts measured



Complexity: Assesses the mix and uniqueness of products a country can make as a result of the amount of useful knowledge embedded in the economy and the ways in which this knowledge is combined.

Scale: Assesses both the total volume of manufacturing output within a country (Manufacturing Value Added) as well as the significance of manufacturing to the economy (Manufacturing Value Added, % of GDP).

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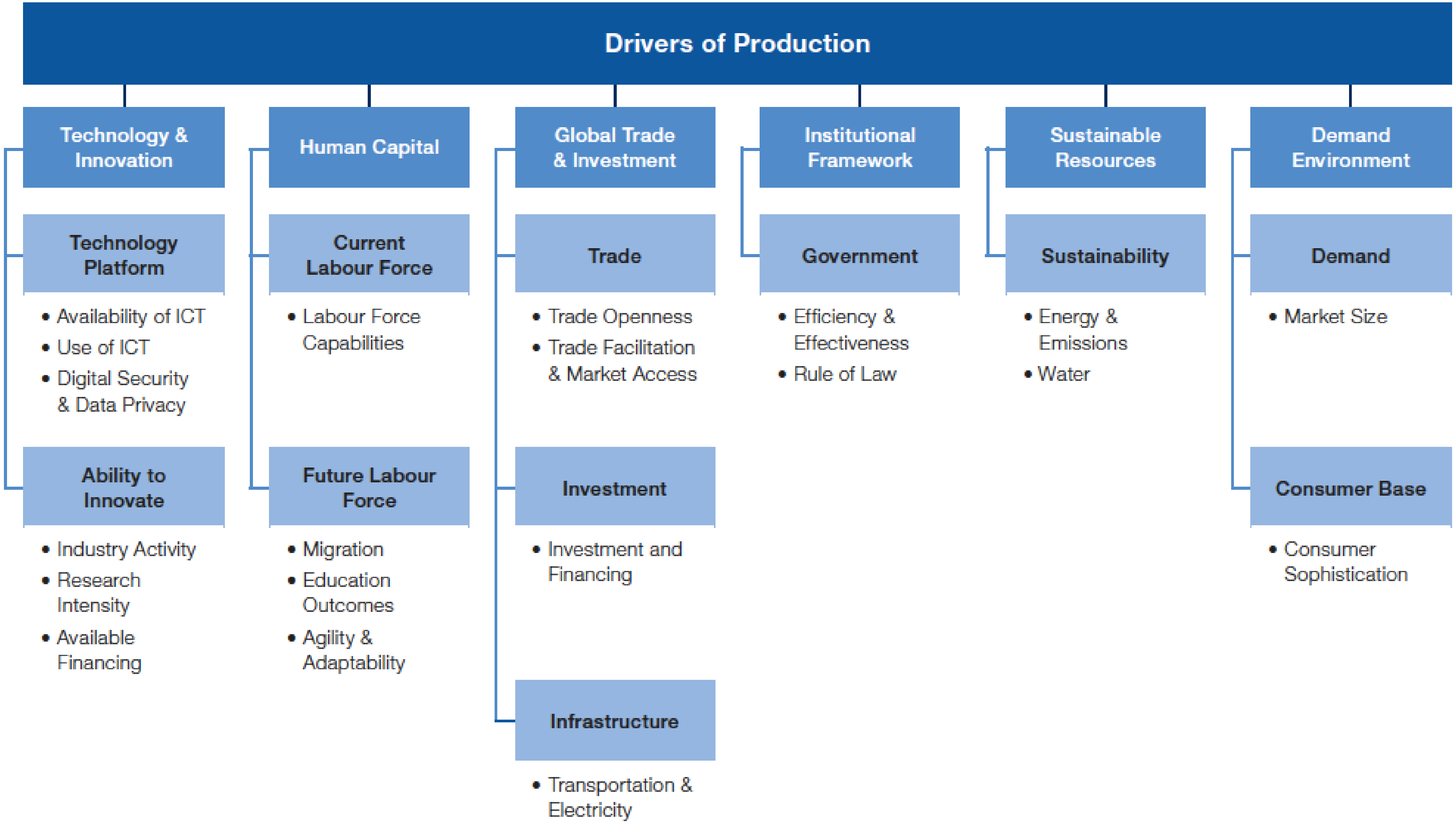
Source:. World Economic Forum, *Readiness for the Future of Production Report 2018.*

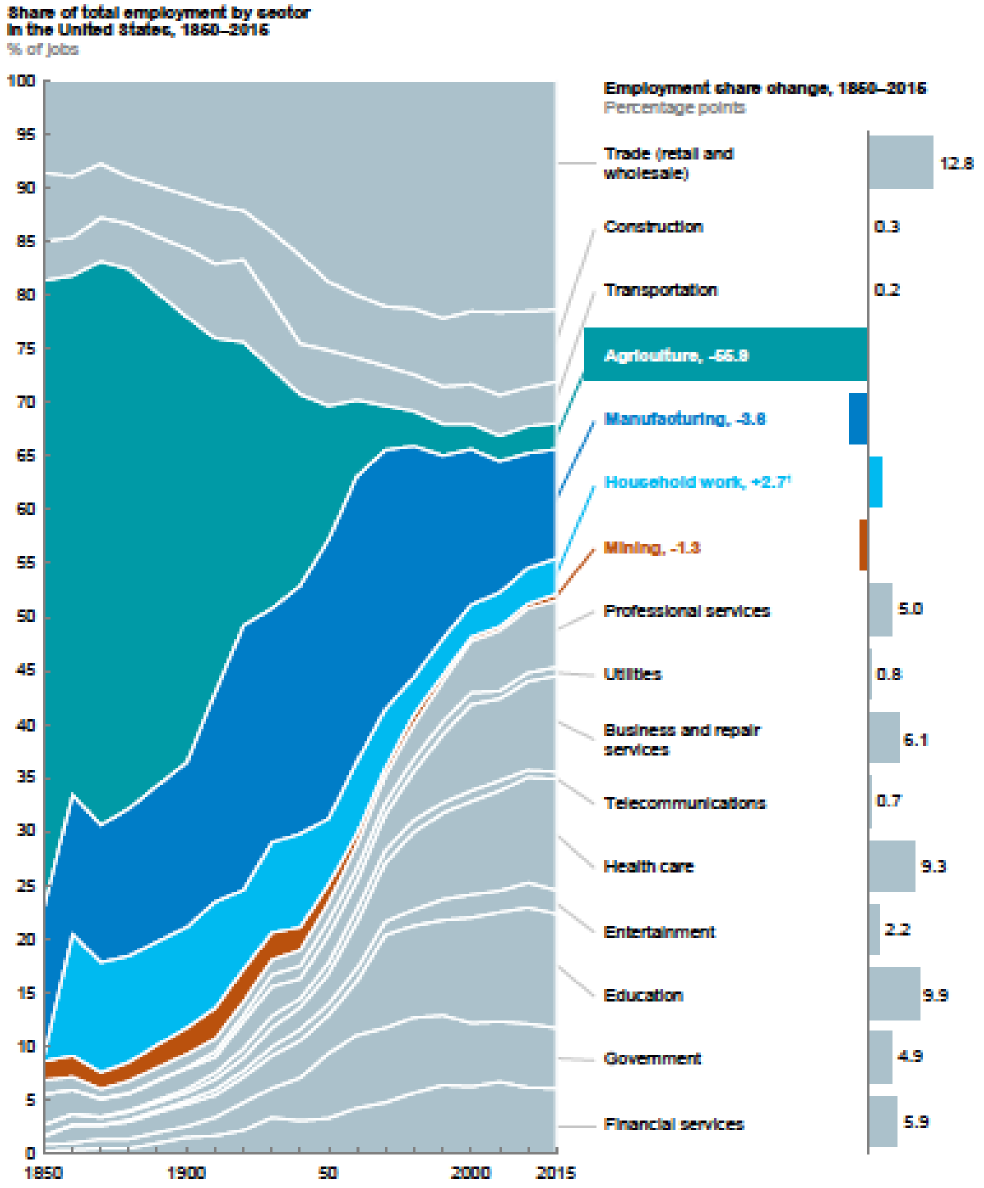
Drivers of Production: Concepts Measured



Source:. World Economic Forum, *Readiness for the Future of Production Report 2018.*

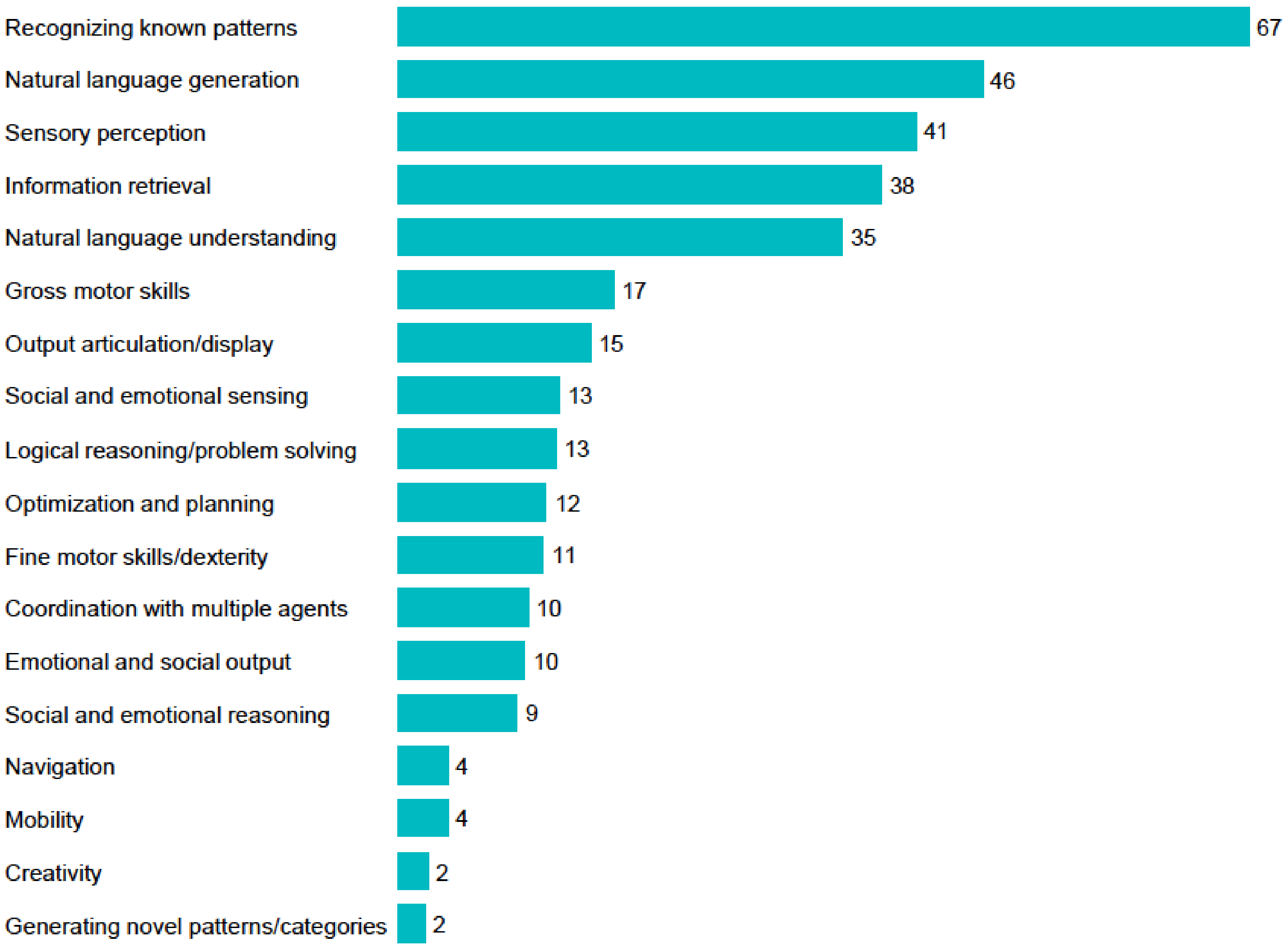
III. 2. Employment and skillset challenges in Industry 4.0

Historically, large-scale sector employment declines have been countered by growth of new sectors



Source: McKinsey Global Institute. *Jobs Lost, Jobs Gained: Workforce Transitions*, 2017.

Recognizing known patterns and natural language generation are the two most-used capabilities in work activities
Time spent by US workers on activities that require median or higher levels of human performance for each capability (% of time)



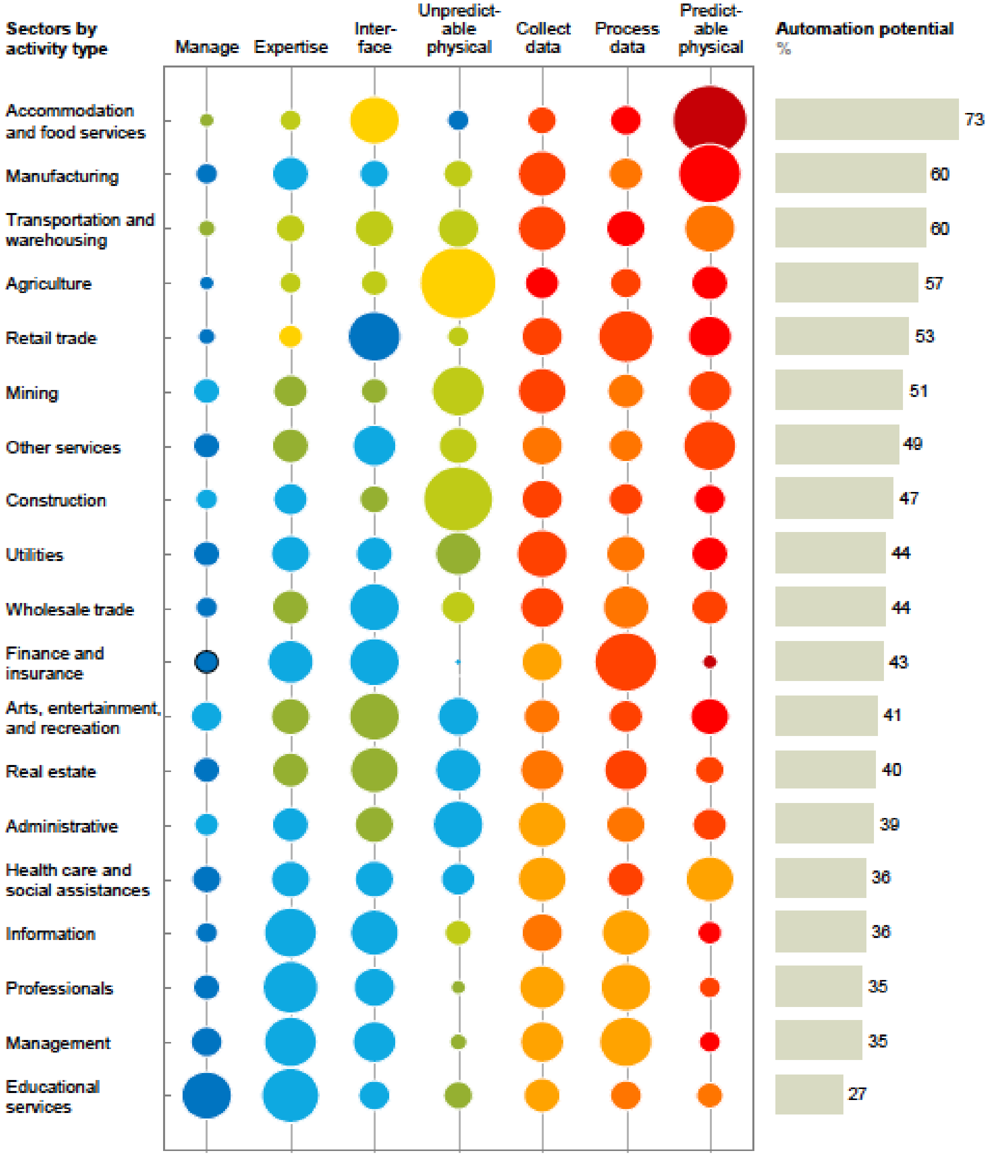
Source: McKinsey Global Institute. *Jobs Lost, Jobs Gained: Workforce Transitions*, 2017.

Current technologies have achieved different levels of human performance across 18 capabilities

	Automation capability	Capability level[1]	Description (ability to …)
Sensory perception	Sensory perception		Autonomously infer and integrate complex external perception using sensors
Cognitive capabilities	Recognizing known patterns/categories (supervised learning)		Recognize simple/complex known patterns and categories other than sensory perception
	Generating novel patterns/ categories		Create and recognize new patterns/categories (e.g., hypothesized categories)
	Logical reasoning/ problem solving		Solve problems in an organized way using contextual information and increasingly complex input variables other than optimization and planning
	Optimization and planning		Optimize and plan for objective outcomes across various constraints
	Creativity		Create diverse and novel ideas, or novel combinations of ideas
	Information retrieval		Search and retrieve information from a large scale of sources (breadth, depth, and degree of integration)
	Coordination with multiple agents		Interact with others, including humans, to coordinate group activity
	Output articulation/ presentation		Deliver outputs/visualizations across a variety of mediums other than natural language
Natural language processing	Natural language generation		Deliver messages in natural language, including nuanced human interaction and some quasi language (e.g., gestures)
	Natural language understanding		Comprehend language, including nuanced human interaction
Social and emotional capabilities	Social and emotional sensing		Identify social and emotional state
	Social and emotional reasoning		Accurately draw conclusions about social and emotional state, and determine appropriate response/action
	Social and emotional output		Produce emotionally appropriate output (e.g., speech, body language)
Physical capabilities	Fine motor skills/dexterity		Manipulate objects with dexterity and sensitivity
	Gross motor skills		Move objects with multidimensional motor skills
	Navigation		Autonomously navigate in various environments
	Mobility		Move within and across various environments and terrain

Source: US Bureau of Labor Statistics; McKinsey Global Institute analysis, 2017.

Technical potential for automation across sectors varies depending on mix of activity types



Source: US Bureau of Labor Statistics; McKinsey Global Institute analysis, 2017.

Employment and skills .

- The global labor share of national income has been in decline since the early 1980s, and this is occurring within the large majority of countries and industries. It has to do with the decline in the relative price of investment goods. Efficiency gains in capital producing sectors, often related to advances in ICT induced firms to shift away from labor and toward capital to such a large extent that the labor share of income declined. The dominant trend has been stagnant rates of unemployment and growing underemployment.

- Decline in medium-skilled routine jobs in recent years reflected in the polarization of skills in demand and labor market dynamics, the parallel but uneven growth of **mcjobs** (>) and **macjobs** (<) across the OECD countries, effectively leading to the hollowing out of middle-class jobs. At the same time the emergence of the platform economy and corporate disintegration through *Nikefication* undermine occupational mobility because by contracting out “non-core” jobs, these jobs become separated from the ladders that once offered a means to move up within an organization. Outsourcing traditional entry-level positions, as a result, tends to leave the holders of these positions stranded without an obvious path for promotion.

- This is one aspect of a deeper fragmentation of the labor process itself. It involves a shift from the **death of the career** and its replacement by **jobs** with employees often moving from firm to firm, or working as independent – a pattern that originated in the 1990s – to a shift from jobs to **tasks** to be performed under task-oriented contracts – a key feature of the platform economy and a pattern observable in several industries today.

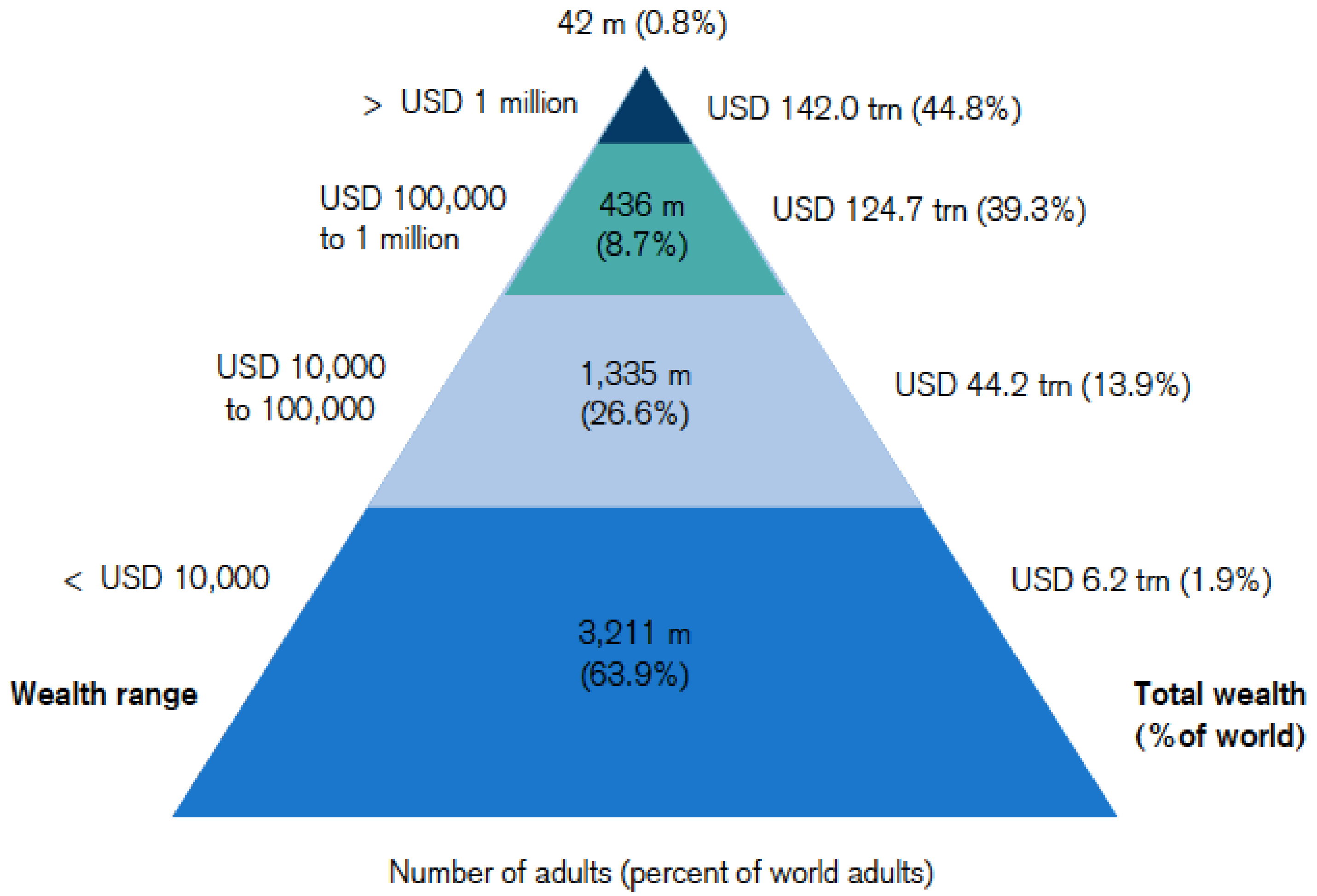
- The most important thing is what Uber and other platforms mean for labor markets and how employment is organized. Platforms like Uber make it easy to create a spot market for all kinds of labor. Someone needing a work crew for the day could post a virtual sign-up sheet, and potential contractors with the relevant skills could bid against each other to be in the first, say, five slots. Those who “won” would find their own way to the worksite. This is what is meant by the *Uberization* of labor and the broader transition to a “labor-light” economy.

Data Science in the New Economy

A new race for talent in the Fourth Industrial Revolution

Key insights

- While data science roles and skills form a relatively small part of the workforce, recent trends indicate that these are currently among the highest in-demand roles in the labour market.
- The demand for data science skills is not limited to the Information Technology sector as data's importance grows across multiple sectors, including Media and Entertainment, Financial Services and Professional Services.
- Data science skills are particularly critical to a distinctive set of growing roles. For example, in the United States those roles are Machine Learning Engineers and Data Science Specialists. These skills are only nominally in demand across more traditional roles such as Relationship Consultants, but those roles are also facing major churn in skills.
- The data science skillset is not fixed and is rapidly evolving as new opportunities in data analysis and further technological advances redefine the specific skills composition of data scientist roles.
- The disparities in achievement of data science learners point to varying levels of data science talent across industries and economies:.
    - The Information Communication and Technology (ICT), Media and Entertainment, Financial Services and Professional Services industries are currently taking the lead both in hiring data science talent and in the achievements of online learners who are actively updating their skillsets across industries.
    - Across most industries, online learners based in Europe demonstrate higher proficiency in data science skills than in North America, followed by emerging regions. Exceptions to such trends exist in sectors such as Telecommunications and Technology, where learners in the Asia Pacific region and the Middle East and Africa outperform regional averages across industries.
- Jobs such as Artificial Intelligence and Machine Learning Specialists or Data Scientists, in which data science skills are perhaps most profoundly applicable, are forecasted to be among the most in-demand roles across most industries by 2022.



Highlights:

- The group of billionaires and millionaires who comprise 1% of the global population control 45% of total global wealth, while 3.4 billion individuals – or 71% of adults worldwide – have wealth below USD 10,000.
- By 2014, in the US the six Walmart heirs together had more wealth than the bottom 42% of Americans combined (up from 30.5 percent in 2007).
- 2017 EU-28: In Romania (40.2 %) and Bulgaria (40.1 %), close to two fifths of the population were considered to be at-risk-of poverty or social exclusion, while in Greece the proportion was 36.0 %.
- Over 25% was considered to be at-risk of-poverty or social exclusion in Latvia, Hungary, Croatia, Spain, Italy, Portugal, Ireland, Cyprus, Lithuania and Estonia.

III. 3. Systems of business and innovation governance: regulation, innovation and sustainability

Governance, regulation and sustainability

- ***A Marshall Plan for Europe?*** How likely is it? Can be implemented without EU institutional reform?
- ***Algorithmocracy, "black boxes" and biases:*** Secret and proprietary algorithmic models govern behavior in increasingly larger areas of economic, social and, indeed, political life. Algorithmic models, despite their reputation for impartiality, reflect goals and ideology. The fundamental question for each domain of their operation is not only who designs these models but what the designer's – be that an individual, a company or a state agency – objectives are.
- ***Challenges of traditional forms of regulation:*** "code is law": it embodies binding restrictions on behavior. Algorithms and platforms structure and shape behavior according to the objectives built into them. Traditional forms of regulation and the law in the books are often difficult to apply or enforce in the digital world where action is possible only if it conforms to frameworks expressed in the code that shapes and directs behavior. But code and algorithmic models are proprietary.
- ***Cross-industry boundary regulations:*** Disruptive forms of technological change often cross traditional industry boundaries. As products and services evolve, they can shift from one regulatory category to another. If a ride-hailing company begins delivering food, it can fall under the jurisdiction of health regulators. If it expands into helicopter service, it will fall under the purview of aviation regulators. If it uses autonomous vehicles for passengers, it may come under the jurisdiction of telecommunications regulators.

- ***Monopoly / Monopsony:*** Regarding anti-trust policy will the break-up of the likes of Google and Amazon by extending and adapting anti-trust regulation? Traditional anti-trust policy will most likely need a more comprehensive reach. For breakup of the dominant platform players would not stop network effects from reasserting themselves: in time, one of the new smaller ones would become dominant again. Nevertheless, regulatory authorities at a minimum will have to sharpen their tools for the digital age.

- ***Technological concentration of power:*** There is accumulating evidence that “super-platforms” wield too much power and their superior technological capabilities, access to data and advanced algorithms facilitate price manipulation and discrimination through tacit collusion. The reality is that we have entered an era where the invisible hand is being replaced by a highly programmable and longer “digital hand”.

- ***Concentration of data reservoirs and refineries and the growing possibility of conflict:*** Currently, most big data refineries are based in the United States or are controlled by American firms. As the data economy progresses, this does not seem sustainable. Past skirmishes between the US and the EU over privacy give a taste of things to come.

- ***Weaponizing the internet? Toward “digital Westphalianism”?*** Conflicts over control of oil, the fuel of the industrial era, have scarred the world for decades. Even though it is difficult to delineate the battlefield, the data economy has the same potential for international and cross-regional confrontation.

Thank You

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