2.9 Digital intensity, a taxonomy of sectors

Why measure digital intensity in sectors?

The digital transformation is a multifaceted and fast-moving phenomenon that has significant impacts, including on the business processes and models of firms. As a result, the pace of technology uptake will depend, among other factors, on the type of sector in which a given firm operates. While no single indicator is able to reflect the pace of technology development and diffusion, combining indicators can provide insights into how different sectors, are positioned in terms of technology adoption.

Based on seven different metrics, Calvino et al. (2018) propose a taxonomy of sectors by digital intensity. The indicators considered highlight how the extent of digital transformation in sectors is shaped by firms' investments in "digital" assets, as well as by changes in the way companies approach markets and interact with clients and suppliers, by the (type of) human capital and skills needed, and the way production is organised. Since different sectors develop and adopt different digital technologies and business models at differing rates, sectors may appear in different parts of the taxonomy during the early 2000s (2001-03) as compared to more recent years (2013-15). In Calvino et al. (2018), industries are benchmarked according to each of the dimensions considered. An overall summary indicator of digital intensity is also proposed.

The taxonomy of sectors by digital-intensity is intended as an operational tool to help analysts and policy makers better understand and monitor the digital transformation. It is not intended to be used to measure the size of the digital economy, but rather for empirical work as a proxy variable for the digital transformation in sectors, as well as for tabulating indicators of the digital transformation according to the quartiles of digital-intensity identified. As such, the digital intensity taxonomy complements existing industry-level classifications focusing on individually considered measures, such as R&D expenditure, ICT or information industries, or firms' innovative activities.

What are the challenges?

Calvino et al. (2018) use information, covering the period 2001-2015, for 36 sectors in 12 countries, namely: Australia, Austria, Denmark, Finland, France, Italy, Japan, the Netherlands, Norway, Sweden, the United Kingdom and the United States. Sectors are classified according to ISIC Rev.4. The indicators considered were:

- ICT equipment and software investment relative to total fixed investment;
- Intensity in purchases of ICT intermediate goods and services relative to output;
- Stock of robots per employee;
- Number of ICT specialists over total employment (often referred to as "ICT-specialist intensity"); and
- Propensity to engage in e-commerce sales.

For each indicator, cross-country averages are calculated at the sector level and used to benchmark each sector relative to all the others. The "global" taxonomy summarises these dimensions into an overall benchmark. It lists sectors according to their relative position in the overall economy's ranking and groups them into "high", "medium-high", "medium-low" and "low" digital intensity, depending on whether sectors appear in the top 25% (or quartile, denoted as "high"), in the bottom 25% ("low"), or in between the two. The figure shows the digital intensity of different sectors in the overall ranking. The darker the colour, the higher the digital-intensity of the sector.

The availability and coverage of internationally comparable data from official sources dictated the choice of indicators used for the ranking, as well as countries and years covered. Measures related to frontier technologies such as machine learning or 3D printing could not be included as data by country, industry and year are currently scant. The few gaps in the remaining time series were filled with alternative sources where available, or extrapolation and interpolation. Some of the indicators considered only relate to a subset of sectors, due to the design of the underlying data sources (e.g. surveys).

Each of the seven indicators proposed raised specific challenges. For instance, identifying "ICT-specialist" occupations required an understanding of cross-occupational differences in workers' involvement in the production of ICT goods and services, rather than in their use of ICT tools on the job. In the absence of official data sources, information on robot use was obtained from the International Federation of Robotics. The time series required assumptions on, among others, the depreciation of robots over time and the way in which annual robot sales data should be transformed into an estimated stock.

Some challenges remain unaddressed. Indicators of ICT (equipment and software) investment, for instance, only capture an industry's direct investment in ICT capital goods, but do not account for the value of ICT embodied in other types of capital. This, in turn, can affect the relative position of sectors sourcing ICT capital indirectly, in other words, through purchases of goods that contain many ICT parts or devices e.g. complex machines. Conversely, the intensity in purchases of ICT goods and services may be over-estimated, as data are sourced from Input-Output rather than Supply-Use tables.

By providing information at the product rather than industry level, Supply-Use tables allow for a more precise mapping of the ICT goods and services that industries use as intermediates.

Taxonomy of sectors by digital-intensity, overall ranking, 2013-15

ISIC Rev.4 industry denomination	Quartile intensity	ISIC Rev.4 industry denomination	Quartile intensity
Agriculture, forestry, fishing	Low	Wholesale and retail trade, repair	Medium-high
Mining and quarrying	Low	Transportation and storage	Low
Food products, beverages and tobacco	Low	Accommodation and food service activities	Low
Textiles, wearing apparel, leather	Medium-low	Publishing, audiovisual and broadcasting	Medium-high
Wood and paper products, and printing	Medium-high	Telecommunications	High
Coke and refined petroleum products	Medium-low	IT and other information services	High
Chemicals and chemical products	Medium-low	Finance and insurance	High
Pharmaceutical products	Medium-low	Real estate	Low
Rubber and plastics products	Medium-low	Legal and accounting activities, etc.	High
Basic metals and fabricated metal products	Medium-low	Scientific research and development	High
Computer, electronic, optical products	Medium-high	Advertising and other business services	High
Electrical equipment	Medium-high	Administrative and support service	High
Machinery and equipment n.e.c.	Medium-high	Public administration and defence	Medium-high
Transport equipment	High	Education	Medium-low
Furniture; other manufacturing; repairs	Medium-high	Human health activities	Medium-low
Electricity, gas, steam and air cond.	Low	Residential care and social work activities	Medium-low
Water supply; sewerage, waste	Low	Arts, entertainment and recreation	Medium-high
Construction	Low	Other service activities	High

Source: Calvino et al. (2018) based on Annual National Accounts, STAN, ICIO, PIAAC, International Federation of Robotics, World Bank, Eurostat Digital Economy and Society Statistics, national Labour Force Surveys, US CPS, INTAN-Invest and other national sources.

Prices are an additional challenge. Deflators are needed for a number of the indicators considered but may not be available, leading to the use of less appropriate alternatives. Purchases of intermediates, for instance, are deflated using output prices for ICT-goods vs ICT-service- producing industries, but doing so prevents differences between domestic and international (import) prices from being taken into account. Furthermore, ICT and software investment figures are deflated using country-level price series that do not always account for quality improvements in the underlying technology ("hedonic adjustment"), depending on the country considered.

Options for international action

The effort to measure how the digital transformation impacts different industries and countries will continue, and may rely on improved data timeliness and availability across countries. Additional data collection and international harmonisation would allow future studies to encompass other important dimensions of the digital transformation, such as the quality of ICT-related human capital, the generation of ICT-related technological innovation (e.g. patents) and services e.g. through the use of trademark data, or the production and use of data. Further efforts towards the creation of hedonic price series for ICT investment would also help, as would the production of new price indices for ICT intermediate goods and service consumption. For indicators to provide a timely picture of the continuously evolving dynamics at hand, data and information also need to be readily processed and harmonised.

The level of disaggregation at which data are collected and/or made available is another area for development. Companies in the same industry share similar technological opportunities, market structure, nature of production and knowledge requirements. However, technology generates and diffuses differently within industries, such that industry-level data hide significant heterogeneity, with each industry likely to have relative "leader" and "laggard" firms. To this end, and to be able to provide policy-relevant timely indicators, it would also be important for countries to expand the scope of business surveys to gather more information on technology generation and/or use at the micro-level, and to further invest in the harmonisation of relevant questionnaires across countries.

References

Calvino, F., C. Criscuolo, L. Marcolin and M. Squicciarini (2018), "A taxonomy of digital intensive sectors", OECD Science, Technology and Industry Working Papers, No. 2018/14, OECD Publishing, Paris, https://doi.org/10.1787/f404736a-en.