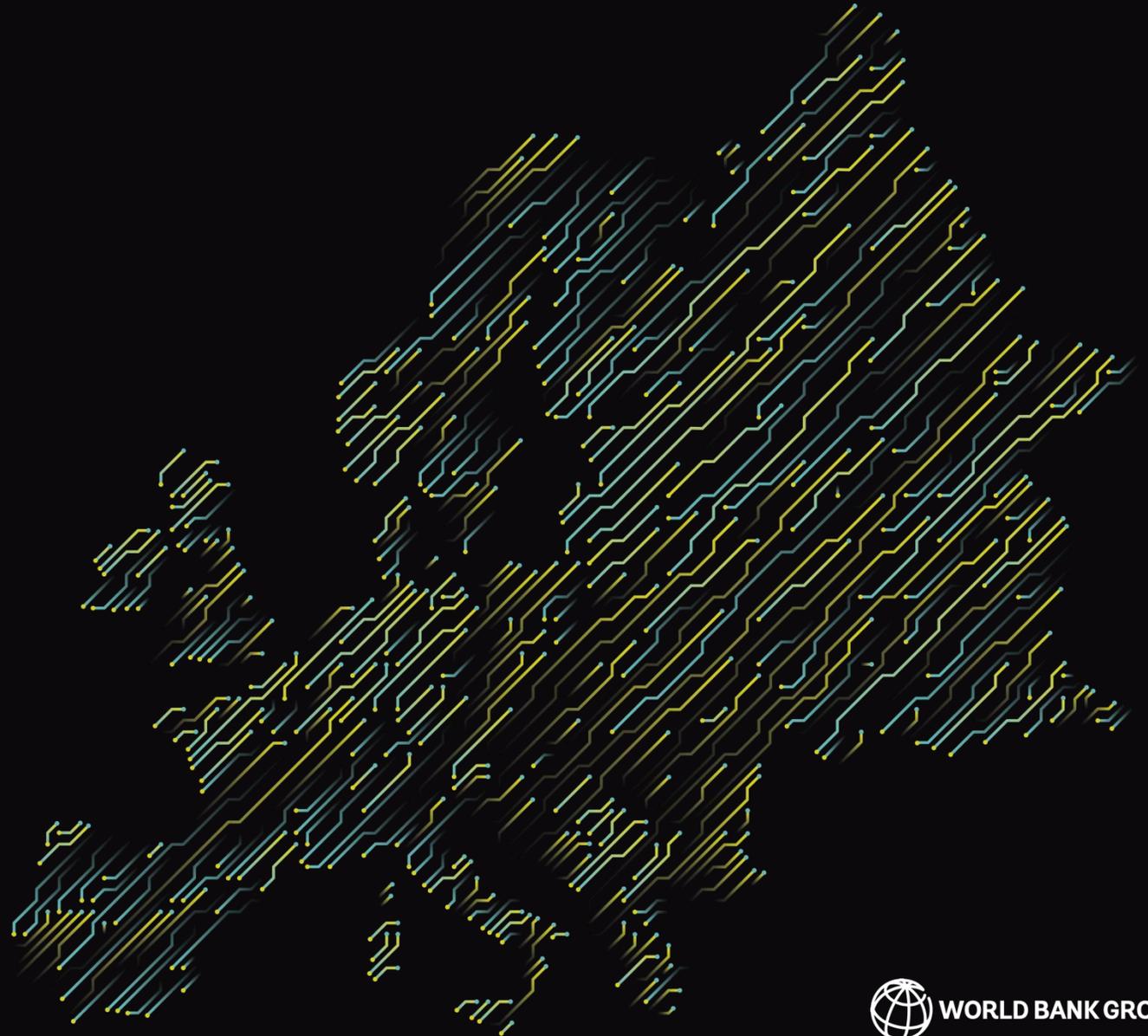


# EUROPE 4.0

## Addressing the Digital Dilemma

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# Europe 4.0 – Addressing the Digital Dilemma

## “Digital Divide” to “Digital Dilemma”

### Scope of agenda

- Who has *access* to digital technologies? Focus often on ICT and analog complements (WDR 2016)
- More recently: Who can *use* digital technologies? Add emphasis on managerial capabilities and innovation ecosystem

### Here, also look at underlying economics of *different* technologies to understand potential impacts on:

- Competitiveness of users
- Market inclusion for entrants and smaller firms
- Geographic convergence

## Europe’s Digital Dilemma

New technologies can help Europe be more competitive. **BUT** some create new challenges for market inclusion and the “convergence machine”

- *Smart robotics* and *3D printing* are technologies where Europe is globally competitive **BUT** they also widen divides between firms and regions.
- *Digital platforms* and *cloud computing* have the greatest potential for market inclusion and convergence **BUT** this is where Europe’s global competitiveness remains weak.

# Europe 4.0 – Addressing the Digital Dilemma

## Europe 4.0 is attainable

New digital technologies can help Europe achieve its triple objective of competitiveness, market inclusion and geographic convergence by:

- *Scaling markets* — Complete the digital market; close gaps in ‘analog complements’ such as skills, logistics
- *Shaping the commercial use of data* — Address challenges posed by AI and new types of market dominance
- *Speeding technology adoption* — Balance investments in frontier innovation with digital catch-up by MSMEs and in lagging regions

## Work informs 3 policy debates

Framework and evidence is relevant for ECA  
– but also for other regions

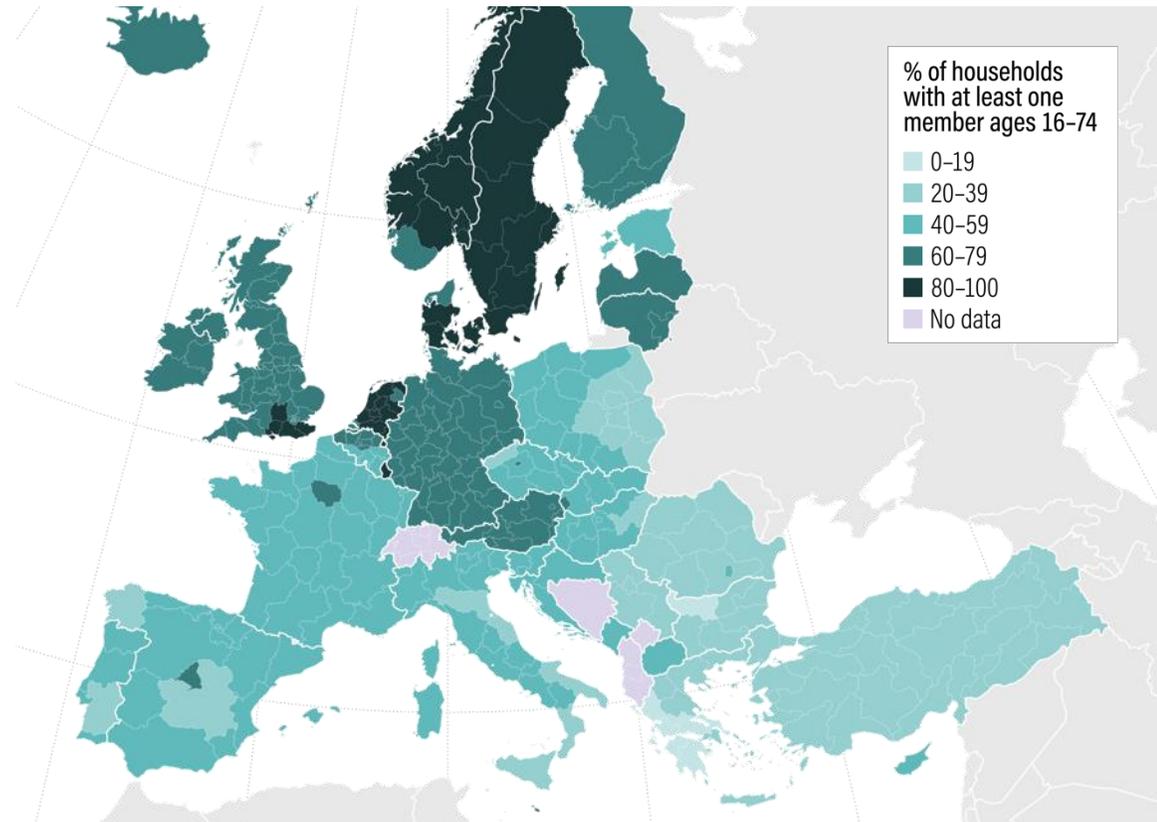
- Does completing the transition to the data economy need more champions or more markets?
- Can Europe’s regulatory choices be a source of comparative advantage, influencing the values and standards of new technologies globally?
- Is leapfrogging possible or is more attention needed to diffuse technologies that can facilitate catching-up?

**COVID19 raises urgency of addressing the digital dilemma**

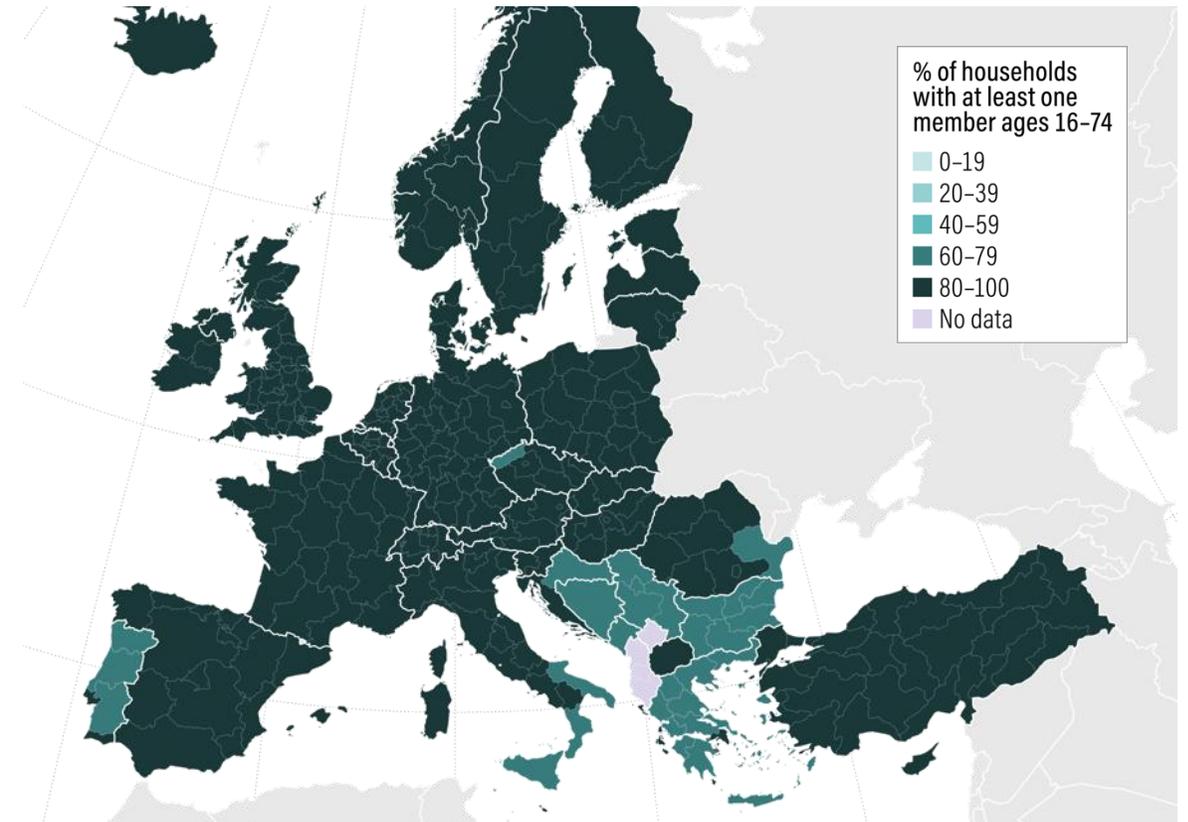
# Europe has converged in digital infrastructure...

## Households with broadband access

2008



2019



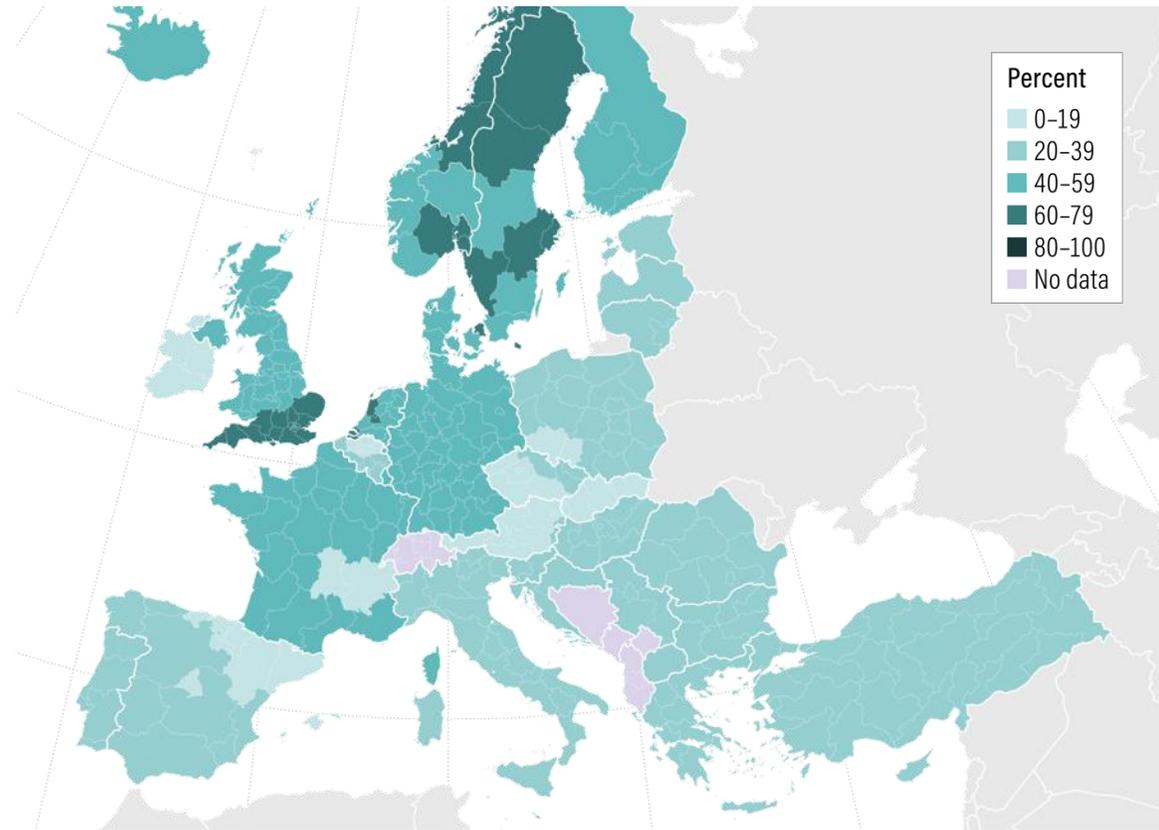
Source: Authors' calculations based on Eurostat.

Notes: The maps reflect NUTS 2 level data. Due to lack of data, Poland, Germany, the United Kingdom, Turkey, and Greece reflect NUTS 1 level data. In addition, France reflects NUTS 1 level data in 2019 and national data in 2008 (except for Île-de-France and Auvergne - Rhône-Alpes in 2008).

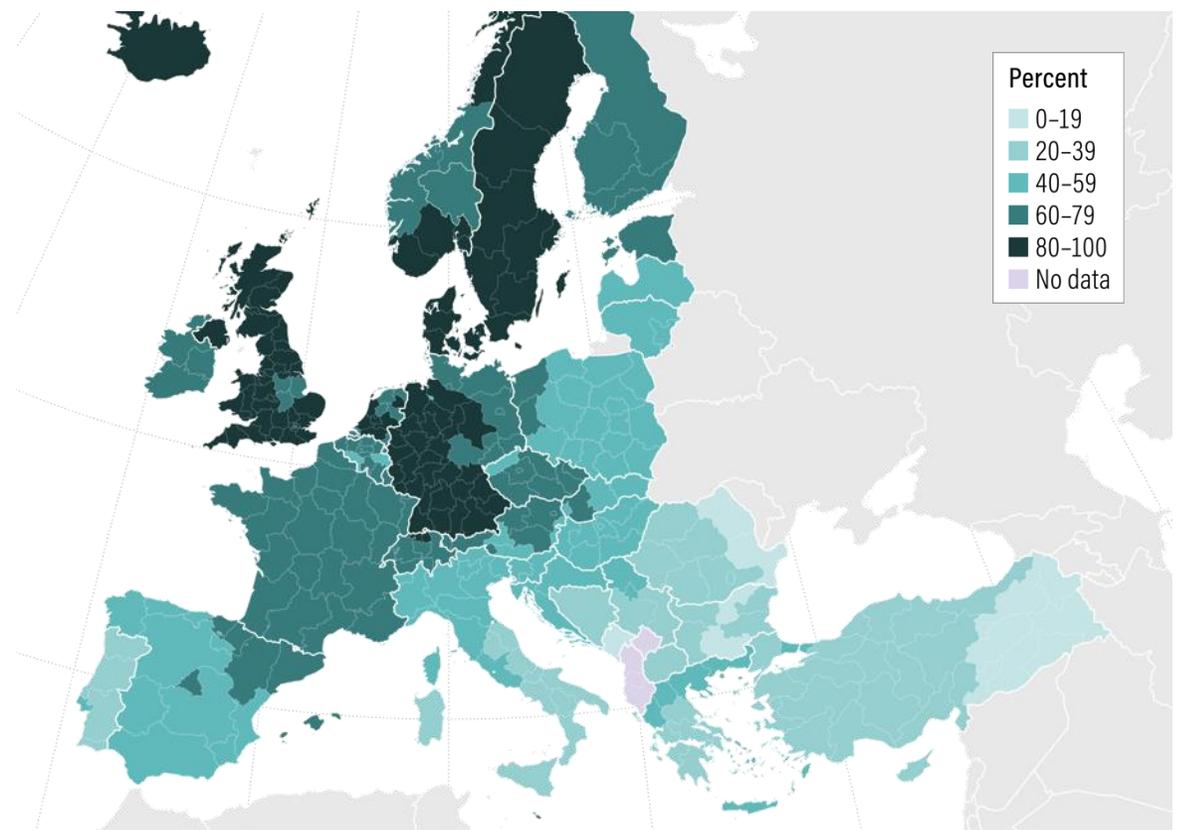
# ...but more needs to be done to accelerate commercial use

## Individuals aged 16-74 who ordered goods or services online for private use in the last year

2008



2019



Source: Authors' calculations based on Eurostat.

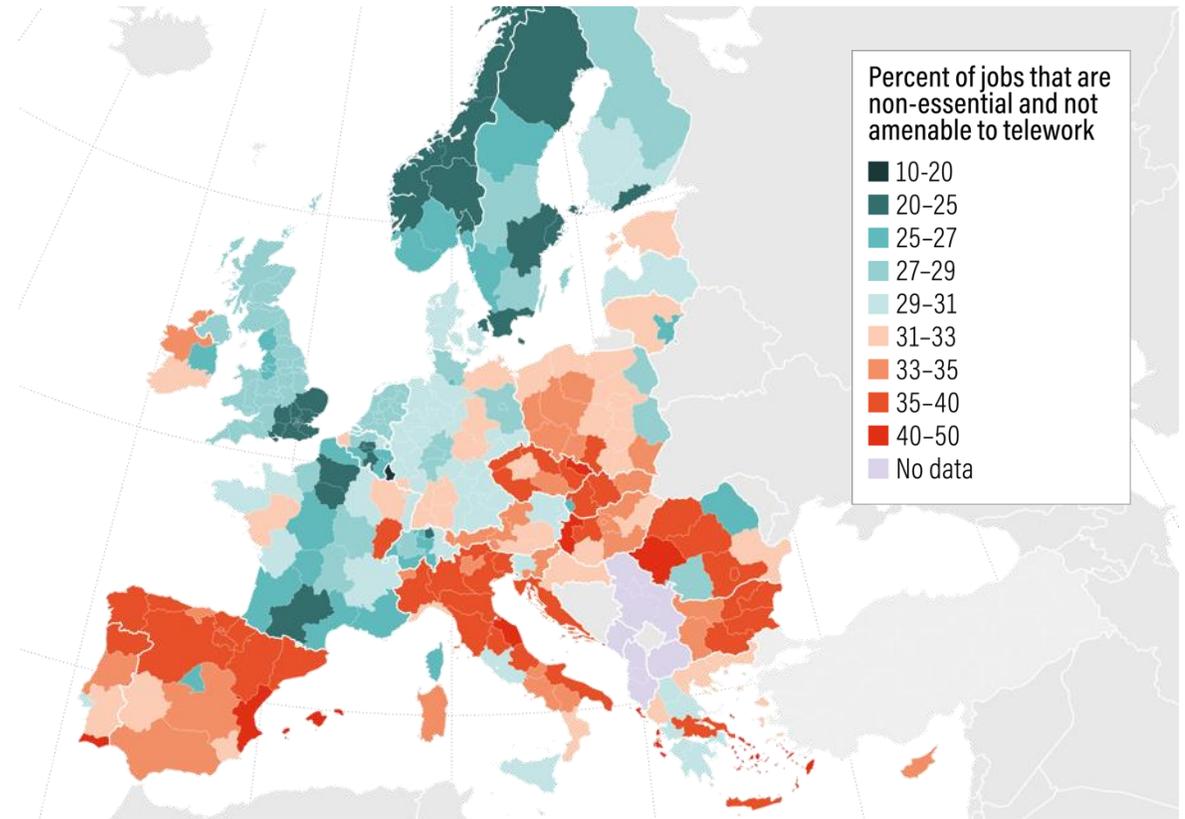
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# COVID-19 raises urgency of digital agenda

Crisis threatens  
Europe's 3 objectives

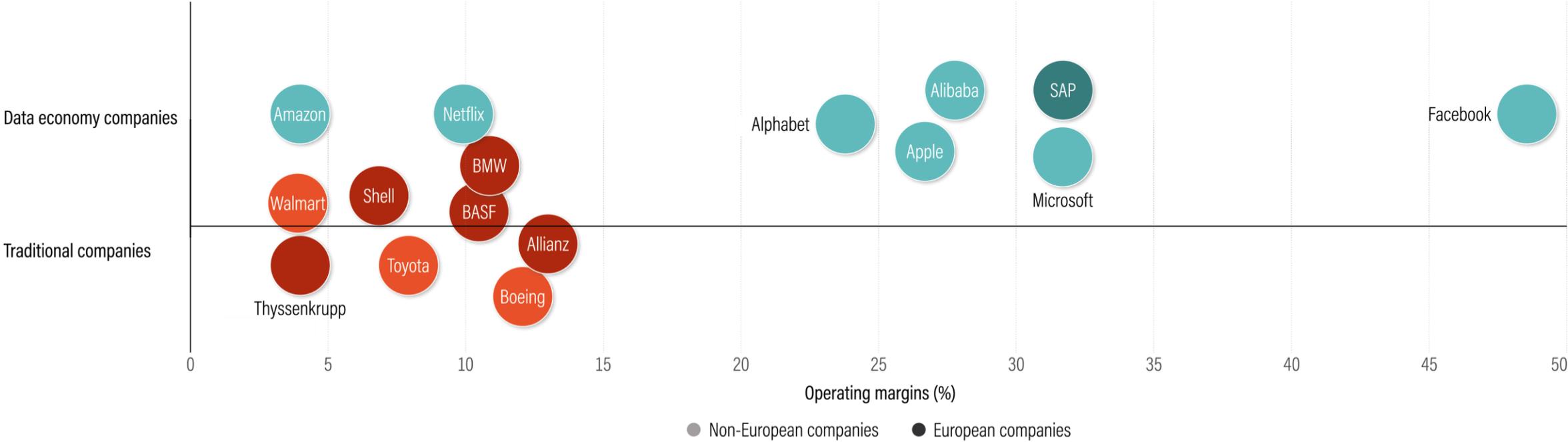
Digital *can* expand  
solutions - but not yet  
everywhere and not  
for all firms

## Jobs made vulnerable by COVID-19



Source: Daniel Garrote Sanchez, Nicolas Gomez Parra, Caglar Ozden, and Bob Rijkers. "Which Jobs Are Most Vulnerable to COVID-19? What an Analysis of the European Union Reveals" May 2020

# Europe's traditional leaders are strong — but data companies are significantly more profitable



Source: Authors' calculations based on Bloomberg, December 2019.

# Digital technology is not monolithic...



Technology category	<b>TRANSACTIONAL</b>	<b>INFORMATIONAL</b>	<b>OPERATIONAL</b>
Source of efficiency gains	Matching supply and demand	Computing and storage	Replace labor
Types of technologies	Platforms Blockchain	Cloud computing Big data analytics Machine learning	Smart robots 3D printing Drones
Examples of companies	Amazon Marketplace, Alibaba, Uber, Spotify	Google, Facebook, Tencent, SAP	Yaskawa, Fanuc, ABB, Siemens, Rockwell

# Europe faces a Digital Dilemma between its objectives and its performance



**TRANSACTIONAL  
TECHNOLOGIES**



**INFORMATIONAL  
TECHNOLOGIES**



**OPERATIONAL  
TECHNOLOGIES**

a. Digital technologies vary in their contributions to Europe's Triple Objective

	TRANSACTIONAL TECHNOLOGIES	INFORMATIONAL TECHNOLOGIES	OPERATIONAL TECHNOLOGIES
<b>Competitiveness</b>	+	+	+
<b>Market inclusion</b>	+	+	-
<b>Geographic convergence</b>	+	-	-

b. Europe's performance across technologies also varies

	TRANSACTIONAL TECHNOLOGIES	INFORMATIONAL TECHNOLOGIES	OPERATIONAL TECHNOLOGIES
<b>Creation</b>	-	-	+
<b>Adoption</b>	-	-	+

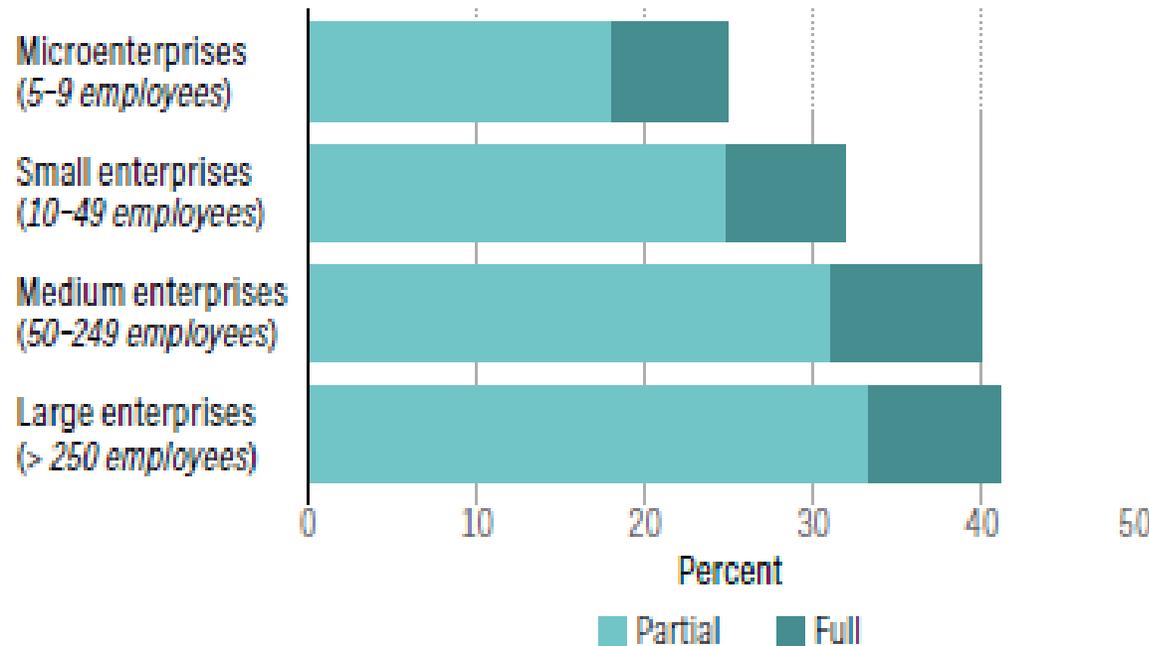
# Data sources and empirical approach

- Eurostat provides data by country, sector and size on use of several categories of technologies and on labor productivity
  - Look at difference-in-difference effects of intensity of adoption
  - Look at relative concentration of production at the NUTS 2 level
- EIB has a large survey of enterprises covering EU countries and US with more details on a larger range of technologies
  - Cross-section, but allows for various firm characteristics to be examined
  - Look at changes in employment and other innovative activities
- Some specialized data sources: International Federation of Robots and greenfield FDI announcements from the fDi Market Database that allow for the testing hypotheses of reshoring



# Transactional technologies boost market inclusion

**The share of SMEs using digital platforms is not very different from large firms, 2018**



Source: EIB-WBG background paper by Cathles, Nayyar and Rückert (2020).

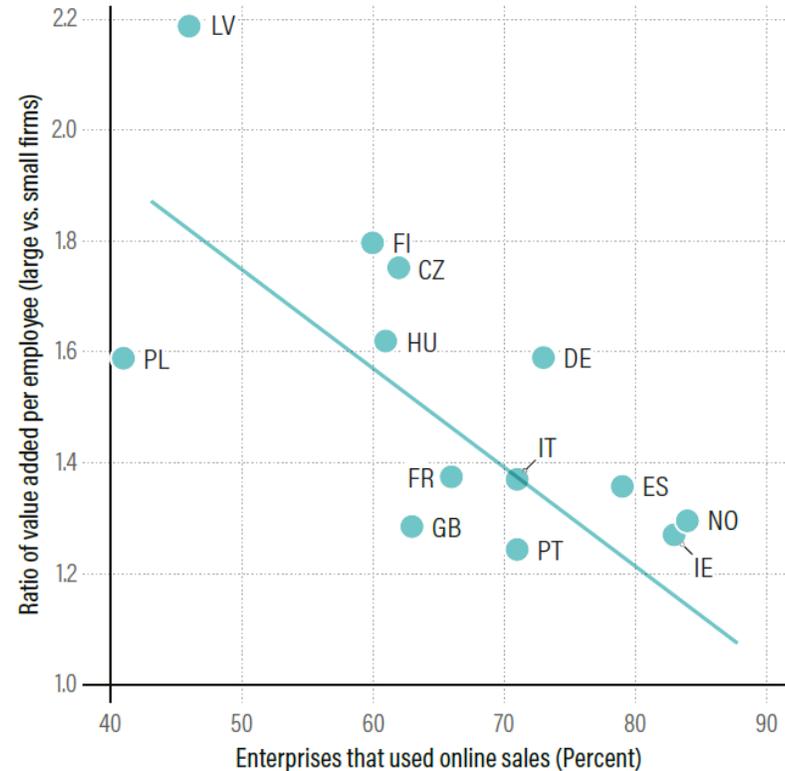
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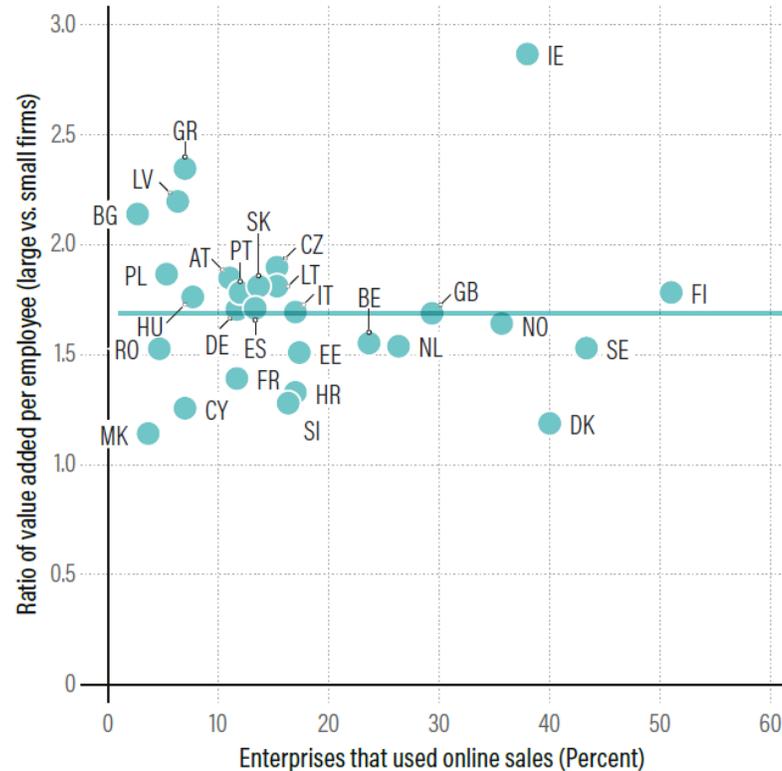
# Transactional technologies boost market inclusion

Higher use of on-line sales is associated with smaller productivity gaps between large and small firms in sectors using online sales intensively

a. The use of online sales is associated with a smaller performance gap between large and small firms in accommodation services where the technology is most widespread, 2016



b. There is no association between the use of online sales and the performance gap between large and small firms in construction, real estate, and professional services where the technology is least widespread



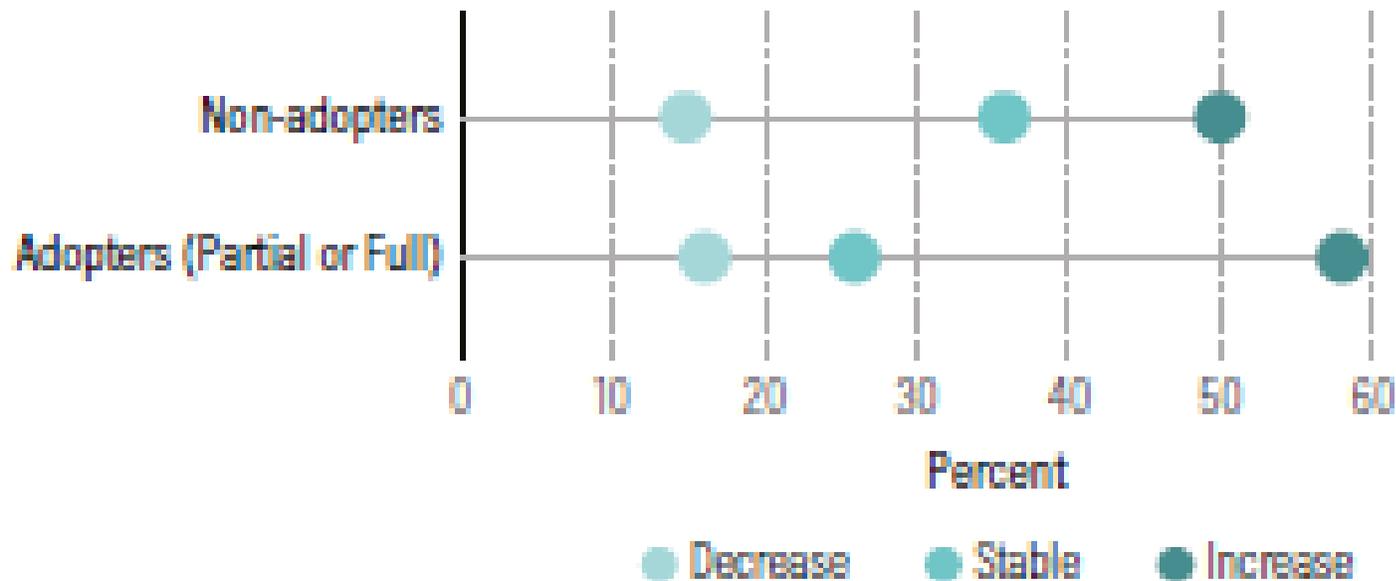
Source: Authors' calculations based on Eurostat.



# Transactional technologies boost market inclusion

And firms adopting digital platforms are more rather than less likely to report hiring workers than non-adopters

By platform adoption, 2019



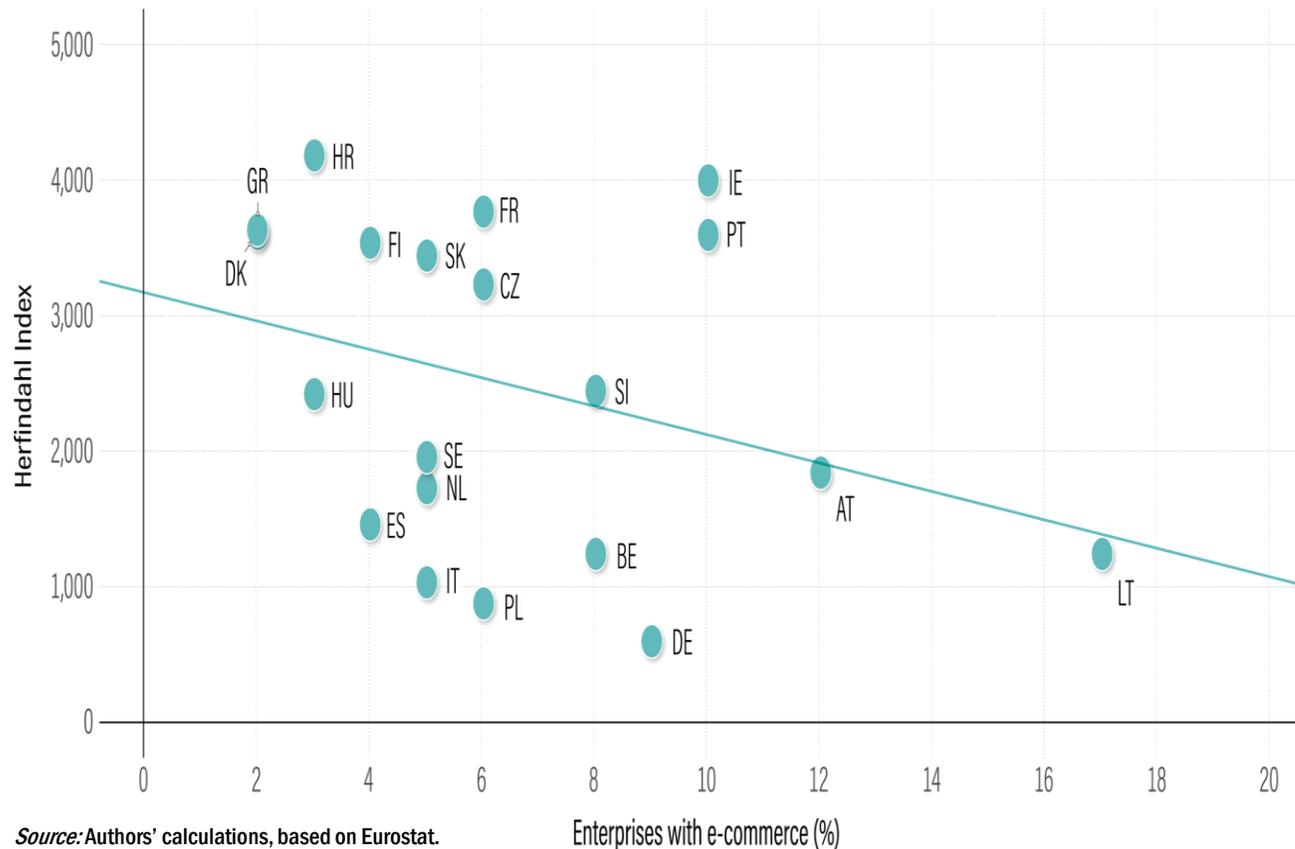
Source: EIB-WBG background paper by Cathles, Nayyar and Röckerl (2020).

Note: Firms are weighted with value added.



# Transactional technologies enable convergence

**Higher use of e-commerce platforms is associated with lower spatial concentration in ICT services, 2018**



Source: Authors' calculations, based on Eurostat.



# Transactional technologies also improve Europe's competitiveness - but there is vast unrealized potential

The share of firms that meet even a minimum threshold of selling online (at least 1% of their turnover) is far from universal, 2016

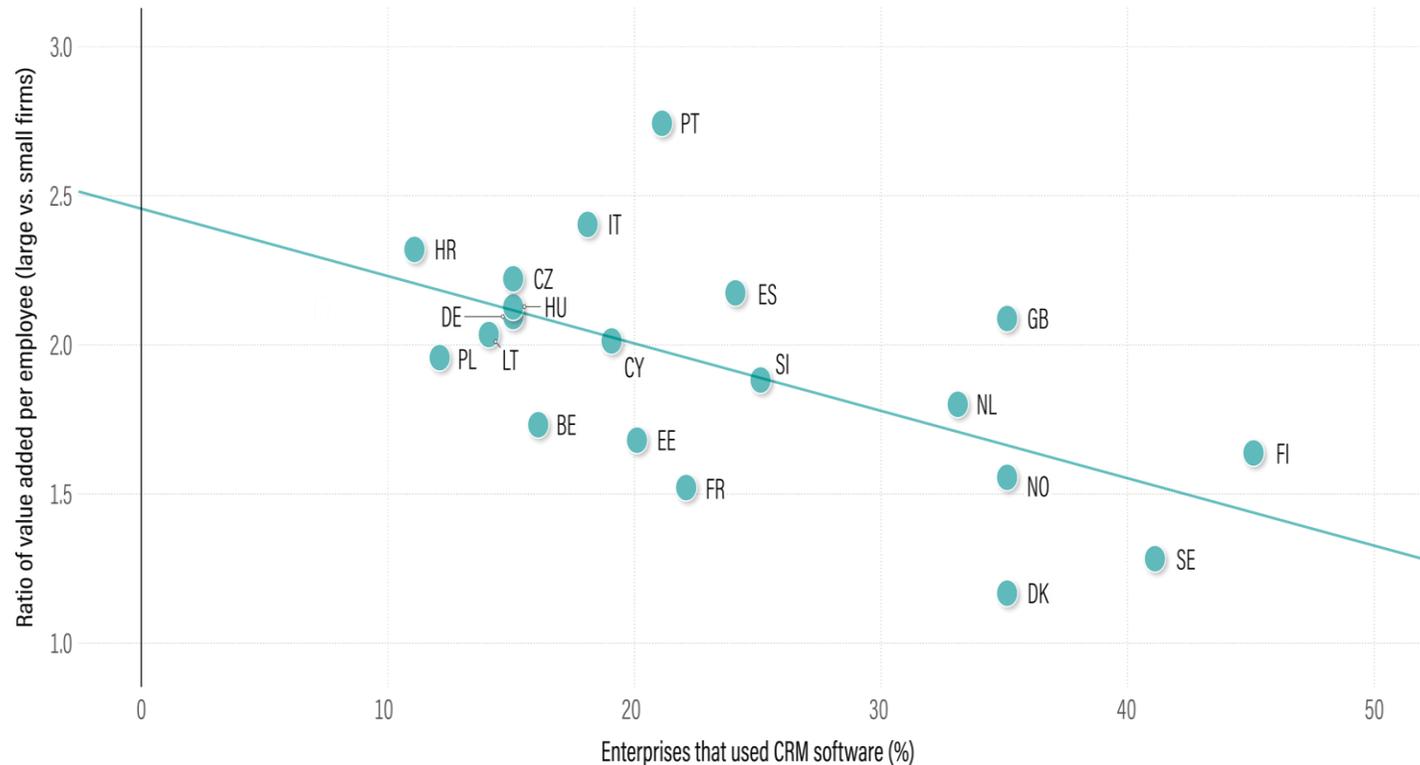


Source: Authors' calculations, based on Eurostat.



# Older informational technologies boost market inclusion

Higher use of customer relationship management (CRM) software is associated with smaller productivity gaps between large and small firms in information and communication services, 2016

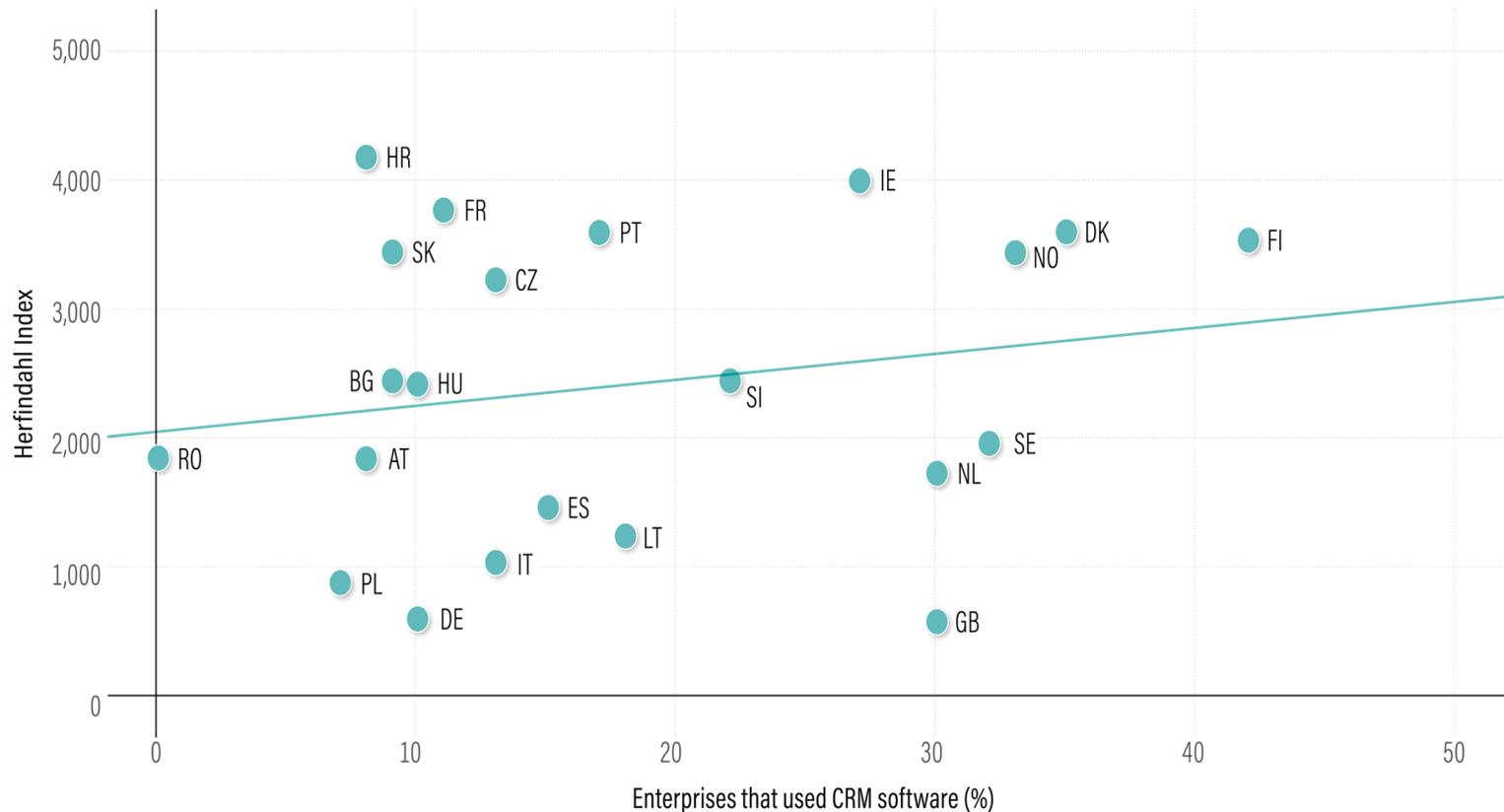


Source: Authors' calculations, based on Eurostat.

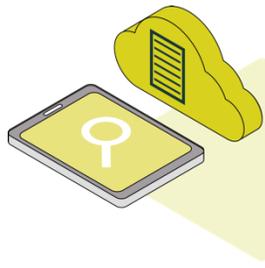


# ... but they have not enabled greater convergence

**The use of CRM software has not reduced the spatial concentration of economic activity in information and communication services, 2016**

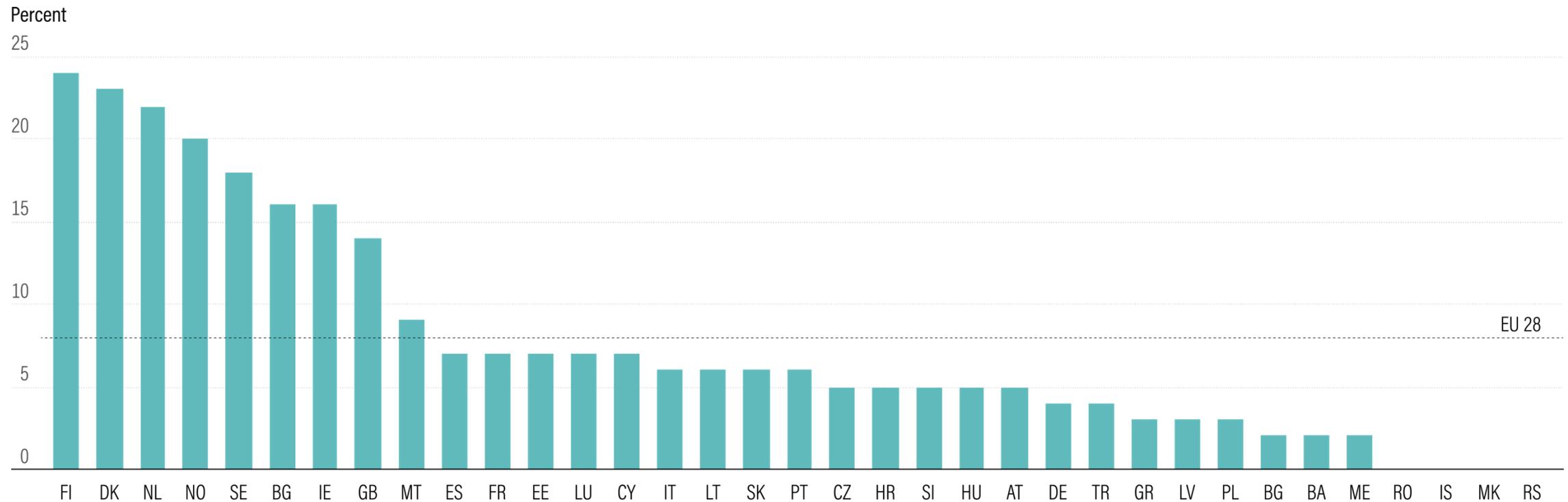


Source: Authors' calculations, based on Eurostat.



# Older informational technologies improve Europe's competitiveness but there is vast unrealized potential

## The share of firms using CRM software is far from universal, 2018



Source: Authors' calculations, based on Eurostat.



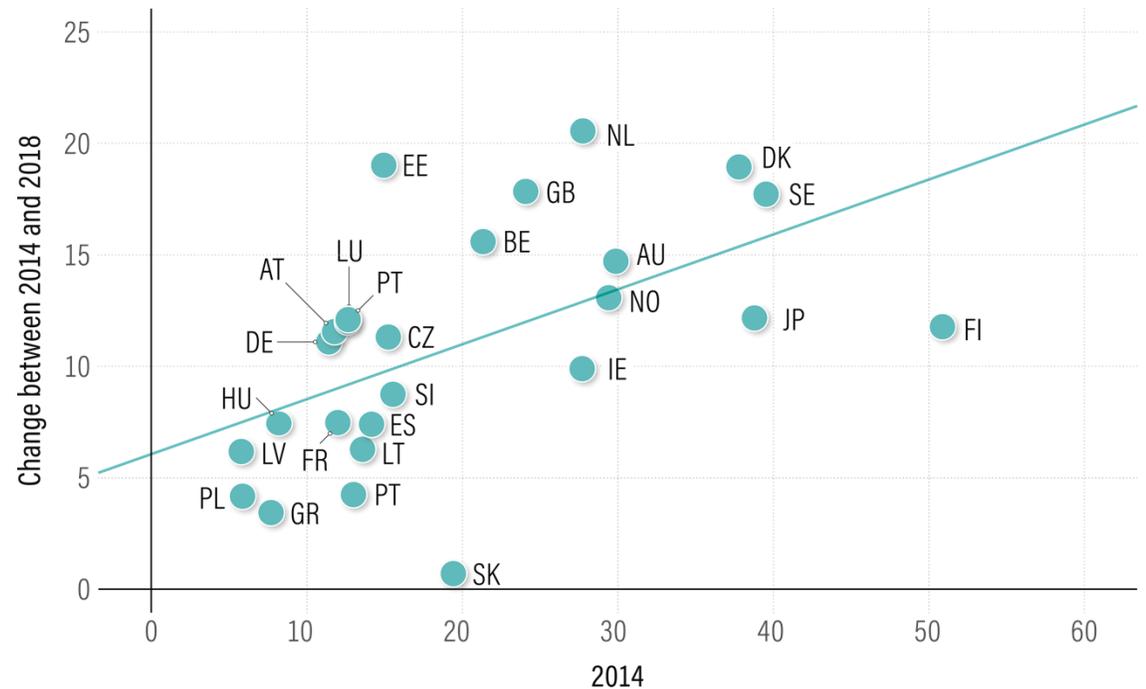
# However, newer informational technologies are reinforcing larger firms and leading regions

A notably higher share of large firms, relative to SMEs, used big data analytics and AI in the EU

And there is growing divergence across countries in the use of cloud computing

Source: EIB-WBG background paper by Cathles, Nayyar and Rückert (2020)

Share of firms (%) that purchased cloud computing, level in 2014 vs change between 2014 and 2018



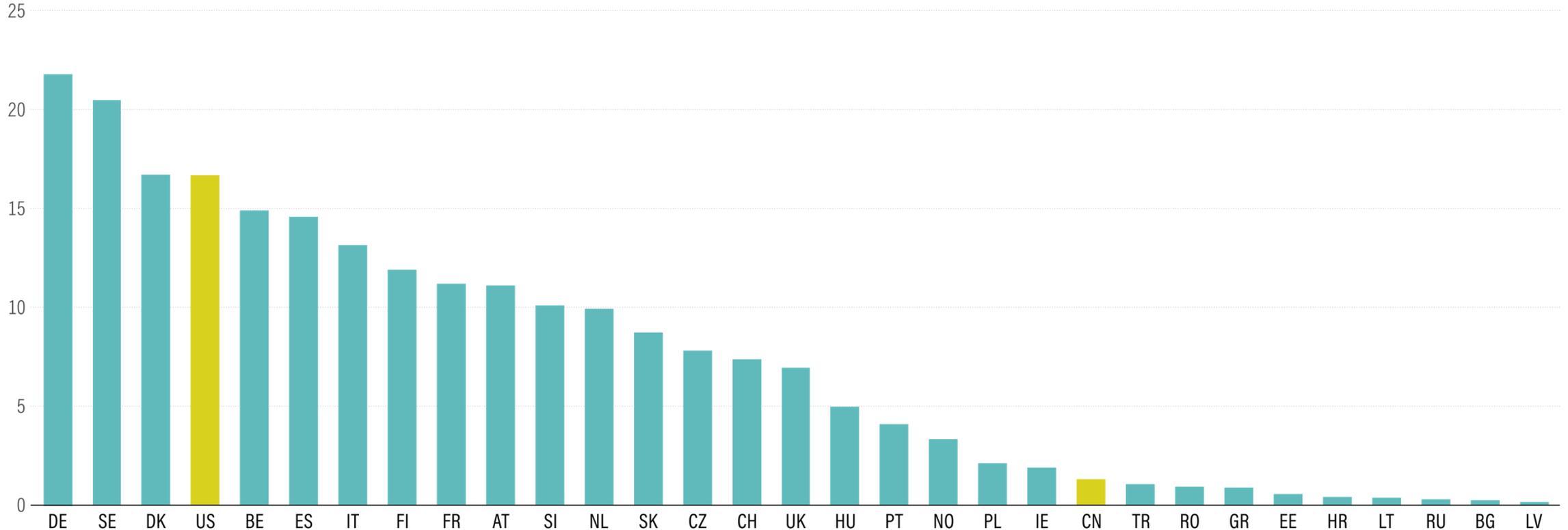
Source: Authors' calculations, based on Eurostat.



# Operational technologies have large potential to boost Europe's competitiveness

## EU14 countries and the United States have the highest intensity of robot use (robots per 1,000 workers), 2016

Number of robots per 1,000 employees, 2016

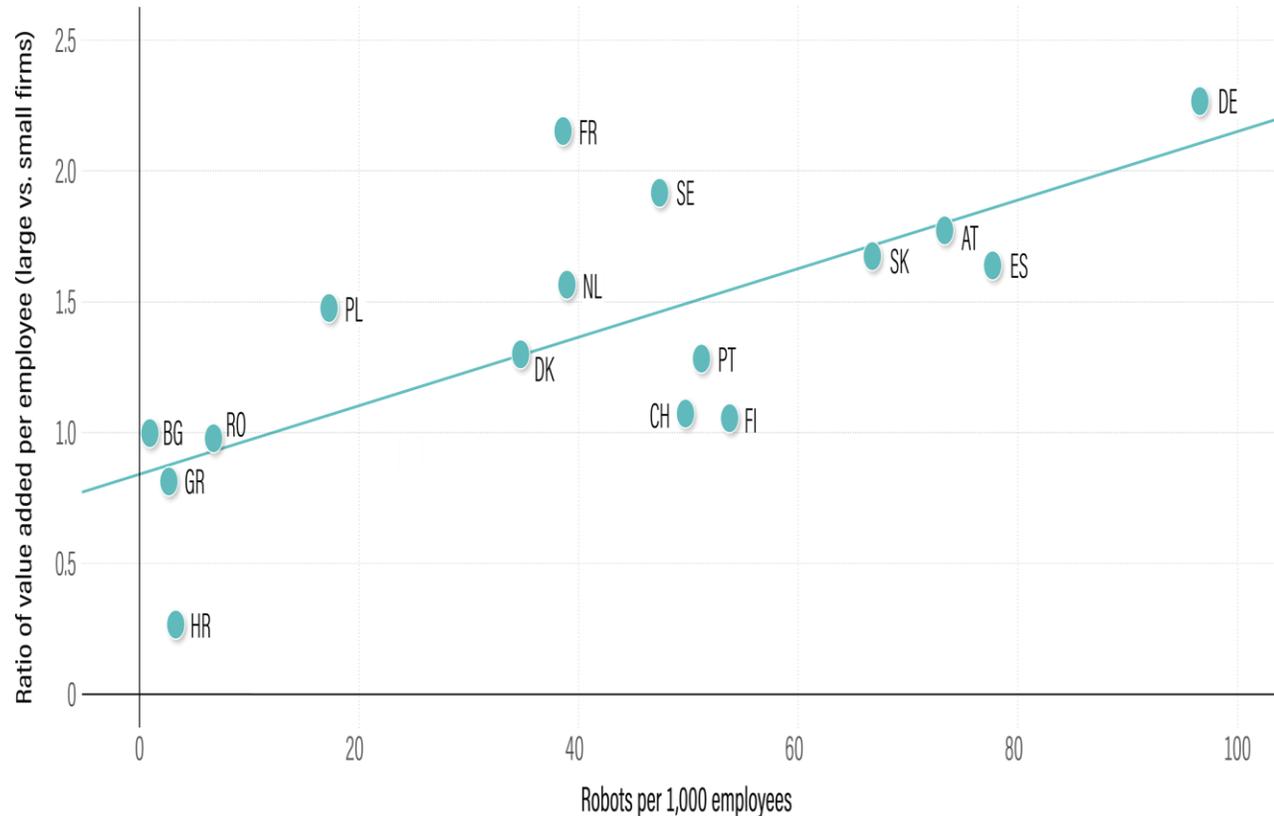


Source: Authors' calculations, based on the International Federation of Robotics and the World Input-Output Database.



# But operational technologies lower market inclusion

**Robots per 1,000 workers are associated with a productivity gap between large and small firms in sectors that are highly automated, e.g. the transportation equipment sector, 2016**

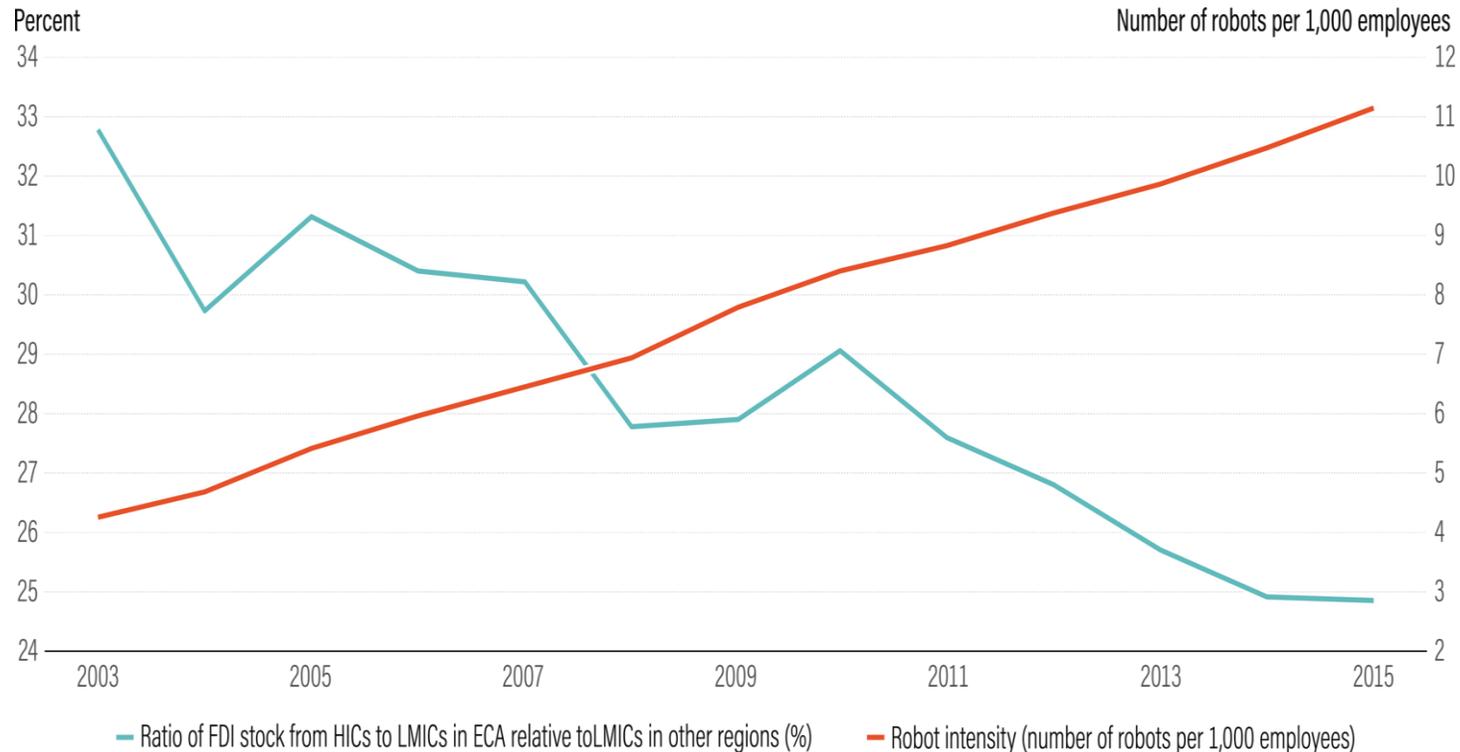


Source: Authors' calculations, based on Eurostat and International Federation of Robotics data.



# Operational technologies also inhibit convergence by slowing down offshoring to LMICs in Europe

**Robotization in Europe's HICs is negatively associated with the share of FDI going from HICs to LMICs in the Europe and Central Asia region, 2004-2015**

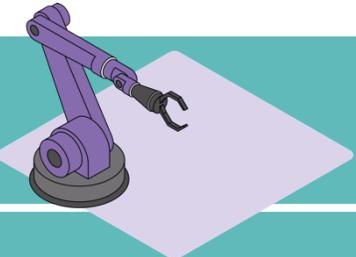


Source: Hallward-Driemeier and Nayyar, 2019.

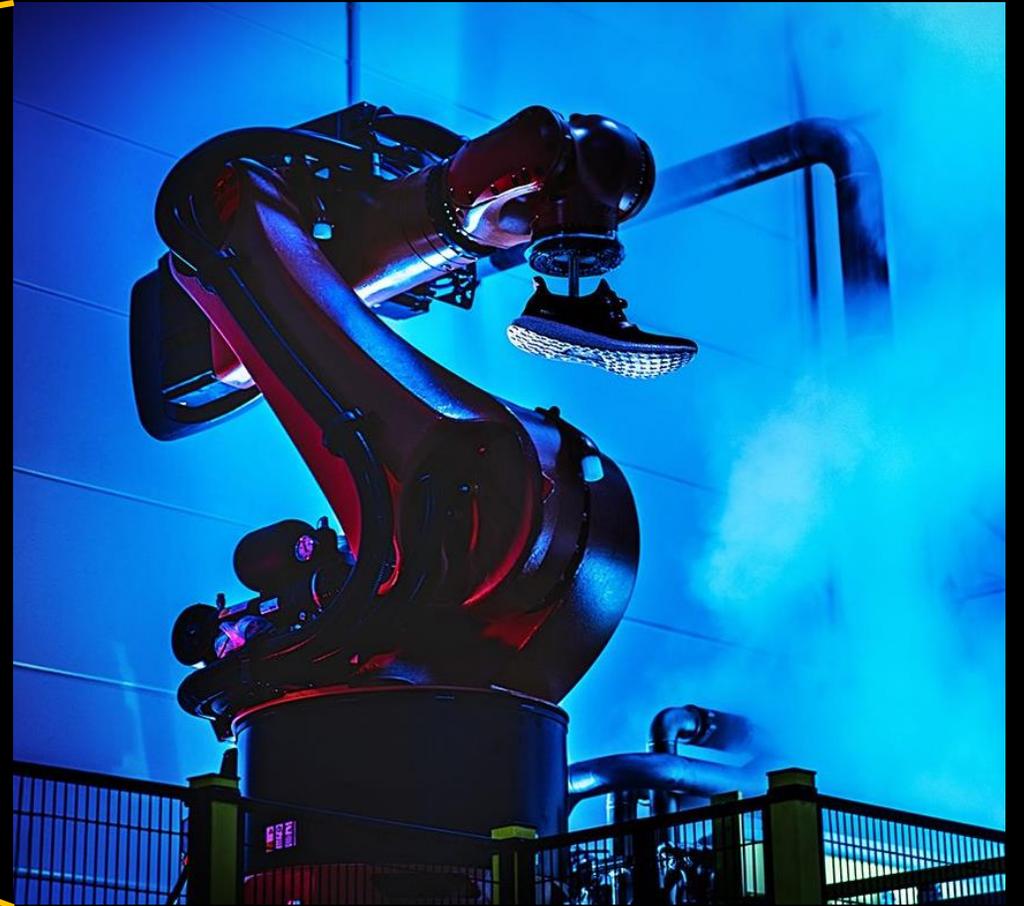
# Estimation

$$\ln(1 + FDI)_{ist} = \alpha + \beta_1 \ln(1 + Robots_{ist}) + \beta_2 [\ln(1 + Robots_{ist})]^2 + \ln(1 + Exports_{ist}) + \gamma_{is} + \delta_{it} + \varepsilon_{ist}$$

- Estimate impact of automation on outbound FDI at the country-sector-year level
- Controlling for country-sector and country-year fixed effects
- Allow for non-linear impacts of automation
- And control for exports, other ICT intensity

	Full Sample OLS	Full sample IV	Transportation equipment sector excluded	China excluded as a destination country	Share of FDI to ECA country-pairs
	(1)	(2)	(3)	(4)	(5)
Exports	-0.0160 (0.0415)	-0.00367 (0.0586)	0.0085 (0.0637)	-0.0044 (0.0586)	0.0189 (0.0123)
Robots per 1000 employees	0.1329*** (0.0426)	0.2276** (0.1239)	0.6546*** (0.2284)	0.2269* (0.1243)	-0.0444*** (0.0139)
Robots per 1000 employees-squared	-0.0209** (0.0098)	-0.0793*** (0.0286)	-0.2123*** (0.0665)	-0.0778*** (0.0286)	0.0005 (0.0033)
Country-sector fixed effect	Yes	Yes	Yes	Yes	Yes
Country-year fixed effect	Yes	Yes	Yes	Yes	Yes
Observations	2208	1275	1157	1275	1741
(Centered) R-squared	0.980	0.983	0.981	0.983	0.883
Under identification test (Anderson canon. corr. LM statistic)		366.909	127.493	366.162	
Weak identification test (Cragg-Donald Wald F statistic)		213.133	58.638	212.525	
Instrumented		robots per 1000 employees, robots per 1000 employees-squared;			
Instruments		robots per 1000 employees in the 4 most similar countries in terms of GDP per capita, and squared			

All hype?



Technologically feasible  
Economically viable

# Addressing the Digital Dilemma



## TRANSACTIONAL TECHNOLOGIES



## INFORMATIONAL TECHNOLOGIES



## OPERATIONAL TECHNOLOGIES

### Digital dilemmas

Contributes to all three goals, but limited competitiveness means that potential is only partially realized

European firms show more promise, but new opportunities are more concentrated

European firms are among leaders, but technologies favor large firms and increasingly concentrate production

### Policy directions

Scaling markets

Shaping commercial use of data

Smoothing adoption in MSMEs and lagging regions

# Broader policy debates



## TRANSACTIONAL TECHNOLOGIES



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## OPERATIONAL TECHNOLOGIES

### Digital dilemmas

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### Broader policy debates

What is needed – more digital champions or more digital markets?

Can regulatory approach be a source of comparative advantage and way to influence global standards?

Is leapfrogging possible or is wider support to tech adoption needed?



## TRANSACTIONAL TECHNOLOGIES

# Scale to realize potential for inclusion and convergence

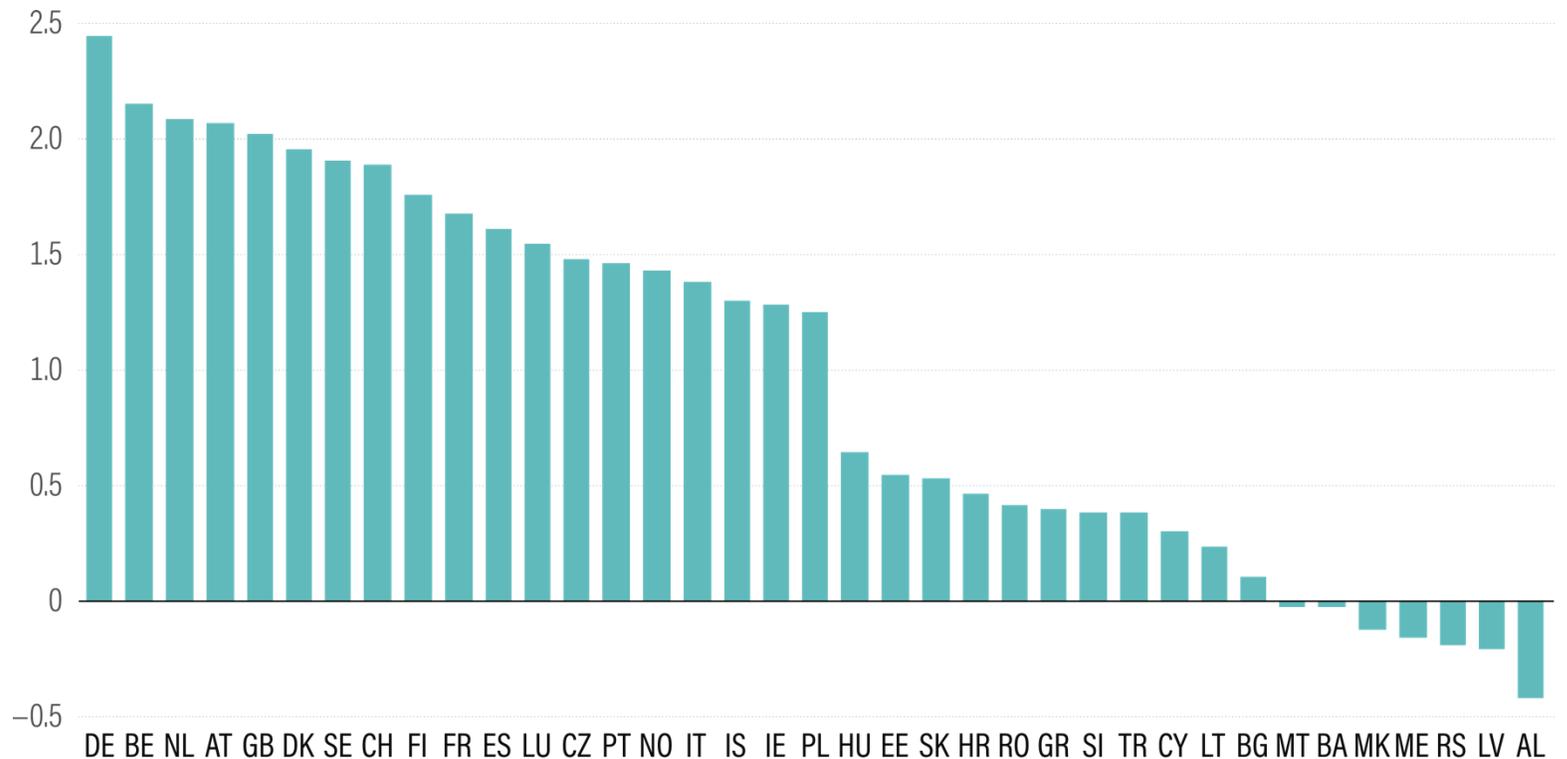
## WHAT IS AT STAKE?

- Scale of markets matter for users and creators
- Access to ICT is not sufficient to use ICT enabled technologies

The cost of sending packages across the EU is 3.71 times the cost, on average, of sending the same package domestically

Even by 2030, less than 50% of households are projected to use e-commerce in Romania, Bulgaria, Italy and Portugal

Normalized LPI scores (global average=0; standard deviation=1)



Source: World Bank Logistics Performance Index, 2018



## TRANSACTIONAL TECHNOLOGIES

# Scale to realize potential for inclusion and convergence

## HOW TO MOVE FORWARD?

### 1. EU:

#### Complete single market

- Address fragmentation of digital single market (geoblocking; copyright portability)
- Constraints on trade in services
  - In key supporting sectors, e.g. postal services and logistics
  - But also ability to provide digital services remotely, especially professional services

### 2. COUNTRIES:

#### Focus on equalizing opportunities – which is not just about technology policies.

- Use of ecommerce is still projected to be under 50% of households by 2030 in Romania, Bulgaria, Greece and Portugal — even with access to ICT
- To access and use new technologies, need the necessary ‘analog complements’ of skills, infrastructure, finance and regulatory enforcement, especially in lagging regions.



## INFORMATIONAL TECHNOLOGIES

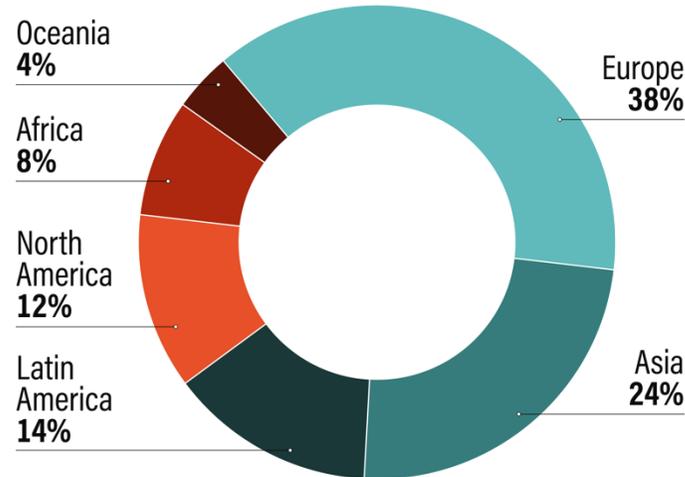
# Shape new opportunities to expand access for SMEs

## WHAT IS AT STAKE?

Network effects and benefits of access to large amounts of data raise new trade-offs between large incumbents and inclusion

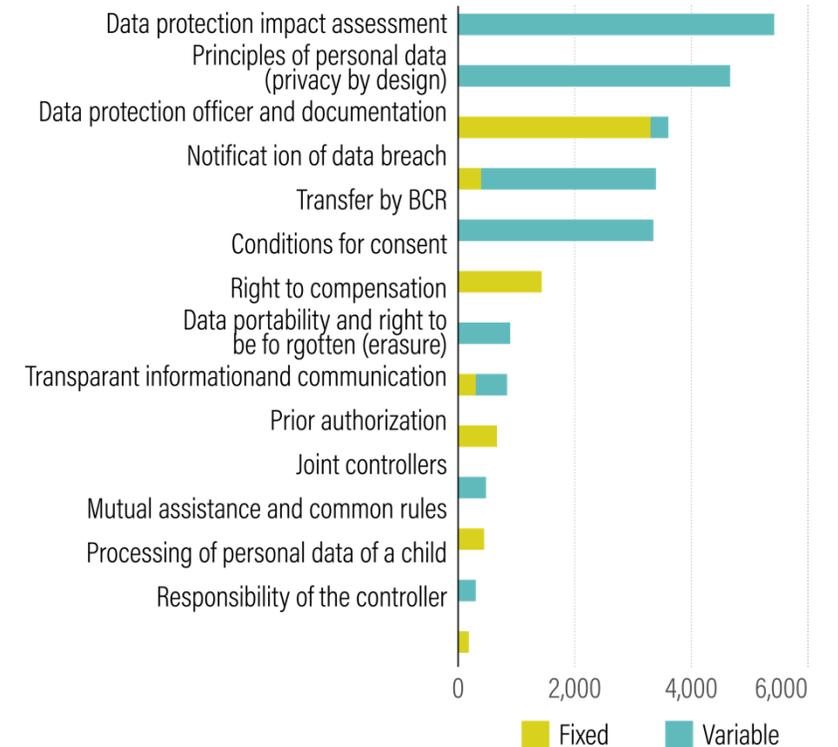
- Need to update regulations to address new forms of potential market dominance
- Data privacy as a constraint to innovation or source of advantage?

## European competition authorities lead among regions in launching investigations

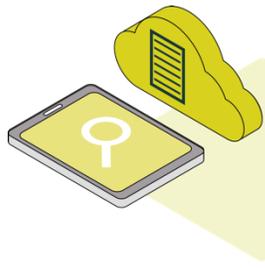


Source: World Bank Competition Policy Project.

## Average expected direct costs of complying with GDPR (€)



Source: Background paper, van der Marle 2019



## INFORMATIONAL TECHNOLOGIES

# Shape opportunities to expand access for SMEs and entrants

## HOW TO MOVE FORWARD?

### 1. EU:

#### Shape regulations to address new challenges digital technologies bring:

- Continue to adapt competition policy for the digital age and new forms of market domination – avoid self-preferencing; thresholds & criteria for M&A; speed of enforcement; relevant remedies; who bears burden of proof; review of algorithms
- Sharing of commercial or B2B data could be new source of innovation, if compliant with competition rules, e.g. to avoid collusion or price setting
- Address costs of compliance to GDPR for smaller firms – make data portability and interoperability standardized and transparent
- Data privacy could limit some innovation – or ‘privacy by design’ become a new source of comparative advantage

### 2. COUNTRIES:

#### Strengthen start-up ecosystem for entrants to thrive

- Strengthen venture capital – including transferability of stock options
- Reform restrictions and administrative burdens on IPOs



## OPERATIONAL TECHNOLOGIES

# Speed access to opportunities for greater convergence

## WHAT IS AT STAKE?

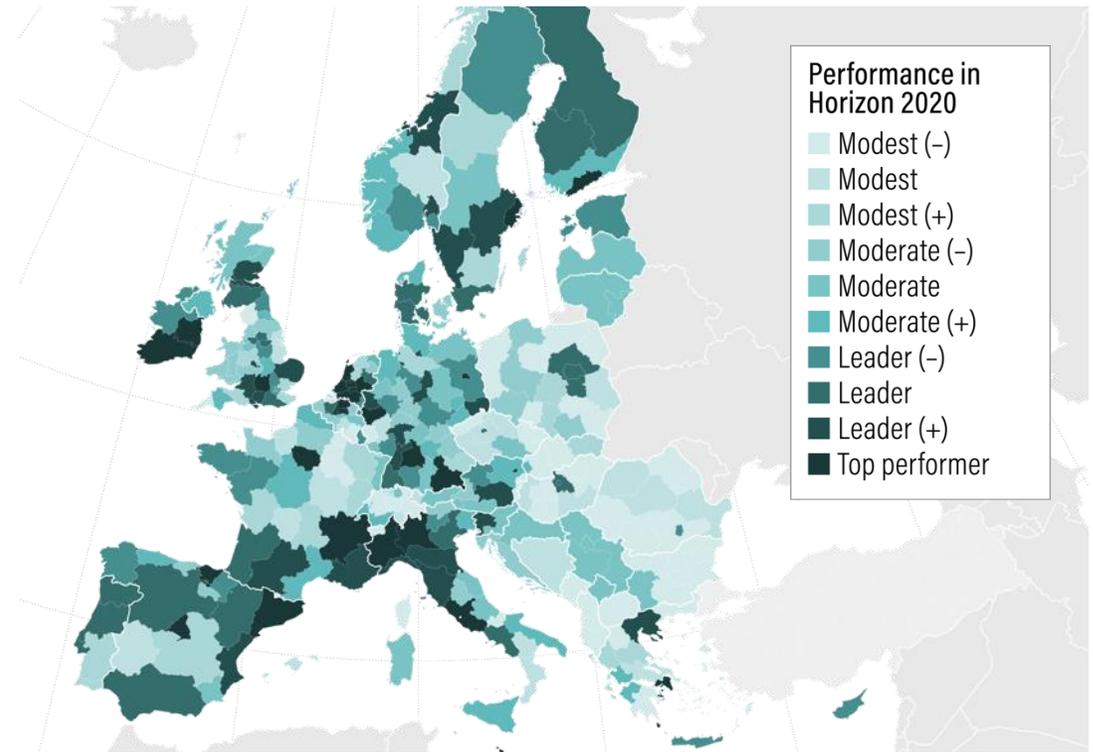
- Is it possible to leapfrog to Industry 4.0?
- Intersection of digital and green: harness AI to improve efficiency – of energy and material inputs used

Frontier innovation is highly clustered – but opportunities to diffuse technology are widespread

Two areas in Poland and one in Czech are among 20 top innovation hubs in Europe

Locations can specialize and become centers of excellence in some areas; only a handful master multiple types of technologies

## Allocation of Horizon 2020 funds, 2018



Source: Background paper, Ballard and Bosch 2019



## OPERATIONAL TECHNOLOGIES

# Speed access to opportunities for greater convergence

## HOW TO MOVE FORWARD?

### 1. EU and COUNTRIES:

#### Applied R&D to assist with technology diffusion

- Private sector's share in R&D in Europe is relatively low compared to other leaders
- Allocate resources where build on related strengths and links to market opportunities; attempts to leapfrog are rarely successful
- Support firm capabilities (management practices, skills) to adapt and adopt technologies

**Expand industrial IoT and B2B platforms to help more SMEs participate in industrial value chains.**

**Use redistribution tools to help workers during transitions**

# Policy Agenda for Europe 4.0



## TRANSACTIONAL TECHNOLOGIES



## INFORMATIONAL TECHNOLOGIES



## OPERATIONAL TECHNOLOGIES

### Policy directions

Scaling markets

Shaping commercial use of data

Smoothing adoption in MSMEs and lagging regions

EU

Complete digital single market and support trade in services

Making competition and data privacy regulations fit for purpose in digital economy

Allocation of R&D and regional funds to build capabilities and links to markets

### Policy priorities

National governments

Implementation of the single market  
Support complements in logistics (e.g., postal systems)

Start-up ecosystems  
Venture capital markets  
Digital skills

Support applied R&D, research-firm links

Subnational governments

“Last-mile” infrastructure, enforcement

Innovation hubs  
Expand links with local firms and markets

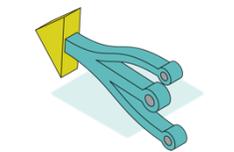
Strengthen firms and governments capabilities to support adoption

# Rather than exacerbate tradeoffs, Europe 4.0 captures synergies

If focus on competitiveness as global champions:

- Competition rules should favor larger firms
- Allocation of investment funds to larger incumbents
- Emphasize innovation over diffusion

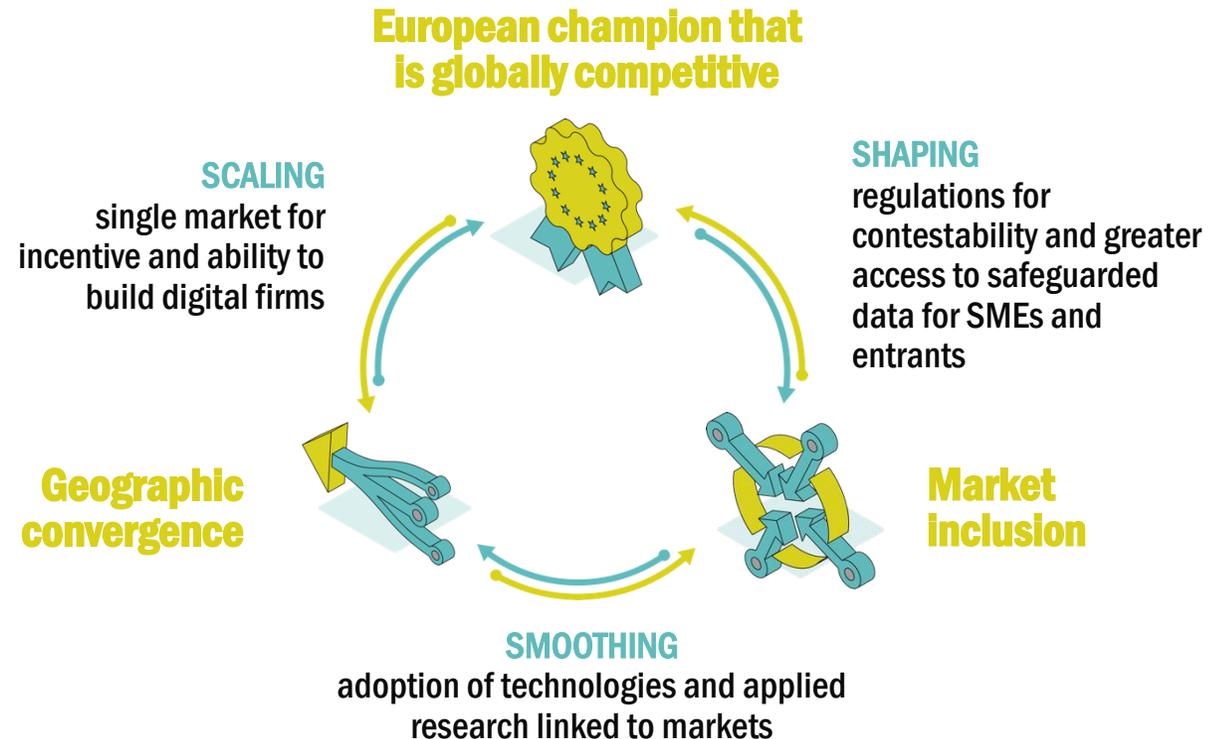
**European champion that is globally competitive**



**Geographic convergence**



**Market inclusion**



And, realizing a dynamic digital economy could well make it more likely that global firms emerge from Europe – and thrive

# With COVID-19, Europe 4.0 is more resilient and better positioned for recovery



## TRANSACTIONAL TECHNOLOGIES



## INFORMATIONAL TECHNOLOGIES



## OPERATIONAL TECHNOLOGIES

### Contributions to crisis response

More jobs can be performed remotely  
 Ecommerce expands activities, safely  
 Lowers supply shocks and thus demand shocks

Big data for public health applications (balancing innovation and privacy)  
 Improve monitoring of activities and effectiveness of programs  
 Improved efficiency can contribute to green agenda too

Combined with AI, can respond more nimbly to disruptions  
 More work can be done safely  
 Rethinking of value chains may encourage *somereshoring*

### **BUT**, watch for short run priorities for inclusion and convergence

Address bottlenecks in 'analog complements', esp. logistics, in lagging regions  
 Ensure fair terms for all on platforms  
 Enable trade in more service sectors

Watch for consolidation  
 Ensure MSMEs can take up new technologies

Allocate funds where can absorb, accelerate technology adoption and integrate with markets  
 Encourage B2B platforms to assist with inclusion and diversify suppliers

Source: Europe 4.0 Team

And, monitor impacts and be ready to adjust



Look for

# EUROPE 4.0

Available online [here](#)

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Republic of Austria  
Finance

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