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

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).

2019
...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

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).
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

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...

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

Source: Europe 4.0 Team
Europe faces a Digital Dilemma between its objectives and its performance

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<tbody>
<tr>
<td>Competitiveness</td>
<td>+</td>
<td>+</td>
</tr>
<tr>
<td>Market inclusion</td>
<td>+</td>
<td>+</td>
</tr>
<tr>
<td>Geographic convergence</td>
<td>+</td>
<td>-</td>
</tr>
</tbody>
</table>

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

b. Europe’s performance across technologies also varies

Source: Europe 4.0 Team
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
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).
Transactional technologies boost market inclusion

Higher use of online 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

% Decrease % Stable % Increase

Non-adopters
Adopters (Partial or Full)

Source: EIB-WBG background paper by Cathles, Nayyar and Röckert (2020).
Note: Firms are weighted with value added.
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.
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.
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)

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

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

Technologically feasible
Economically viable
## Addressing the Digital Dilemma

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<td>Contributes to all three goals, but limited competitiveness means that potential is only partially realized</td>
<td>European firms show more promise, but new opportunities are more concentrated</td>
<td>European firms are among leaders, but technologies favor large firms and increasingly concentrate production</td>
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| Policy directions | Scaling markets | Shaping commercial use of data | Smoothing adoption in MSMEs and lagging regions |

*Source: Europe 4.0 Team*
## Broader policy debates

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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? |

Source: Europe 4.0 Team
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.

Source: World Bank Logistics Performance Index, 2018
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.
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?
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
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
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

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</thead>
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<tr>
<td>Scaling markets</td>
<td>Complete digital single market and support trade in services</td>
<td>Making competition and data privacy regulations fit for purpose in digital economy</td>
<td>Allocation of R&amp;D and regional funds to build capabilities and links to markets</td>
</tr>
<tr>
<td>Shaping commercial use of data</td>
<td>Start-up ecosystems Venture capital markets Digital skills</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Smoothing adoption in MSMEs and lagging regions</td>
<td>Innovation hubs Expand links with local firms and markets</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Support applied R&amp;D, research-firm links</td>
<td></td>
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<tr>
<td></td>
<td></td>
<td>Strengthen firms and governments capabilities to support adoption</td>
<td></td>
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</tbody>
</table>

### Policy Priorities

<table>
<thead>
<tr>
<th>Policy priorities</th>
<th>National governments</th>
<th>Subnational governments</th>
</tr>
</thead>
<tbody>
<tr>
<td>EU</td>
<td>Implementation of the single market Support complements in logistics (e.g., postal systems)</td>
<td>“Last-mile” infrastructure, enforcement</td>
</tr>
<tr>
<td>National governments</td>
<td>Start-up ecosystems Venture capital markets Digital skills</td>
<td>Innovation hubs Expand links with local firms and markets</td>
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<td>Subnational governments</td>
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<td>Strengthen firms and governments capabilities to support adoption</td>
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*Source: Europe 4.0 Team*
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

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

**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 some reshoring

**TRANSACTIONAL TECHNOLOGIES**

- 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

**INFORMATIONAL TECHNOLOGIES**

**OPERATIONAL TECHNOLOGIES**

And, monitor impacts and be ready to adjust
Supported by:

Federal Ministry
Republic of Austria
Finance

Look for
EUROPE 4.0
Available online here

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And copy Anna Karpets (Brussels) akarpets@worldbank.org