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Data, Intangible Capital and Productivity: are there new drivers of growth?

Cecilia Jona-Lasinio

LUISS Business School

Joint work with

Carol Corrado, McDonough School Center for Business and Public Policy, Georgetown University

Jonathan Haskel, Imperial College Business School and Bank of England

Massimiliano Iommi, ISTAT and LUISS Lab of European Economics

Filippo Bontadini, LUISS University

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Intangible Capital and Modern Economies

Reference:
Corrado, Haskel, Iommi, Jona-Lasinio (2022), “Intangible Capital and Modern Economies”, ***Journal of Economic Perspectives***—*Volume 36, Number 3—Summer 2022—Pages 3–28*

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To understand production in modern economies, we must:

- Look beyond the typical textbook story around Y=F(L,K,t)
  - ✓ Examples may be from manufacturing, where K is P&E, L is workers and F the state of technology
  - ✓ The state of this know-how advances with time, driven by R&D and R&D & IP policies
- Look instead at Y=F(L, K, R, t) where R = intangible capital
  - ✓ R is defined to include the stock of technical knowledge accumulated from past investments in R&D, but in addition, it includes the *stock of commercially valuable knowledge* reflecting current and past investments in e.g., software tools, new industrial designs, new marketing platforms, and organizational and management efficiency (including new operating models, supply chains and distribution networks)

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Main questions

- ✓ What does it mean to expand investment to include broad range assets in intangibles?
  - – Impacts on investment, investment behavior, and realized rates of return (profitability)
- ✓ How is intangible capital measured and how does it impact productivity growth?
- ✓ Why intangible capital is a key asset in the digital economy?
- ✓ What’s role for data as an asset?

Gap between market capitalization and tangible asset of top companies is enormous; R&D does not begin to close this gap.

Table 1

The World's Largest Companies by Market Capitalization March 31, 2021 (billions of US dollars)

Company name	*Market capitalization*	*Tangible assets*	*R&D assets*
Apple	2,051	344	75
Saudi Aramco	1,920	322	5
Microsoft	1,778	245	92
Amazon	1,558	330	137
Alphabet	1,393	300	105
Facebook	839	141	51

Source: PWC and company reports (market capitalization and tangible assets for 2020). R&D assets are authors' estimates of 2020 R&D stock based on time series of R&D spending from company reports; see data Appendix.

Does the value of these companies is more closely related to their "intangible" assets, that is, their "know-how"?

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Background

- The potential importance of intangible investment in understanding the economy has deep roots in economics:

  ✓ R&D was treated as an intangible capital asset in both firm-level and neoclassical growth studies in the 1970s and 1980s (Griliches 1973, 1979, 1986).

  ✓ Brand was considered as strategic capital of the firm already in the management/marketing literature (Farquhar 1989; Aaker 1991).

- But the significance of intangible investments in the structure of organizations and the macroeconomy did not emerge until the information technology-driven productivity “boom” of the late 1990s (Brynjolfsson and Hitt 2000; Brynjolfsson, Hitt, and Yang 2002)

- Then measurement-oriented economists started considering seriously the notion that there was more to business investment than captured in official standard macroeconomic statistics (Young, 1998; Nakamura 1999, 2001).

The intangibles framework

Included in GDP

Digitized information
- Software
- Databases

Innovative property
- R&D
- Mineral exploration
- Artistic, entertainment, and literary originals
- Attributed designs (industrial)
- Financial product development

Economic competencies
- Market research and branding
- Operating models, platforms, supply chains, and distribution networks
- Employer-provided training

- The approach of Corrado, Hulten, and Sichel (2005, 2009) expands the range of spending by firms that should be viewed as an investment.
- It applies a fundamental economic criterion that defines investment, namely, that business (or public) investments are outlays expected to yield a return in a future period.
- Many of the components of intangibles relevant for analyzing modern companies are not included in GDP
- **Spending to create knowledge that expands productive capacity in the future is classified as investment**.

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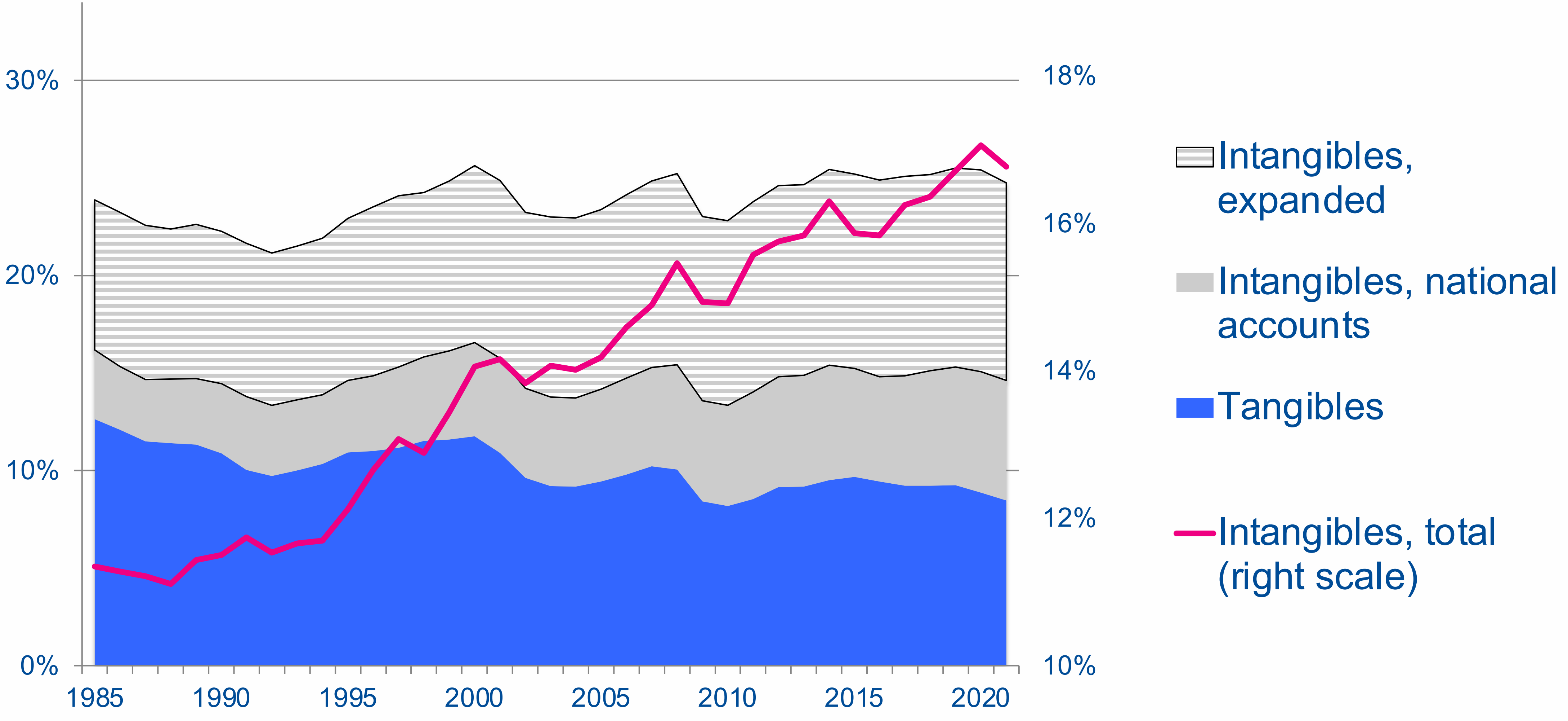
U.S private nonresidential investment, percent of private GDP



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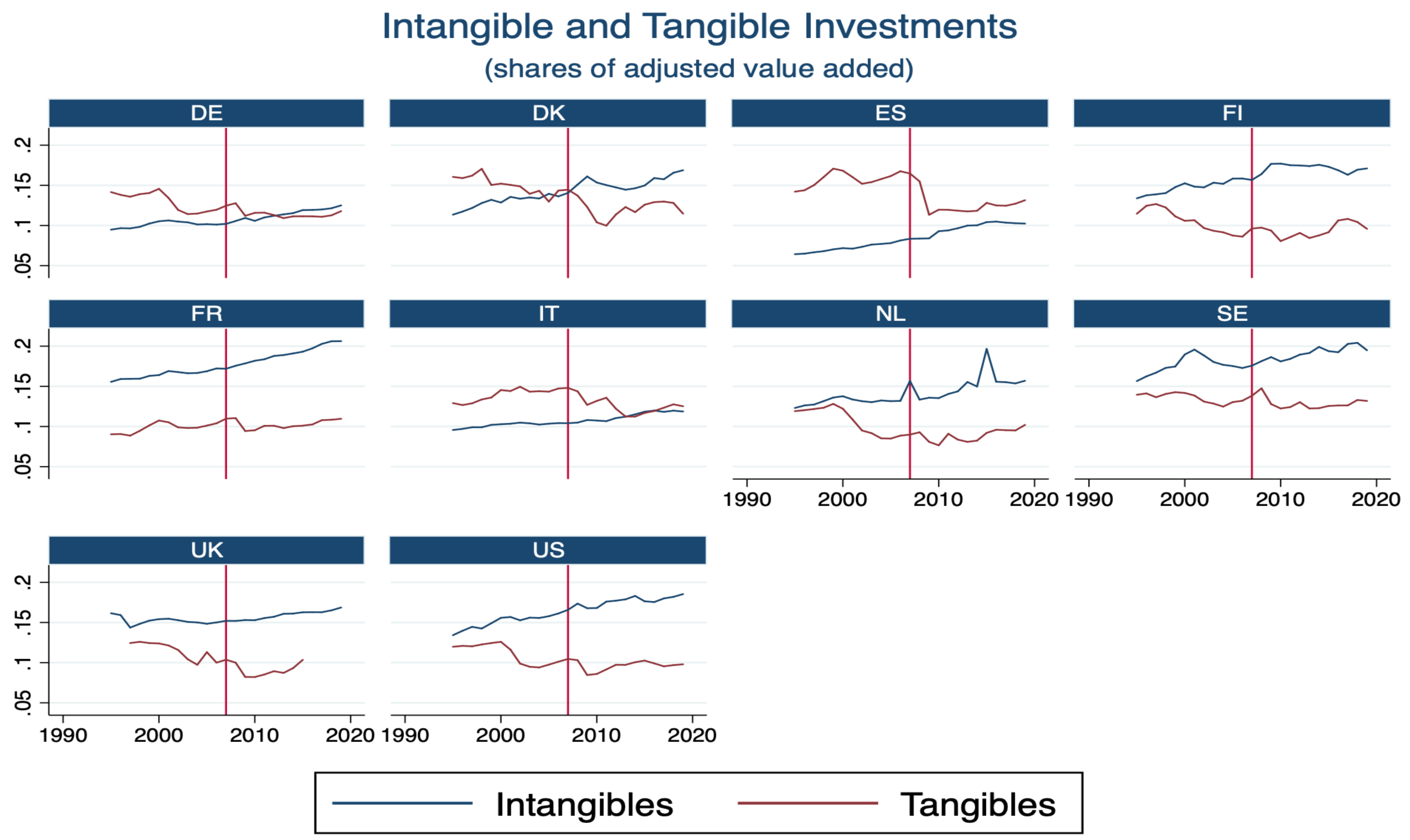
Intangible investment are substituting tangible physical investment

(GDP intangible shares ranges between 6%-13% and tangible shares 7%-10%)



Market sector excluding agriculture

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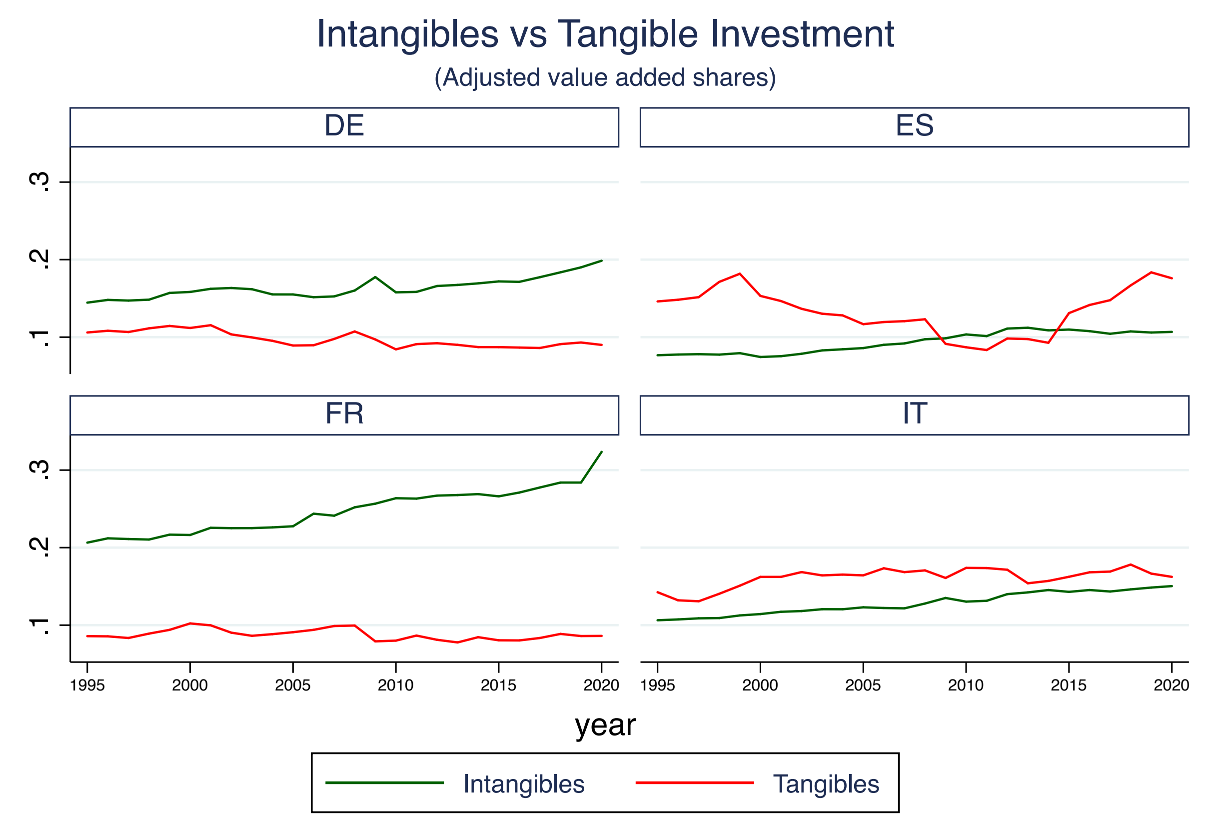
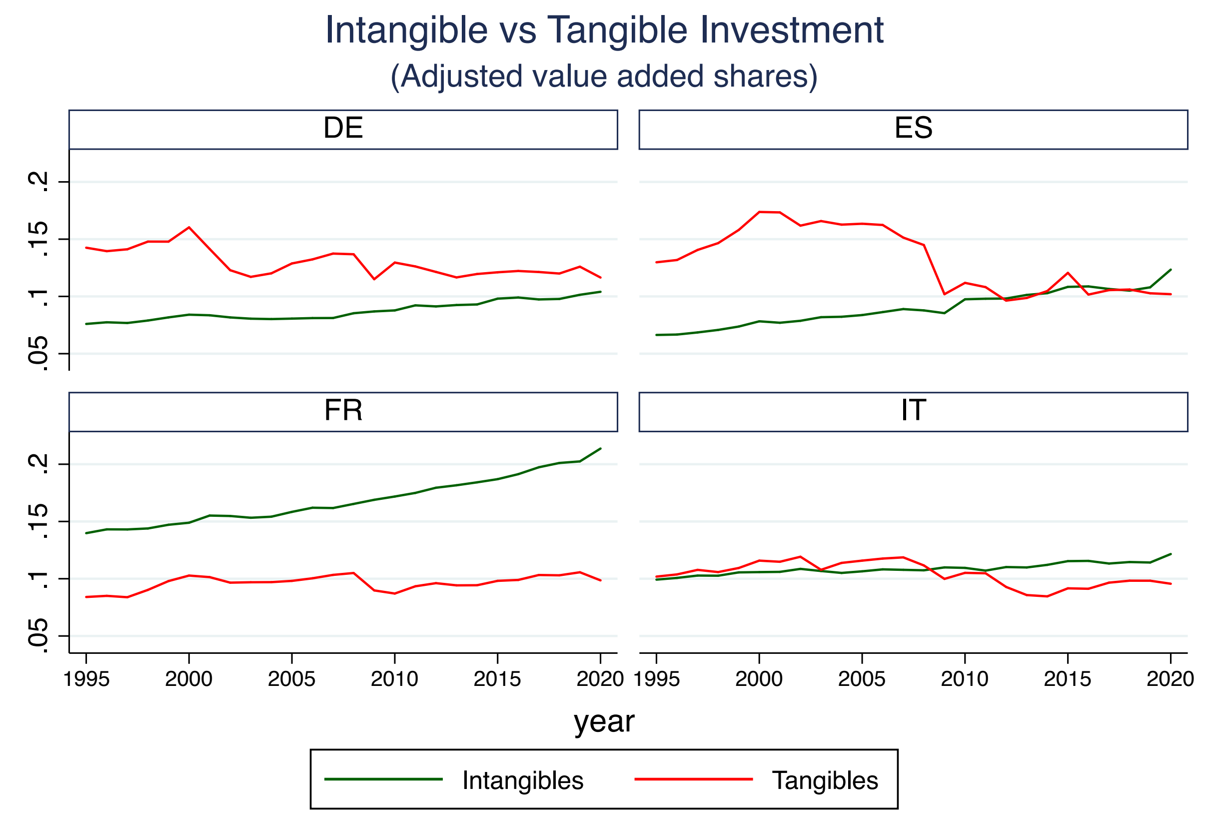
Intangible assets are substituting tangible physical assets but not with homogeneous patterns in manufacturing and services across EU economies.

Manufacturing



Manufacturing

Services



Services

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Data and Intangible Capital: Concepts and Empirical Relationships

Reference:
Corrado, Haskel, Iommi, Jona-Lasinio and Bontadini (2024), “Data, Intangibles and Productivity”, forthcoming **NBER Working Paper**.

Data and digital-based business platforms

- Digital transformation is affecting whole societies, and is a topic of interest in many disciplines
- In a digitizing economy, many economic activities are potentially driven by data.
- Data are becoming a key corporate asset, complemented with analytics, and organizations are
- Investing heavily in digital platforms and the *accumulation of proprietary data and its analysis*
- Demanding a workforce with skills in data science

Many claims in business and technology literature:

- Volume is growing > 50% per year
- "Data is the new oil"
- Digital transformation of business and societies:
  "You ain't seen nothing yet"

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Linking intangible and data assets

- We consider how the increased use of data in economies has affected productivity growth
- Data assets are conceptually encompassed in the Corrado, Hulten and Sichel, (2005, 2009) intangible framework:
  - **Data assets are intangible assets**
- We develop measures of industry level data investment for:
  - 9 European economies in 2010-2019
  - Market sector at 1 digit NACE Rev 2

Main contribution

- Test a simple model of an economy with data/intangible capital to assess the impact of the increased use of proprietary data by business economies.
- We find two first-order macroeconomic impacts:
  - Data capital boosts labor productivity due to its greater relative efficiency **(the efficiency effect).**
  - The increased data intensity of intangible capital weakens commercial knowledge diffusion and diminishes Total Factor Productivity (TFP) growth **(the appropriability effect)**.
    - Due to the largely proprietary nature of bigdata

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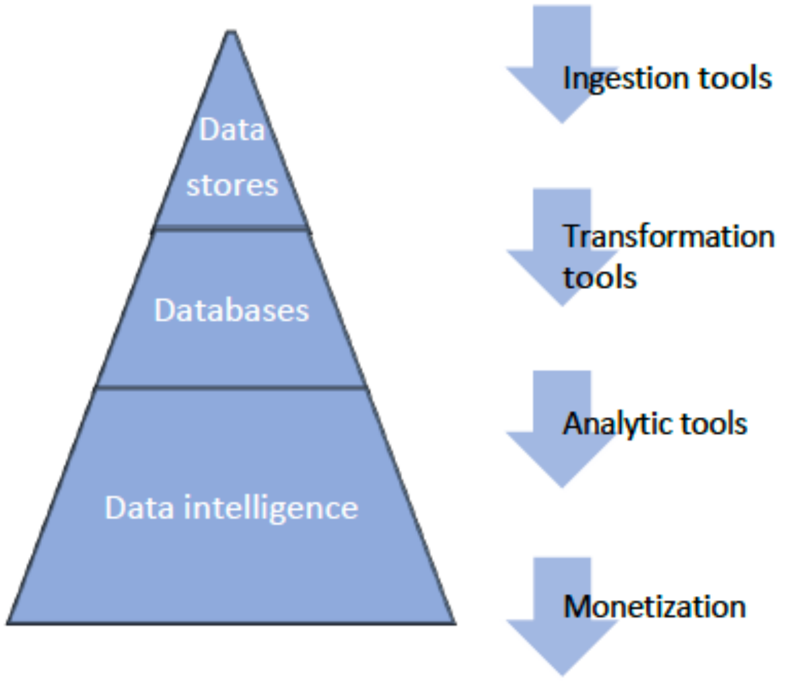
Data value creation: What do technologists and business strategists say?

Data value chain



Note. The stack to the left depicts the stages of data asset value creation based on applying layers of tools shown on the right.

- **Data stores** are raw records not yet cleaned, formatted, or transformed for analysis
- **Databases** consist of transformed raw data suitable for some form of data analytics or visualization
- **Data intelligence** reflects the further integration of data with advanced analytic tools—a set of quantitative inputs that provide guidance for decision-makers/solutions to problems
  - Greater value is produced as data is processed into **usable intelligence**.
  - ***Takes many forms***, e.g., scientific; computer, engineering & product designs; marketing strategies; and business operations and strategy (i.e., business models and logistics)

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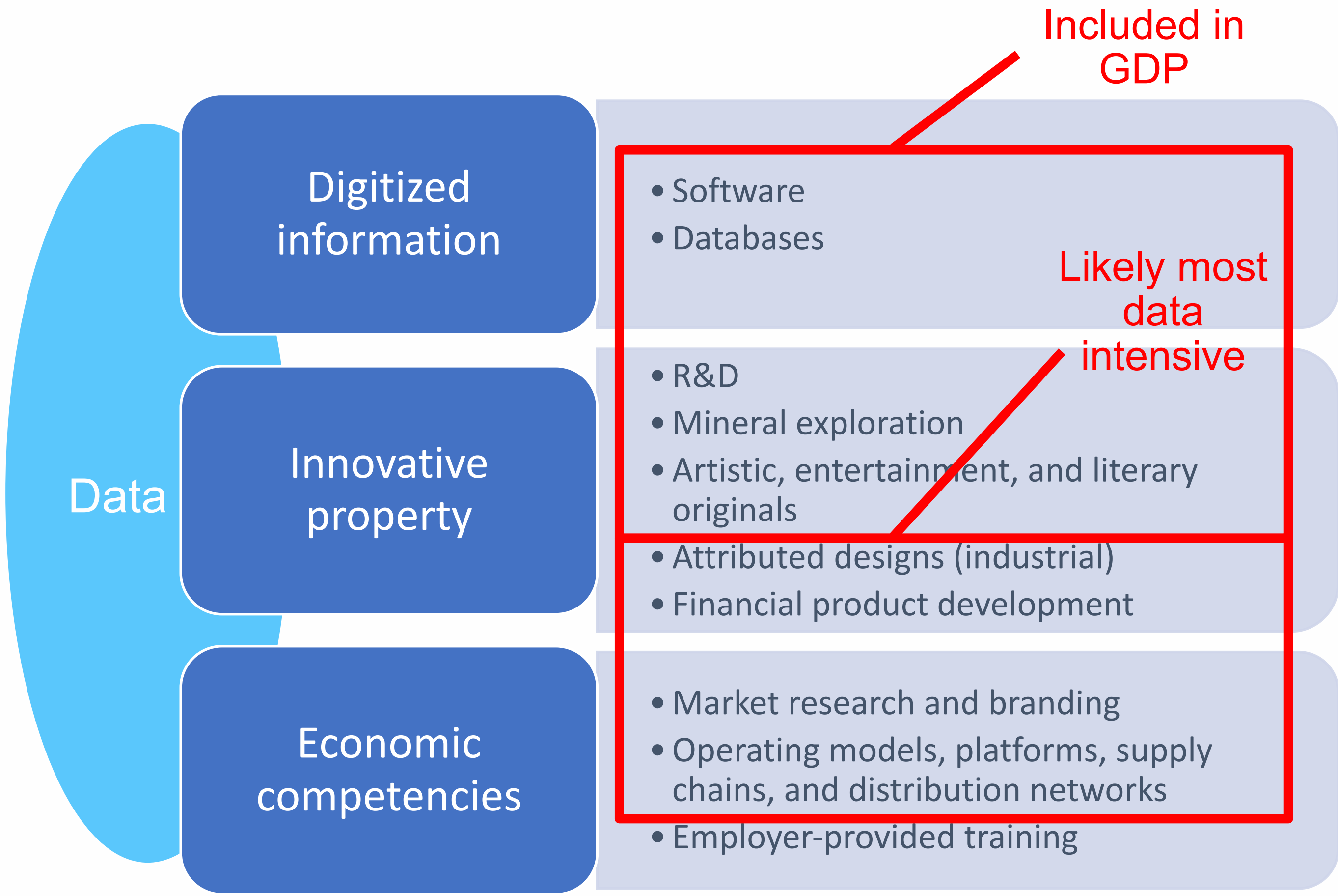
Data as an intangible asset: Nearly all components of intangible capital are potentially driven by data

- No one-to-one correspondence between components of intangibles and components of data stack
- Intangible investment includes most forms of data intelligence
  - Also, data tools/apps and databases
- Research strategy of paper:
  - Develop independent measures of investments in data assets
  - Compare with intangible investment
  - Investigate impacts of proprietary nature of intangible capital (via overlap with data assets) on productivity growth



Source: Adaptation of Corrado, Hulten, and Sichel (2005, 2009)

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Conceptual framework

A conceptual framework for measuring and analyzing data needs to account for the fact that: (a) data is nonrival and capable of improving economic welfare when shared or replicated at low cost; but that (b) data, though nonrival, is frequently used exclusively.

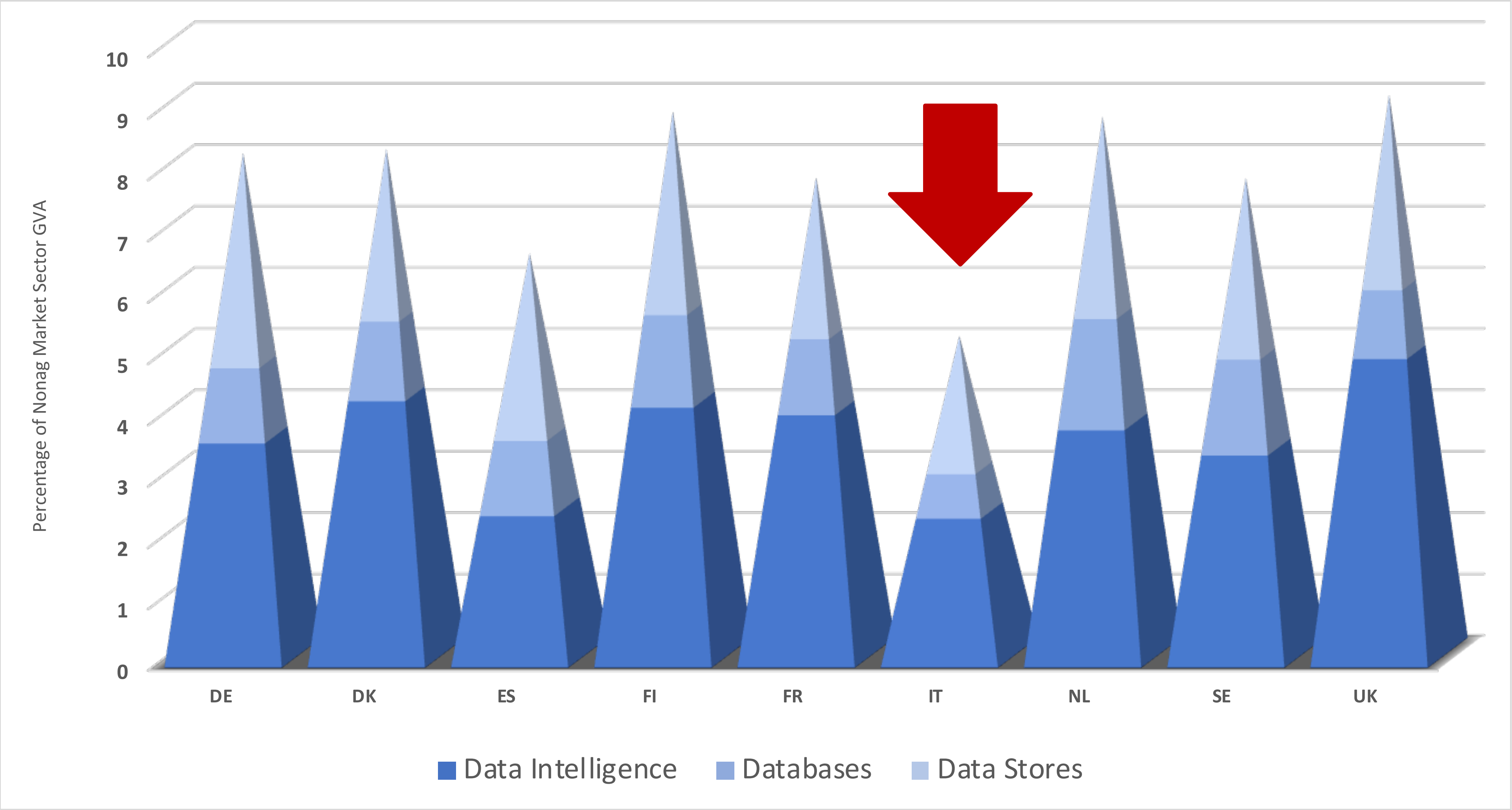
We make two main assumptions to develop a framework for analyzing data:

- The accumulation of data as the potential to boost real output only when producers invest also in transforming such records into analytical insights and actionable business intelligence;

- The knowledge assets gleaned from the application of data technologies to data are productive assets.

The appropriability of returns to these assets implies that business spending on data accumulation and transformation and data analytics are intangible assets.

Data Value Chain: 9 European countries, 2010-2019



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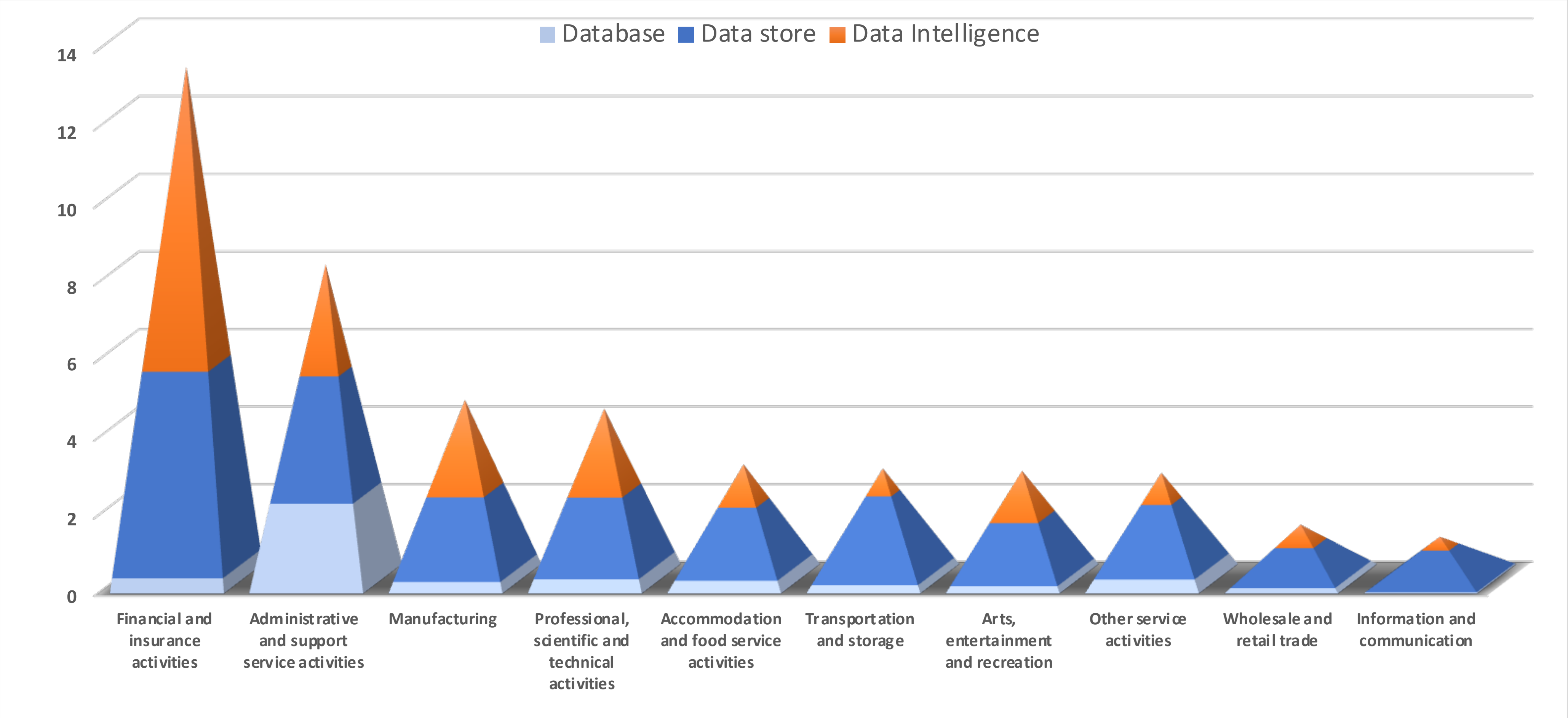
Notes: All series pertain to market sector industries and are plotted as percent of market sector GVA. Data asset production, software asset production, and net imports of intangibles are authors' estimates for market sector industries. Total investment in intangibles are from EUKLEMS & INTANProd (LLEE 2023).

Data value chain: Italian industries, 2010-2019



- The total data value chain averages **7.8** percent relative to nonagricultural market sector gross value added (GVA) in the covered EU countries and years.
- The United Kingdom is the most data intensive of the countries included (9.1 percent), and **Italy** and Spain are the least (**5.2** and 6.5 percent, respectively).

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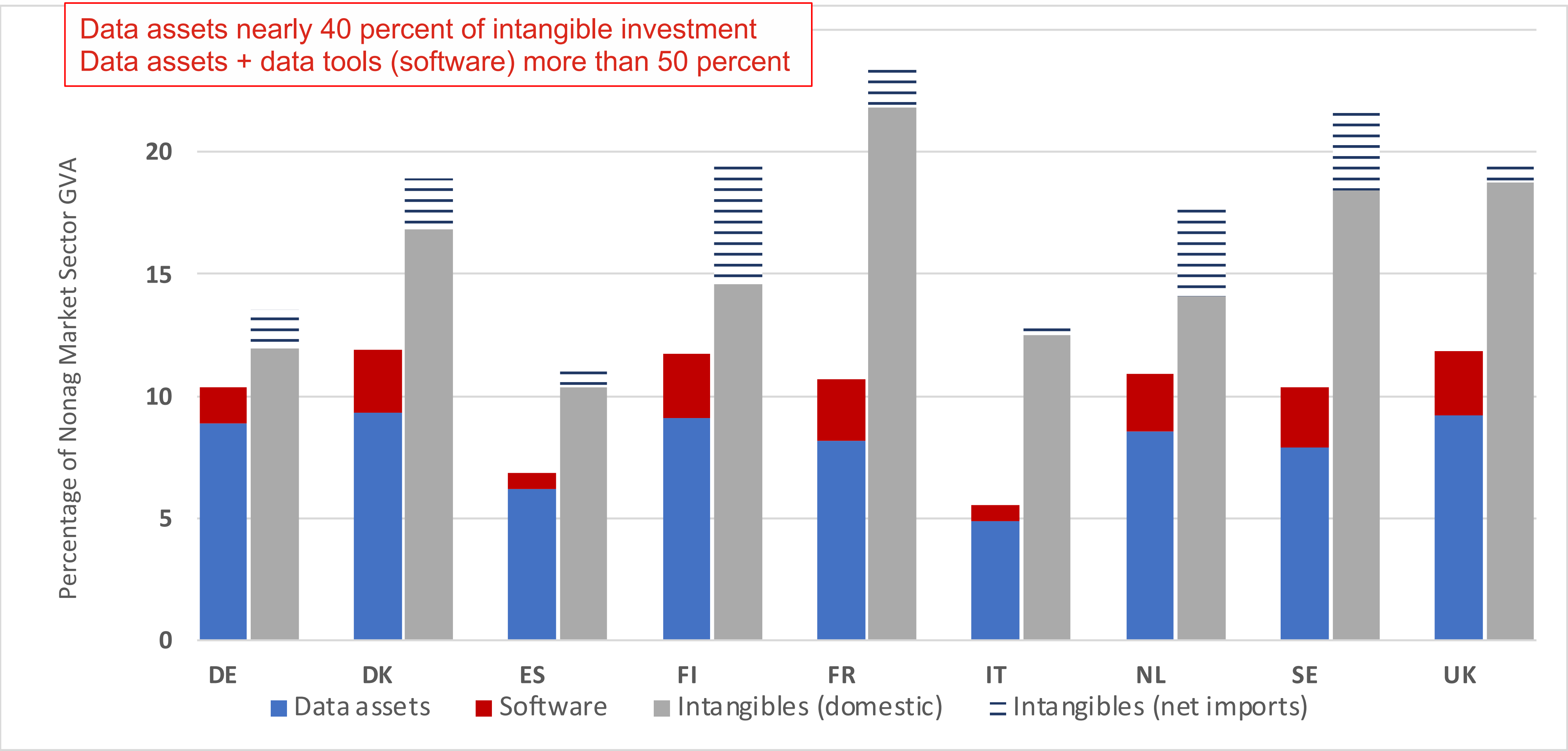
Data and Software asset production vs intangibles, 2019



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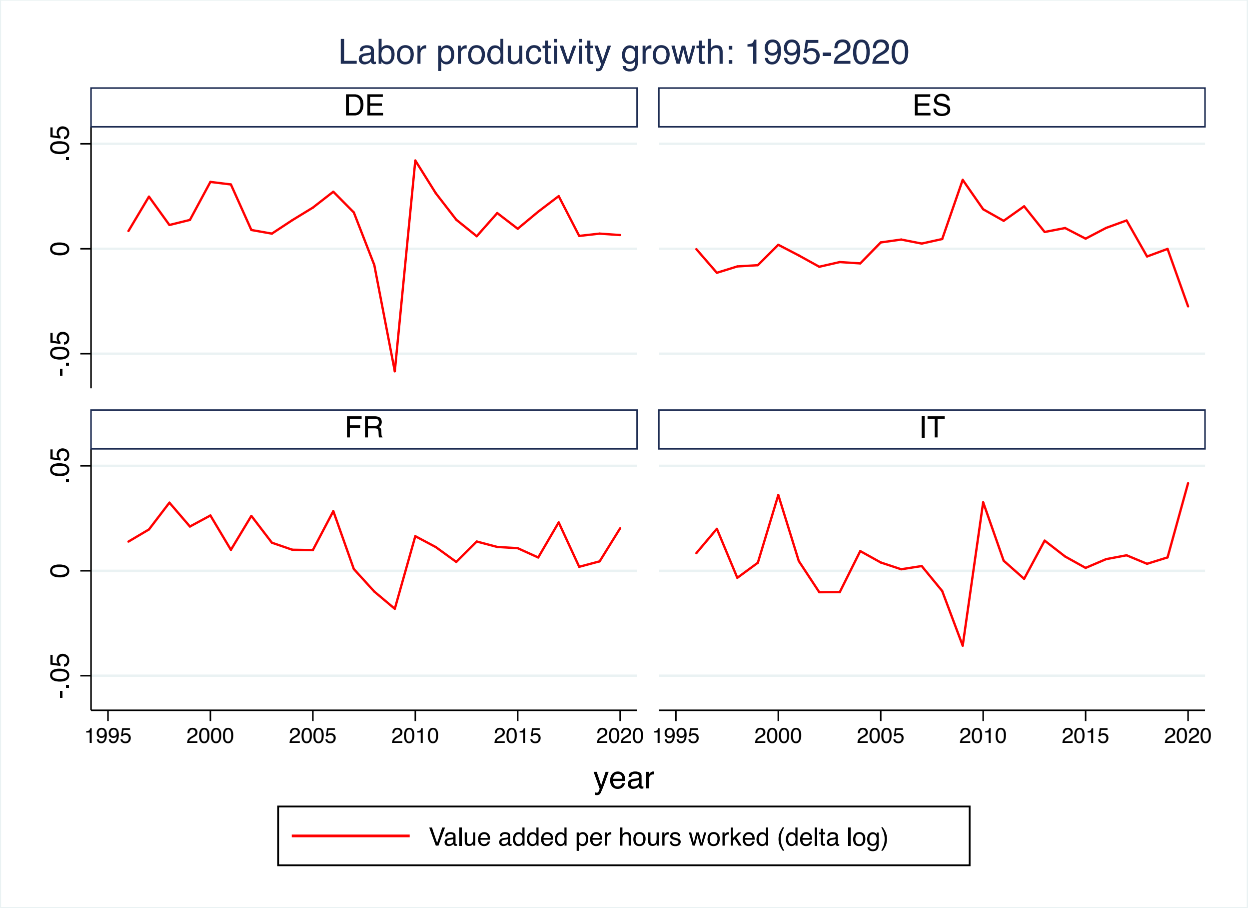
Productivity and the Rise of Proprietary Data

Reference:
Corrado, Haskel, Iommi, Jona-Lasinio and Bontadini (2024), "Data, Intangibles and Productivity", forthcoming **NBER Working Paper**.

Labour productivity growth following the GFC has slowed down and it is still below pre-GFC rates

Source: authors' calculations from EUKLEMS & INTANProd database. Labour productivity is value-added (adjusted for intangibles) per person-hour worked. Country groupings are: **EU Centre**: Austria, Belgium, Germany, France, Ireland, Luxemburg, Netherlands. **EU East**: Bulgaria, Czechia, Estonia, Croatia, Hungary, Lithuania, Latvia, Poland, Romania, Slovenia, Slovakia. **EU North**: Denmark, Finland, Sweden. **EU South**: Cyprus, Greece, Spain, Italy, Portugal; Remaining countries: United Kingdom & United States.

Market sector labour productivity growth: Italy vs Germany, France and Spain



- Productivity growth is persistently slowing down in manufacturing sectors in the sample economies with average growth rates still lower than before the GFC.
- The slight increase of market sector Italian productivity is mainly driven by a decline in hours worked not a proper increase of efficiency.

Data asset and intangibles by industry

Table 3. Sectoral distribution of investment in data and total intangibles, percentages of sector gross value added in nine European countries, 2010 to 2019.

	Data Investment	*Intangible investment*
Selected industry sectors	*(1)*	*(2)*
1. **Professional, scientific & technical activities**	15.4	27.0
2. **Information and Communication**	13.3	28.2
3. **Financial and Insurance activities**	12.4	21.6
4. **Manufacturing**	7.6	21.6
5. **Administrative & support service activities**	3.0	11.1
Memo:		
6. **Nonagricultural market sector**	7.8	16.9

Note: Each cell represents the unweighted average of investment as a percentage of sector gross value added over time and countries. Industries shown correspond to NACE letter sectors M (row 1), J (row 2), K (row 3), C (row 4), N (row 5) and B to K, M, N, R, and S (row 6). European countries include Denmark (DK), Germany (DE), Finland (FI), France (FR), Italy (IT), Netherlands (NL), Spain (ES), Sweden (SE) and the United Kingdom (UK).

- **Most data intensive sectors:** Professional and scientific activities , Information technology and Financial activities (key role of data intelligence)

- **Manufacturing**: sector invests disproportionately in R&D compared with other intangibles, however, suggesting that R&D processes (in manufacturing) are less data intensive than business functions such as marketing, and supply logistics that are more predominant in services industries

Data asset, intangibles and productivity growth: what linkages?

	(1)	(2)	(3)	(4)	(5)
DlnR	.216***	.123***			
	(.027)	(.031)			
$DlnK^{Tangible}$	.168***	.029	.166***	.034	.034
	(.029)	(.036)	(.029)	(.036)	(.036)
$DlnK^{Data}$		.325***		.331***	
		(.05)		(.051)	
$DlnR^{Data\ Intensive}$			.033**	.005	.007
			(.016)	(.016)	(.016)
$DlnR^{Non\ Data\ Intensive}$			.073***	.05**	.049**
			(.02)	(.02)	(.02)
$Dln\_R^{Training}$			.132***	.061**	.067**
			(.027)	(.029)	(.029)
$Dln\_K^{Data\ Base}$					-.006
					(.037)
$Dln\_K^{Data\ Store}$					.005
					(.061)
$Dln\_K^{Data\ Inteligence}$					.316***
					(.065)
Observations	6614	6522	6680	6588	6588

Standard errors are in parentheses

**** p<.01, ** p<.05, * p<.1*

Note: dependent variable is labor productivity computed as delta log adjusted value added per hour terms; all explanatory variables are in per hour terms and delta log.

- We expect data capital and intangible capital overlap.
- Conceptually, data capital is subsumed within intangible capital, especially in its “data-intensive” components: new financial products, industrial design, branding and marketing, and organizational processes.
- They are both relevant drivers of productivity where data capital seems to exert a stronger effect on productivity growth.

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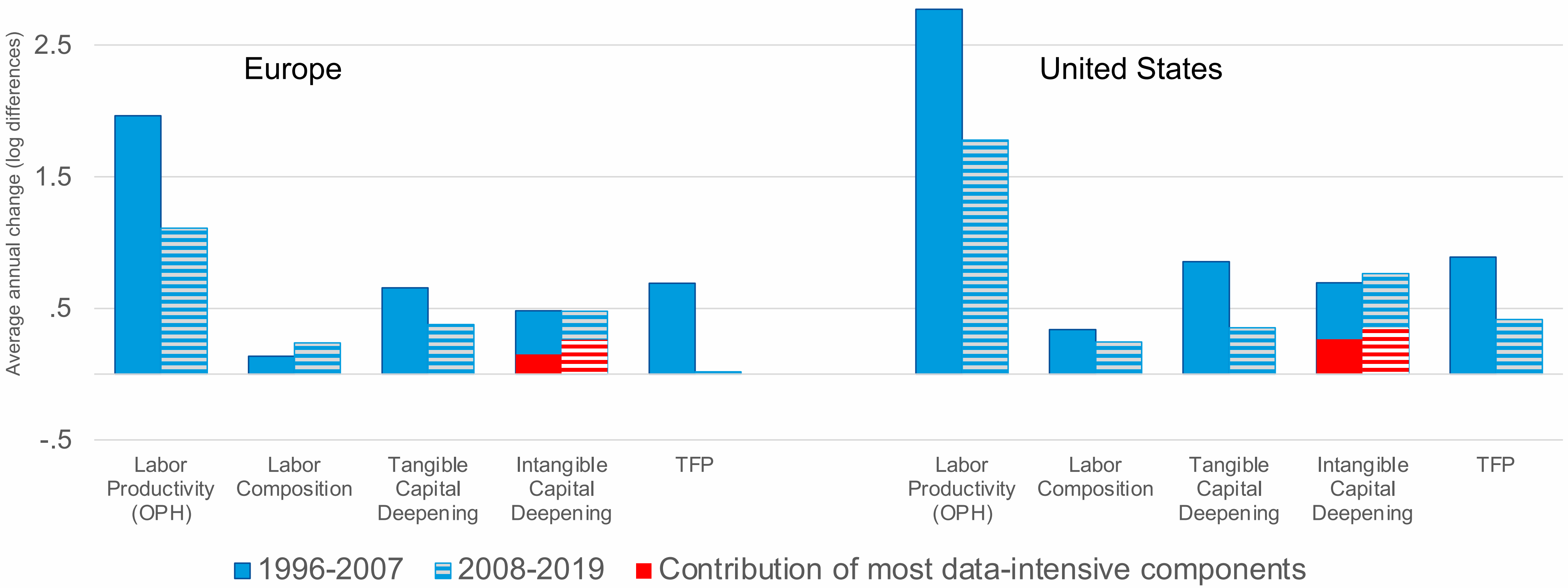
Data-driven knowledge

- Model illustrates how data capital gives rise to opposing forces on TFP growth
- Proprietary data typically is neither disclosed nor shared, like a trade secret
  - This implies fewer productivity spillovers/weaker knowledge diffusion from intelligence derived from proprietary data
    - Fewer spillovers => weaker total factor productivity growth
    - Less knowledge diffusion => increased productivity dispersion, increased concentration, and possibly increased market power
- Data and data tools as an “innovation in the method of innovation”
  - Efficiency of innovation-producing activities (i.e., intangible investments) improves due to AI adoption and availability of open-source software

Decline in TFP growth accompanied by a step up in contribution of data intensive components



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Note: Nonagricultural market sector industries. The 9 European countries are DE, DK, ES, FI, FR, IT, NL, SE and UK.
Source: Elaboration of EUKLEMS & INTANProd estimates (LLEE 2023).

Implications

- Recent TFP growth (2007 to 2019) slows by about 3/4 percentage point (per year) in Europe* and the United States based on new EUKLEMS & INTANProd database

- Research indicates that prices for consumer digital services are mismeasured to an increasing degree…and can account for nearly .3 percentage points of this slowing

- The diffusion of commercially valuable knowledge is the primary determinant of TFP in the intangible capital framework.

  ✓ *The boost to labor productivity stemming from the estimated relative efficiency of data capital is offset by the appropriability effect, which shaved .3 and .4 percentage points off 2010-2019 TFP growth in Europe and the United States, respectively.*

* *Nine country aggregate. Market sector industries.*
** *Exploits past studies of spillovers, data capital overlap, and growth rates of intangible capital.*

Summary

The framework and discussion of intangible capital summarized in the papers provides bridges among GDP measurement, growth accounting and modern growth theory:

- In its focus on the partial appropriability of investments in innovation, the framework also provides economists with a bridge to discussions of methods of business innovation in the management literature.
- Intangible capital has been evolving with the digitization of modern economies and growing use of proprietary bigdata in production processes.

Summary and concluding remarks

- We find that the intangible investments and the “data stack”-inspired estimates of data investment strongly overlap especially in components hypothesized to be most likely driven by modern data use: investments in brand and marketing, marketing research, industrial design, and organization processes and structure.

- The first-order impacts of these results on productivity are that the use of data capital boosts labor productivity growth **(the efficiency effect)** but that the increased data intensity of intangibles weakens commercial knowledge diffusion and diminishes TFP growth **(the appropriability effect).**

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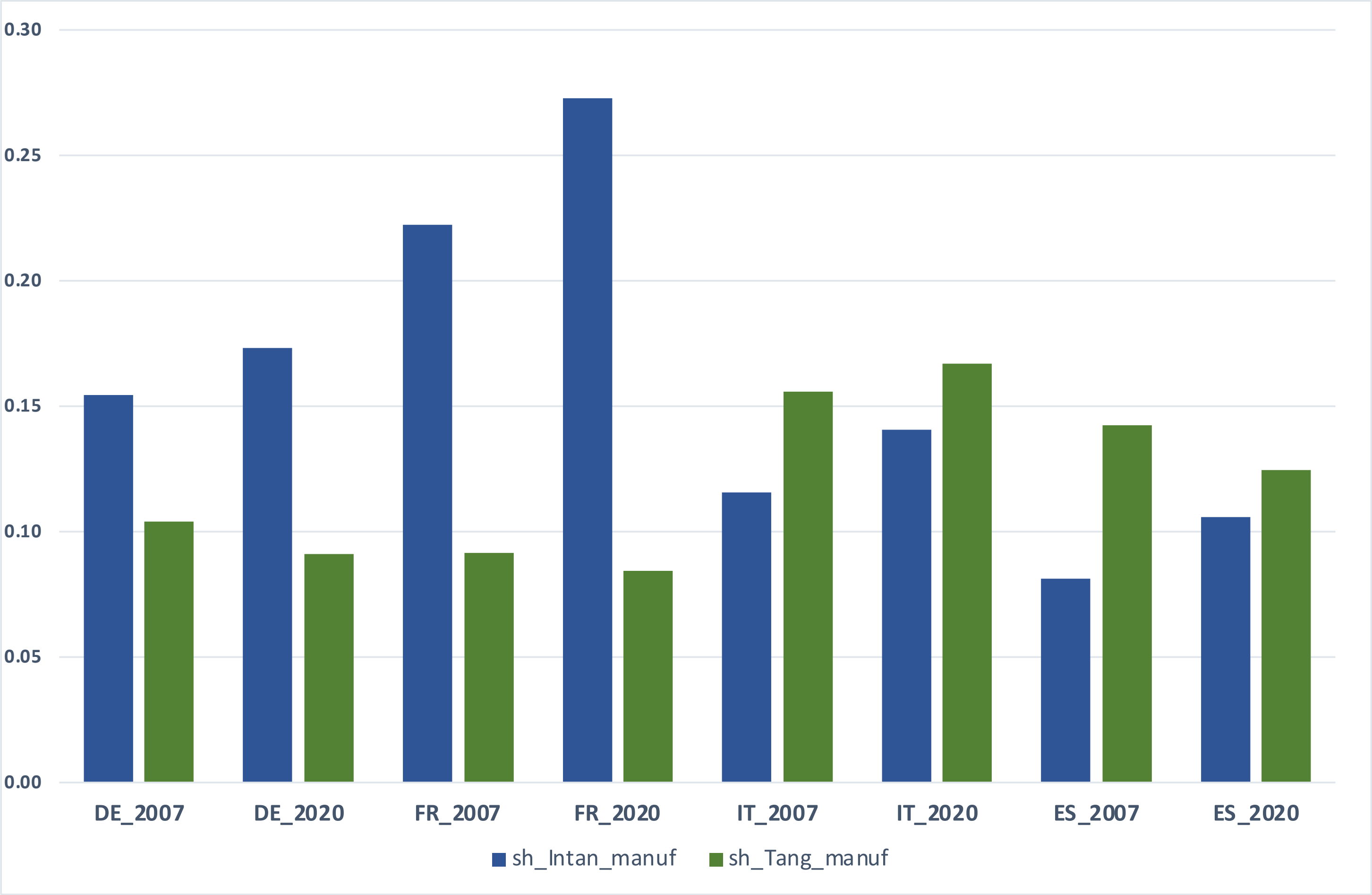
Summary and concluding remarks

- As modern economies become more "knowledge-intensive (and data-driven)" we believe that economic researchers should seek to include the full complement of intangibles in investment and productivity data as well as the profitability measures that feature in competition analysis.
- The Italian economy is lagging behind the digital transformation with serious consequences on economic growth.
- Policymakers should focus on supportive measures for investment in innovation critical for ensuring sustainable and resilient economic growth over the twin transition.

Thank you

cjonalasinio@luiss.it

Italian manufacturing sector still lagging behind in the substitution process



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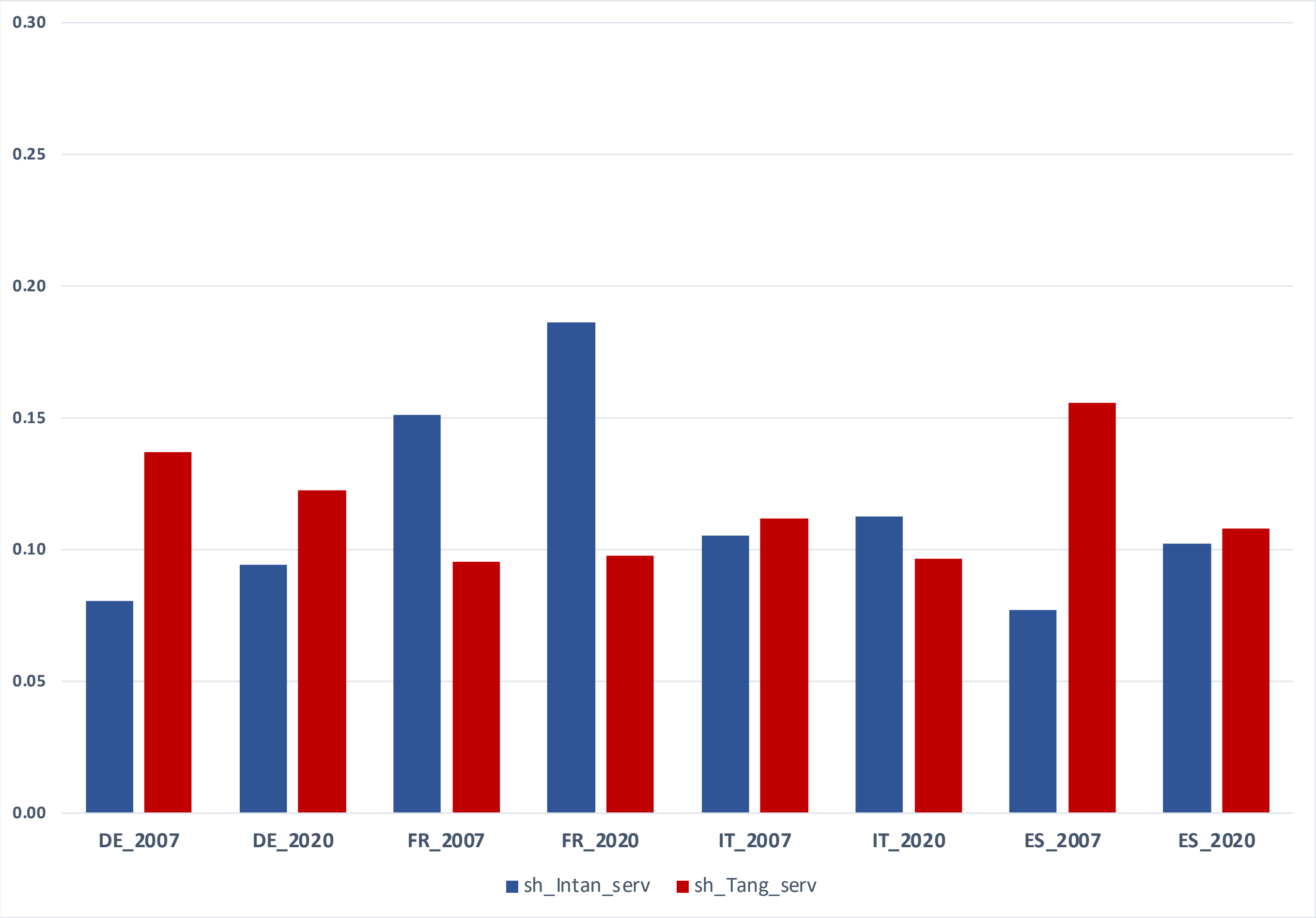
Italian services started the substitution process between tangibles and intangibles



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Proprietary bigdata

Table 1. Examples of Data Use	
Rival	
1.	Product-level forecasting (e.g., Amazon)
2.	A/B Internet testing and marketing (e.g., Google)
3.	IoT factory systems (e.g., Siemens)
4.	Targeted advertising on consumer content platforms
5.	Fintech (e.g., algorithmic trading, digital lending, etc.)
6.	Product-led growth strategies (e.g., Slack)
7.	Customer lists/after sales services design
Nonrival	
8.	DaaS (Data as a Service) platforms (e.g., BDEX)
9.	Financial records (FICO scores)
10.	Vehicle records (CARFAX reports)
11.	Personal medical records (across service providers)
12.	Open-source data generated by web users (traffic patterns)
13.	Private by-product data put to alternative uses (e.g., Zillow data used for economic research)
14.	Genomic and other public biomedical research data
15.	Official statistics (economic, demographic, social)

Note: Data is inherently nonrival. The grouping of examples in the table reflects the degree to which data owners share their data assets with other organizations or the public.

- Lines 1–5 of the table mainly reflect applications of bigdata using new digital technologies by firms, i.e., digital platform-based businesses and/or applications of machine learning and other AI-based algorithms to massive data.
- Line 6 refers to marketing innovations based on user feedback data (also enabled by new technologies).
- Line 7, customer lists and after-sales customer feedback, which long have been inputs to brand development, marketing, and customer retention strategies, are fertile ground for application of data technologies.
- Line 9 indicates financial records held by credit bureaus and shared across financial institutions;
- Line 11 shows personal medical records shared by medical care services providers

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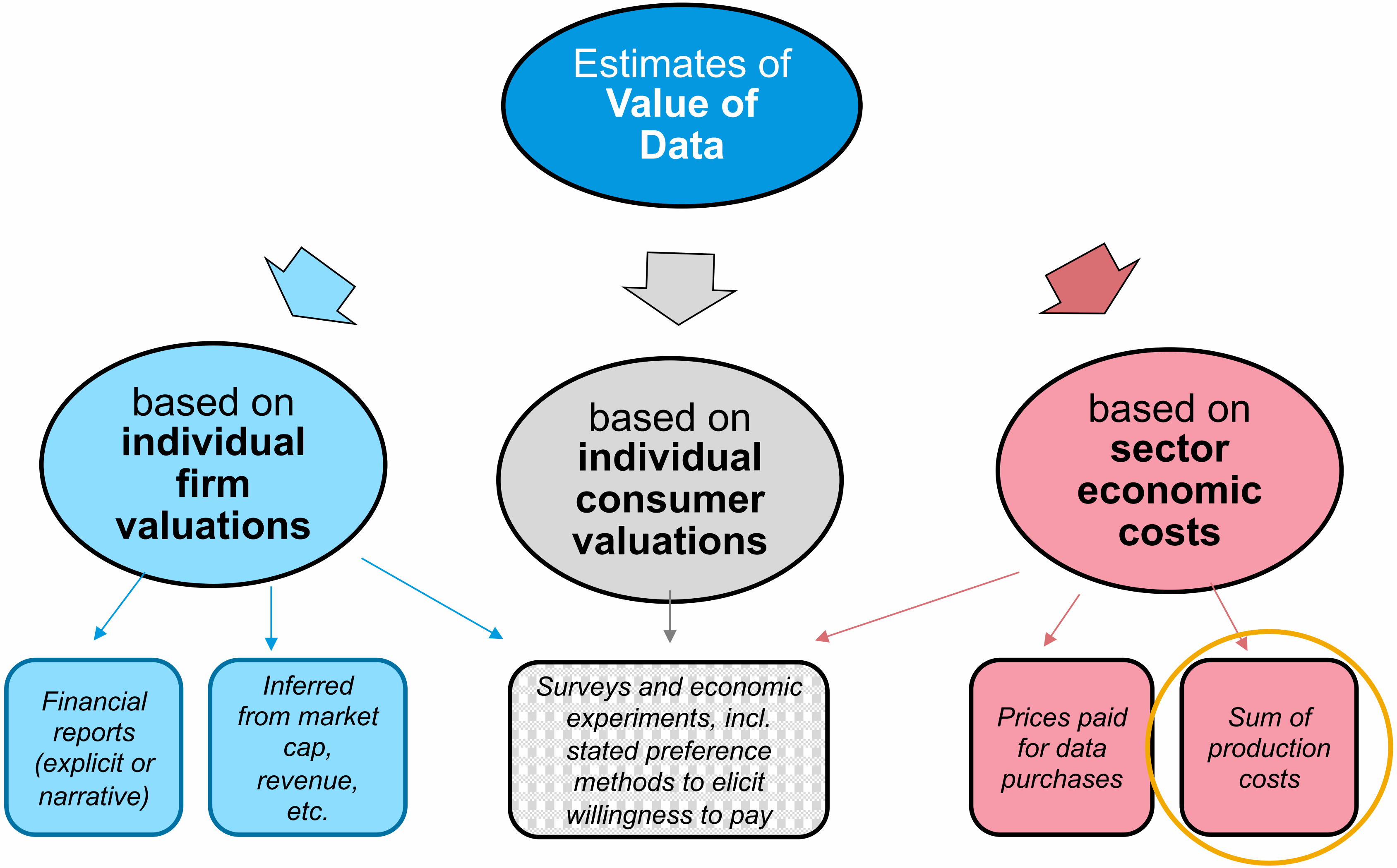
Approaches to measuring data



Total factor productivity estimates

- Intangible investment estimates now available via EUKLEMS & INTANProd project
  - Estimates cover EU countries, UK, US, and Japan
  - EU estimates Include full coverage of own-account components for the first time. For further information, see Bontadini et al. (2023) on project portal: https://euklems-intanprod-llee.luiss.it
- Using these estimates, productivity decompositions were calculated for the US and a European aggregate covering the 9 countries with data production estimates shown on the previous slides.
- Real intangible capital figures for all countries use deflators for marketing assets based on harmonized media cost price indexes.

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