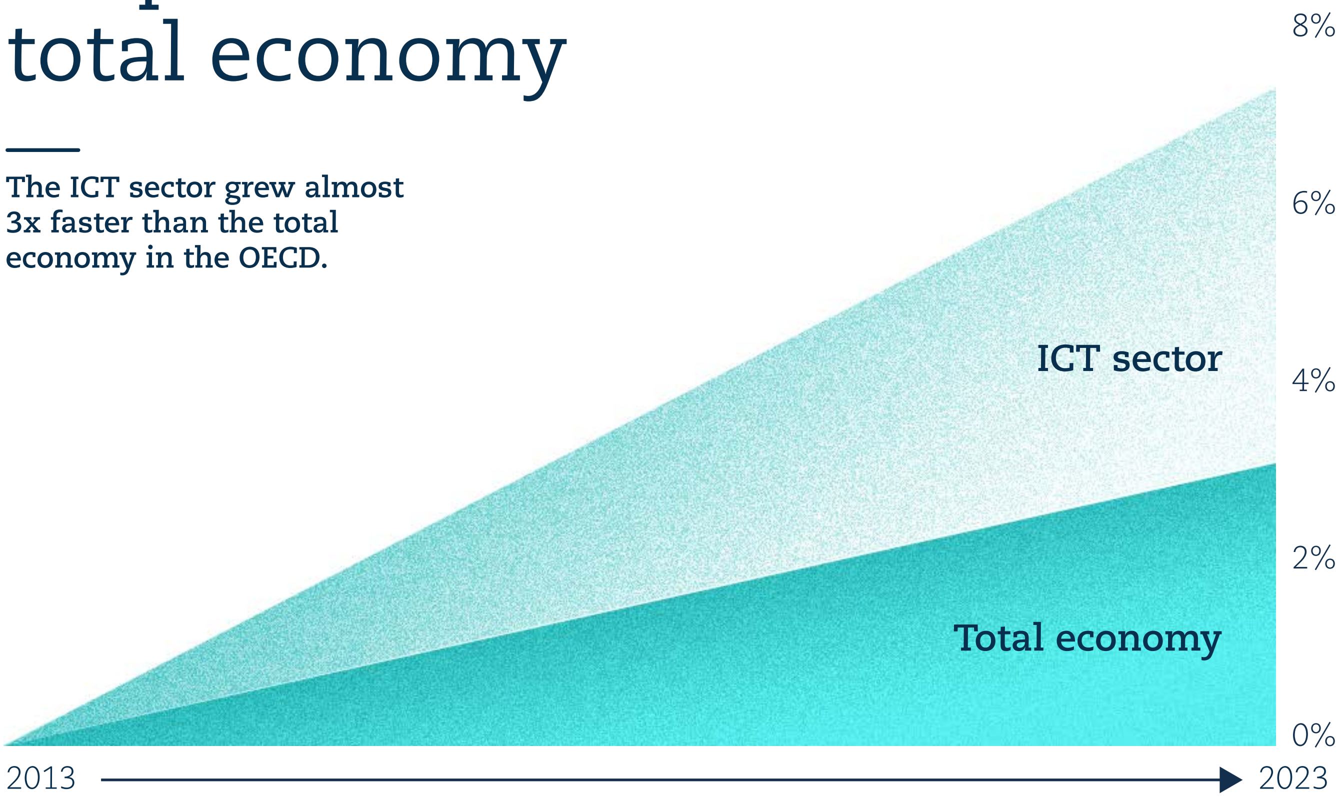
Chapter 1

The growth outlook of the ICT sector

As digital technologies spread and their societal and economic impact deepen, the need for evidence-based policies increases. However, there is a lack of timely and cross-country comparable data on the growth of digital components of the economy. While the "digital economy" is no longer strictly confined to the information and communication technology (ICT) sector, the latter remains at its core and it is essential to supporting further digital innovation. This chapter presents the results of a nowcasting model that leverages online search data and machine-learning techniques to provide policy makers with up-to-date and comparable data on the economic growth of the ICT sector. These estimates can help shed light on how this sector is performing today, which will help inform policy decisions that impact this vital sector of the economy in the future.

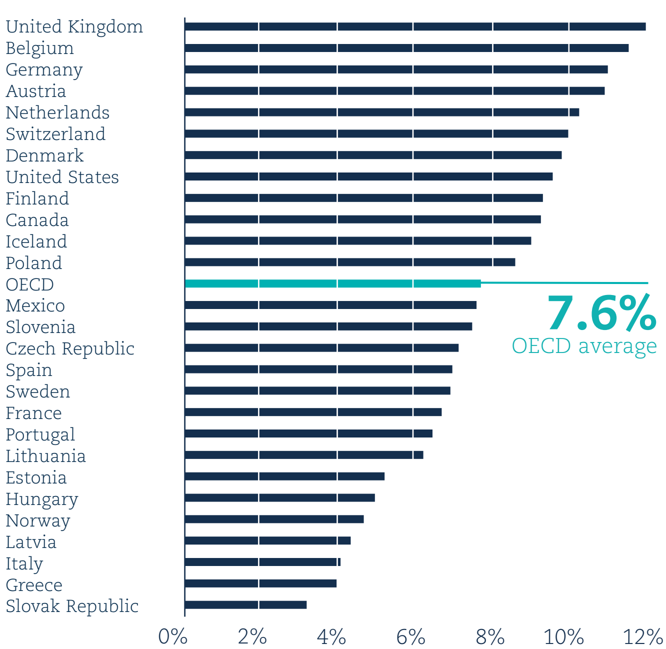
ICT sector growth outperforms the total economy

The ICT sector grew almost 3x faster than the total economy in the OECD.

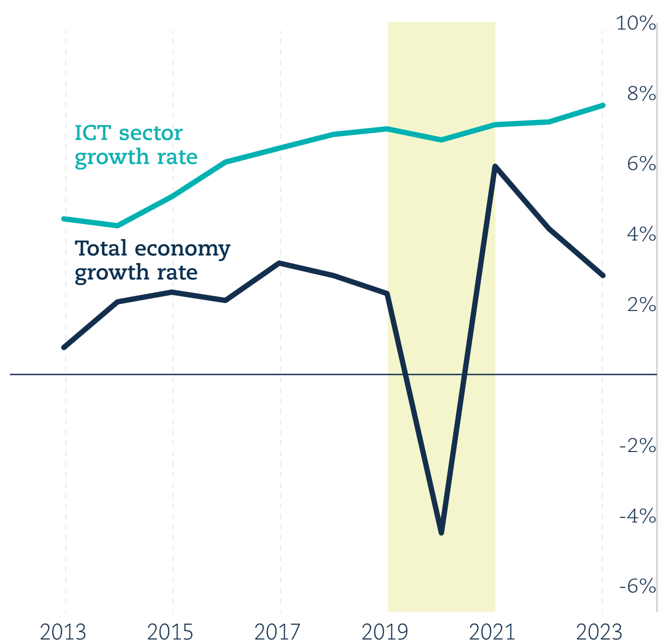


Estimates show strong growth of the ICT sector in 2023.

Predicted ICT sector growth rate, 2023



The ICT sector shrugged off the COVID-19 pandemic, in contrast to the broader economy.



Key findings

Timely estimates of ICT sector growth help inform policy decisions that affect this vital sector

- Non-traditional data and machine-learning techniques can complement official statistics of the digitalisation of the economy. An artificial neural network that leverages Google Trends data provides a measure of ICT sector growth in real time.
- Real-time indicators of economic growth in the ICT sector can help governments understand how the sector performs today, which will help inform future policy decisions.

In the past decade, the ICT sector grew in most OECD countries, but not equally

- Between 2013 and 2023, all OECD countries had positive ICT sector growth rates on average. However, a substantial gap (10 percentage points) separates the economies with top and bottom ICT sector performance.

ICT growth rates in OECD countries are converging

- In 2011, the average growth rate of the fourth quartile (top 25%) of OECD countries was 13 times higher than the average growth of the first quartile (bottom 25%). In 2023, the average growth of the fourth quartile was only twice as high as the average growth of the first quartile. Disparities in ICT sector growth across OECD countries sectors have thus decreased considerably. This is explained both by an increase in the average growth rates in the first quartile and a decrease in the fourth quartile.

The ICT sector performed strongly in all OECD countries in 2023

- Nowcast estimates show that the ICT sector performed strongly in 2023, with an average growth rate of 7.6%. In many OECD countries, 2023 was a record year for ICT sector growth. Ten countries had growth rates above 9%: Austria, Belgium, Canada, Denmark, Finland, Germany, the Netherlands, Switzerland, the United Kingdom and the United States. In Belgium and the United Kingdom, ICT sector growth exceeded 11%. Increased demand for ICT products and services following COVID-19 may partially explain the strong performance in 2023.

While countries measure some aspects of the digitalisation of the economy, they only focus on household and business uptake of digital technologies and activities. Typically, they survey the use of information and communication technologies (ICTs), such as the OECD model surveys on ICT Access and Usage by Businesses, Households and Individuals (OECD, 2015[1]) (OECD, 2015[2]). They may also include additional questions in established business or household surveys.

The uptake and intensity of digital activities in our daily lives are of great interest. However, these metrics do not produce a monetary estimate of the level of production associated with digital transformation or quantify efficiency gains from changing production processes. This lack of a direct link between the value of production associated with digital activity, or productivity gains from using digital technologies, provides only a partial picture of the impact of digital technologies and data on traditional macroeconomic indicators.

Lack of comparable indicators across countries of the value of the "digital economy" has led to a proliferation of measurement efforts. From the national perspective, focus has centred on creation of digital supply-use tables (DSUTs) and digital economy satellite accounts in the System of National Accounts (SNA) (OECD, 2020[3]) (Mitchell, 2021[4]). Incorporating the digital dimension of the economy in the SNA is the best long-term solution to this measurement problem. However, it will take many years before such statistics can be implemented and populated in a comparable way across countries.

As digital transformation intensifies, the need for sound and timely measurements of the digital parts of the economy increases. This chapter aims to help advance efforts to measure a core component of the "digital economy" – the ICT sector. This work contributes to the evidence base by producing real-time estimates of the economic growth of the ICT sector using machine-learning and big data. These estimates can provide timely input into the design and development of digital policies complementing official statistics produced by national statistical offices. A technical paper details the methodology used to construct the nowcast estimates (Umana Dajud, forthcoming[5]).

An overview of the efforts to measure the digital transformation

Measuring the extent of the digital economy is complex, partly because digital technologies and data are everywhere to a greater or lesser extent. Foremost, as countries have tried to measure the impact of digitalisation in a way that is consistent with national accounts, they have questioned what economic activity should be considered part of the "digital economy".

DSUTs will improve measurement in the medium term

DSUTs provide a flexible framework to measure the digital parts of the economy that does not rely on or promote any single definition or indicator as being representative of the digital economy (Mitchell, 2021[4]). DSUTs (Box 1.1) not only focus on the various products and actors associated with digital transformation, but also identify the nature of the transactions between these actors. This framework also delineates transactions based on whether they are digitally ordered and/or delivered.

Among other notable changes, the DSUT framework improves the measurement of digital transformation by adding seven supplementary columns to traditional supply-use tables (SUTs). These seven columns correspond to different types of digital industries (e.g. digital intermediary platforms explicitly charging a fee, data and advertising driven platforms, e-tailers). A second important feature is the inclusion of an aggregation of ICT goods and services product rows. This aggregation will provide a simple measure of use-intensity of ICT products of different activities (household consumption, investment, and exports) (Mitchell, 2021[4]). Finally, DSUTs will include additional product rows to explicitly include cloud computing and digital intermediary services.

Box 1.1. The SNA and the digital economy

The SNA offers the most robust framework to measure the digital economy. International statistical standards for National Accounts ensure that measurements are comparable across countries. The framework captures changes in production chains brought on by digitalisation as it already includes any value added. Adopting DSUTs would carve out the contribution of the digital economy. In the absence of one indicator representing all economic aspects of digital transformation, DSUTs can provide estimates to suit a wide range of user needs.

Once implemented, DSUTs will considerably improve the measurement of the digital economy in official statistics. However, there are significant challenges. If these challenges are overcome, DSUTs could be implemented by OECD countries in the medium term.

One obstacle to be overcome is the lack of the required data to populate DSUTs. For traditional SUTs, statistical offices rely on administrative data and business surveys. These sources provide enough data to produce traditional SUTs but not DSUTs (Mitchell, 2021[4]). As a result, implementing DSUTs requires either modifying currently existing or developing new surveys.

Despite these challenges, DSUTs provide a promising avenue to improve the measurement of the digital economy in the medium-term. Practical guidance for how to compile DSUTs, including an illustrative list of statistics that some statistical agencies currently compile, can be found in Mitchell (2021[4]).

Data on the uptake of digital technologies provides complementary information

A second approach to capture the digital transformation is measuring the uptake of digital technologies. Consumer and business use of ICT goods and services has rapidly evolved during the past decades. The development of digital technologies has transformed consumer behaviour and led to the creation of new business models.

Accompanying these changes, the measurement of the uptake of digital technologies has improved considerably. Official household and business statistics often include several measures of the adoption of both mature digital tools (e.g. online platforms or electronic payments) and sophisticated digital technologies (e.g. artificial intelligence, big data analytics). Multiple surveys implemented at the national level have helped build the evidence base in this area.

In this context, in 2002 the OECD introduced two model surveys meant to set international standards to produce indicators of digital transformation in a comparable way. The model survey on the adoption and use of ICTs by households and individuals, as well as the survey on ICT usage by businesses, were designed to improve the measurement of the availability and use of ICT technologies by households, individuals, and businesses, while considering emerging policy needs (OECD, 2015[1]).

The OECD model survey on households and individuals focuses on the core dimensions of digital transformation such as "access to the Internet, the frequency and intensity of use, the uptake of e-commerce, [and] individuals' IT skills" (OECD, 2015[1]). Similarly, the survey on the use of ICTs by businesses is intended to support national statistical offices in collecting core statistics to measure the digital transformation (broadband adoption, computer use, selling online etc.).

This survey also includes supplementary modules that allow for a more in-depth understanding of the use of ICT technologies (i.e. data analytics services; radio-frequency identification; software-as-a-service). On the one hand, using a core survey guarantees that countries prioritise a common set of measures. This set of common measures is essential as it ensures that the most important aspects of digital transformation are measured in all OECD countries in a comparable way. On the other hand, the supplementary modules allow measurement of emerging technologies and trends without foregoing the core part of the survey (OECD, 2015[2]).

Other approaches to measuring digitalisation of the economy

The digital intensity of economic sectors can also provide an indication of the digital parts of the economy. Countries produce their own taxonomies (Statistics Canada, 2019[6]) (US Bureau of Economic Analysis, 2018[7]), and the OECD developed a taxonomy across 12 countries (Calvino et al., 2018[8]). The OECD taxonomy includes a technological component (ICT investment, ICT intermediate consumption and robots), the human capital required to embed technology in production (ICT specialists), and the way technologies influence firm behaviour on the output market (online sales).

The taxonomy is used in a variety of indicators on the OECD Going Digital Toolkit[1] (e.g. digital-intensive sectors' contribution to value added growth).[2] Dashboards like the Toolkit are an important element of this measurement ecosystem. Along with its Data Kitchen, the Toolkit provides policy makers and analysts with key indicators for each dimension of the Going Digital Integrated Policy Framework (OECD, 2019[9]). In this way, it allows for a comprehensive view of available measures about a country's digital performance.

There have also been various efforts to measure different aspects of digital transformation, including digital trade (Mourougane, 2021[10]). Statistics Netherlands has, for example, developed an innovative methodology that combines firms' value-added tax declarations and web-scrapping techniques to estimate cross-border digital trade flows of goods (Meertens et al., 2020[11]). Credit card data have also been used to measure digital trade flows of both goods and services (OECD, 2019[12]; Cavallo, Mishra and Spilimbergo, 2022[13]). The OECD has also strived to measure developments in artificial intelligence including patents (Dernis et al., 2021[14]), trademarks (Nakazato and Squicciarini, 2021[15]) and skills (Samek, Squicciarini and Cammeraat, 2021[16]).

Despite these efforts, there is a lack of timely monetary measures of the digitalisation of the economy comparable across countries

The uptake of digital technologies by households and businesses provides important information about the speed and extent of digital transformation. However, these measurements do not provide information on the evolution of the monetary value of the digital economy. In the medium term, development and implementation of DSUTs will provide part of this information. In the meantime, timely and comparable data across countries are lacking on this front.

As digital transformation progresses, the digital economy moves beyond ICTs to touch all sectors. At the same time, the ICT sector remains at the core of digital transformation, essential to supporting further digital innovation and the economy as a whole. Previous OECD research shows that an increase of multi-factor productivity in the ICT sector can affect overall economic growth (Nicoletti and Scarpetta, 2003[17]).

The contribution of the value added directly generated by the ICT sector in OECD countries increased during the past decade. For countries covered by the OECD Structural Analysis Database (STAN),[3] the ICT sector represented on average 3.9% of total value added in 2010. By 2019, this figure had increased by almost 40%, reaching on average 5.4% of total value added.

Computers, software, and online services, which all form the backbone of digital transformation are changing rapidly. However, the publication lags inherent in official statistics are considerably longer for sectoral growth rates than for consolidated, economy-wide growth rates. Real-time indicators of the economic growth of the ICT sector can help governments understand the sector's current performance, which will help inform future policy decisions.

Methodology for measuring the growth of the ICT sector in real time

Recent advances in statistical techniques have improved the performance of forecasts that use non-traditional data sources. This chapter uses these techniques to measure the economic growth of the ICT sector in OECD countries in real time (i.e. nowcasting), rather than as a forecast. Google Trends data provides valuable information on economic performance.[4,5] The OECD used Google Trends data to nowcast trade in services during the COVID-19 period (Jaax, Gonzales and Mourougane, 2021[18]), as well as to develop weekly estimates of gross domestic product growth rates (Woloszko, 2020[19]). The OECD AI Policy Observatory also regularly leverages non-traditional data to measure the use and diffusion of artificial intelligence technologies in real time.[6]

A nowcasting approach that is parsimonious with data

The model used for this chapter builds on the innovative methodology used to estimate real-time growth rates for the whole economy as developed in OECD (2020[19]). The modified methodology is used to nowcast ICT sector growth rates in OECD countries. For this purpose, the nowcasting procedure follows the OECD (2002[20]) definition of the ICT sector as “a combination of manufacturing and services industries that capture, transmit and display data and information electronically”. Following this definition at the two-digit level of the ISIC Rev.4 industry classification (Horvát and Webb, 2020[21]), the ICT sector encompasses three subdivisions: Computer, electronic and optical products (D26), Telecommunications (D61), and IT and other information services (D62-63/D62T63). Values in this paper may sometimes differ from those of national statistical offices, as some countries use other definitions of the ICT sector in their national accounts.

STAN[7] provides data on the value added of the ICT sector for most OECD countries. For a few of them, these data are not available (Australia, Chile, Colombia, Costa Rica, Ireland, Israel, Japan, Korea, Luxembourg, New Zealand and Türkiye). Once STAN also makes data available for these countries, they can be easily included in the nowcasting model.

The nowcasting model uses only two different inputs: ICT sector growth rates in OECD countries and Google Trends data. ICT sector growth rates are computed using data from STAN. More specifically, annual estimates of ICT value-added in volumes[8] from this database are used to compute annual ICT growth rates for 27 OECD countries, from 2010 to 2018 or 2019 depending on the country.

Google Trends provides two different types of data on Internet searches: keywords and predefined categories. Keywords are available for any word that was sufficiently searched on line. Predefined categories regroup different keyword searches into meaningful clusters. These categories have the advantage of being directly comparable across countries, whereas this is not always the case for keywords. Also, some categories are directly related to the ICT sector. Table 1.1 shows nine Google Trends categories directly related to the different components of the ICT sector, although many more are available.

Table 1.1. An indicative matching of Google Trends categories related to the ICT sector

ISIC Rev.4 code	ISIC Rev. 4 division	Google Trends category	Google Trends category ID
D26	Computer, electronic and optical products	Computer Servers	728
		Consumer Electronics	78
		Binoculars, Telescopes, Optical Devices	1384
D61	Telecommunications	Telecom	13
		Mobile Phones	390
		Communications Equipment	385
D62-63/D62T63	IT and other information services	Network Storage	729
		Internet Software	807
		Web Services	302

Note: This table includes a non-exhaustive list of available Google Trends categories related to the ICT sector.

Sources: OECD STAN Database, *http://oe.cd/stan*; Google Trends (accessed on 19 February 2024).

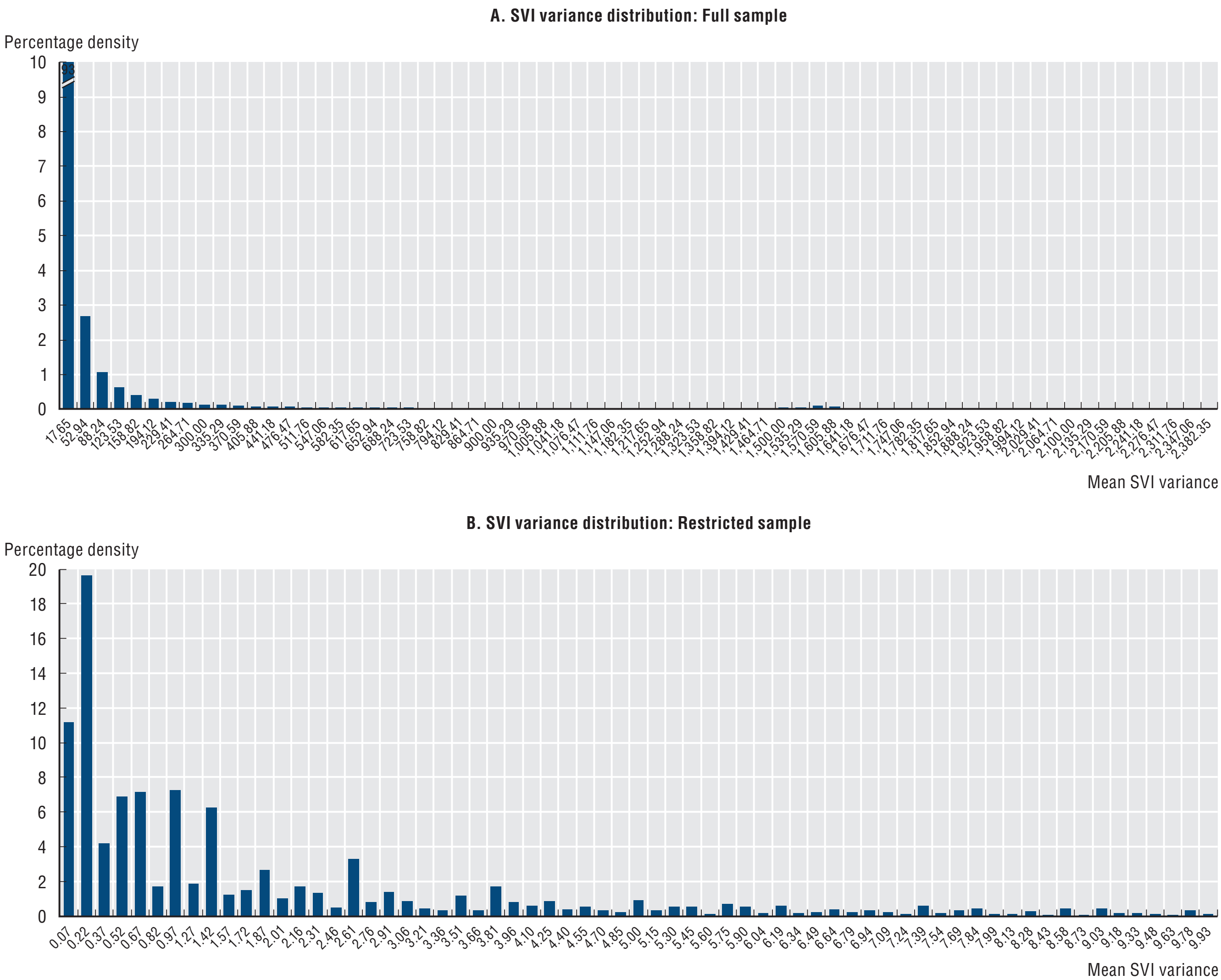
Google Trends provides a time series index of the volume of queries that users enter in Google at a geographic location and at a given time: the Search Volume Index (SVI). The SVI does not represent the actual search volume number; it is an index ranging from 0 to 100 based on the normalised query search volumes in each month and location. The nowcasting estimates in this chapter rely on a monthly panel of SVI queries for 1 131 categories.[9] These cover all OECD countries, from January 2004 to December 2023 (inclusive).

Extracting useful information from Google Trends data

Google Trends data have proven to be valuable in diverse areas (e.g. economics, epidemiology or finance). The data have nonetheless important limitations. First, to preserve the confidentiality of searches, Google provides an SVI based on a random sample of all searches in each category. This is not a problem for popular categories since the sample is large enough to be representative of all searches in those categories. However, for less popular categories, the obtained sample is smaller and therefore might not be representative of the population of searches. Hence, SVIs from categories with few observations in their universe of searches may exhibit a large sampling variance across different draws (Combes and Bortoli, 2016[22]).

One way to identify and fix the sampling noise is to draw multiple samples from Google Trends at different points in time. A threshold is set above which the variance across draws is considered too high. In this chapter, five different Google Trends samples were drawn for every category in every country and the corresponding variance was computed. A threshold of ten[10] was set for the maximum tolerated variance, following an analysis of observed variance in the dataset. Therefore, all the country-category combinations with a variance larger than ten across the five Google Trends samples are dropped.[11] Figure 1.1 shows the distribution of the sampling noise (i.e. SVI variance) before (panel A) and after (panel B), dropping the categories with a variance above ten. As shown in the figure, this threshold eliminates most of the highly volatile categories that could otherwise reduce accuracy of the nowcasting model.[12]

Figure 1.1. Sampling noise distribution before and after correction



Notes: SVI = Search Volume Index. This figure shows the cumulative distribution of the variance across five Google Trends draws (i.e. the "sample noise"). The upper table displays the results for the full sample, while the lower one presents observations whose variance across the five draws is inferior or equal to ten.

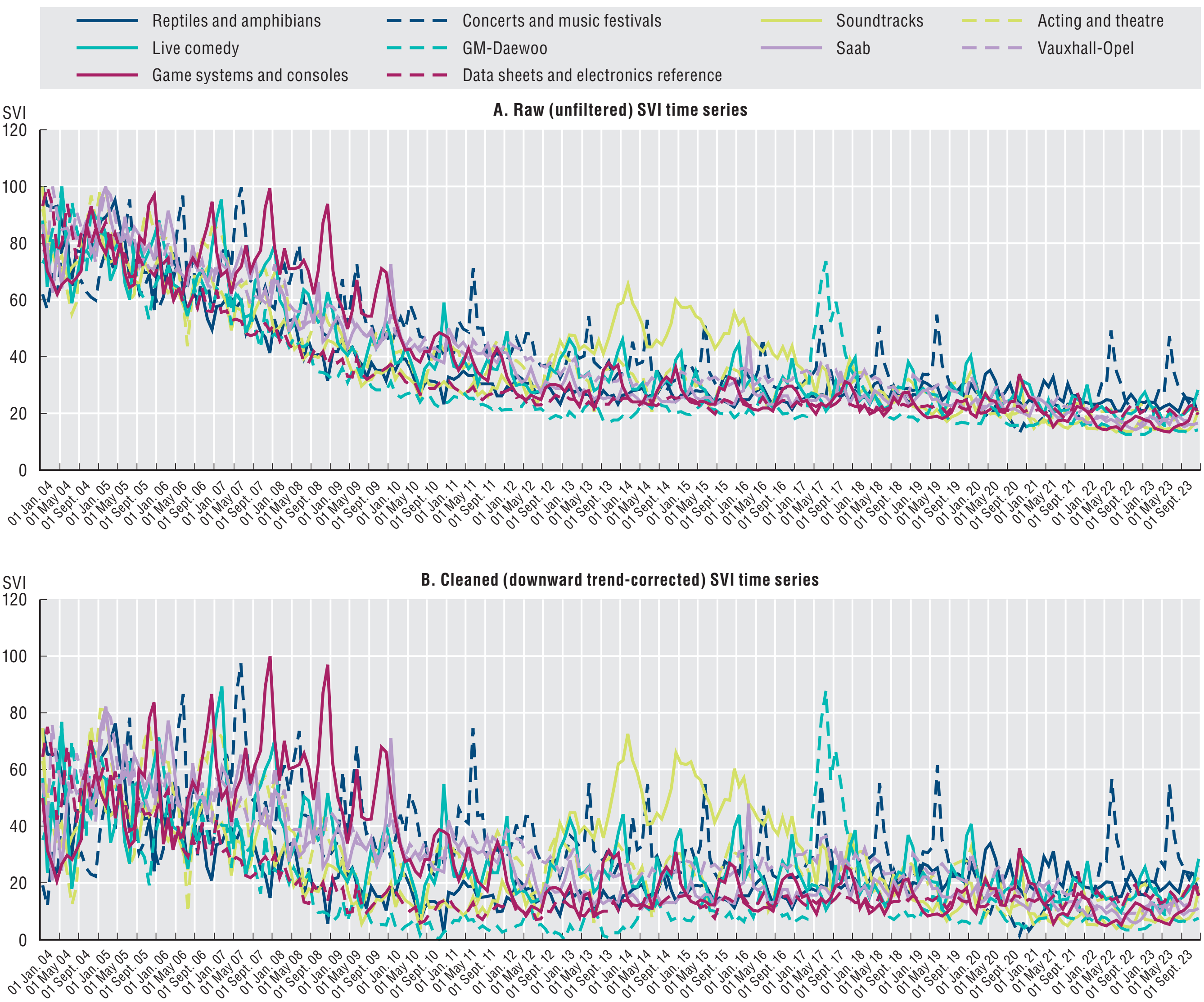
Source: Authors' calculations based on Google Trends data (accessed on 19 February 2024).

StatLink https://stat.link/zuhp79

A second issue with Google Trends is a downward trend for almost all SVIs. An increasing number of Google users since 2004 explains this trend as this number is the denominator for the formula to compute SVIs. This downward bias seems, however, to fade starting in 2010, as the number of Google users increased less rapidly over those years. Panel A of Figure 1.2 plots the SVIs for ten Google Trends categories, chosen randomly in the Netherlands, between 2004 and 2023. The non-linear downward trend, which does not imply these categories became less popular, is clearly visible.

To filter out the downward trend from SVIs, non-parametric locally weighted scatterplot smoothing (LOWESS) is applied to the data. The LOWESS smoother runs a locally weighted regression. The procedure is normally used to filter out the seasonality in Google Trends data (Choi and Varian, 2012[23]). In this chapter, the LOWESS smoother is applied to correct the downward trend of SVIs (Figure 1.2, panel B).

Figure 1.2. Raw and cleaned SVI time series for ten Google Trends categories in the Netherlands, 2004-23



Notes: SVI = Search Volume Index. This figure shows the non-linear bias inherent in all Google Trends series by showing the evolution of the SVIs for ten Google Trends categories (panel A). This downward bias was corrected using a LOWESS smoother on the mean SVI series rescaled from 0 to 100 (panel B).

Source: Authors' calculations using Google Trends data (accessed on 19 February 2024).

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A neural network to measure ICT sector growth in real time

The nowcasting procedure used in this chapter relies on a machine-learning algorithm to fit the relationship between Google Trends data and the ICT sector growth in each country. Given the large quantity of data made available by Google searches, the complex relations between the many features of the data can be modelled using machine-learning. Machine-learning is better suited to detect and model non-linearities than traditional statistical and econometric techniques (Woloszko, 2020[19]).

The model used to nowcast the growth of the ICT sector in OECD countries in this chapter is an artificial neural network.[13] This type of network is based on a simplified probabilistic modelling of organic neurons. More precisely, the machine learning model is a multilayer perceptron. In this type of model, the connection between layers is established only in one direction avoiding any loops in the network.

The model used to compute the nowcasts has two hidden layers of 2 400 and 800 neurons. To train the model, the stochastic gradient-based optimiser developed by Kingma and Ba (2015[24]) is used. The nowcasting procedure in this chapter uses this method due to its computational efficiency. A rectified linear unit function (ReLU) is used to establish connections between the nodes of the model. The function is activated, and thus the connections established, only when a threshold value is exceeded. One of the main advantages of the stochastic gradient-based optimiser is its computational efficiency.

An agnostic modelling approach

The choice of applying machine-learning techniques instead of more traditional statistical and econometrics methods was guided by the ability of neural networks to capture complex, often non-linear, relationships between variables. This principle guides every modelling decision in this chapter. Three of these choices, noted below, are central to the performance of the model.

The first choice is what variables to include in the nowcasting model. Google Trends has 1 131 predefined categories that are comparable across countries. Instead of choosing variables for the model based on intuition, and ultimately arbitrarily, all Google Trends categories are included. The optimisation of the neural network then determines which variables and connections are relevant for measuring the growth of the ICT sector in real time. This modelling decision comes at the cost of not being able to interpret the relation between specific categories and ICT sector growth rates. However, the main goal of the nowcasting model is to measure ICT sector growth in real time as accurately as possible and not to understand how Google searches affect its growth.

The second modelling choice regards network hyperparameters. Hyperparameters are those values set before the model starts learning,[14] while parameters are the estimates learnt by the model. Here again, the methodology is not to be guided by intuition. For this reason, the hyperparameters search was automatised using a grid search function. Root mean squared error (RMSE) was used as the decision parameter for the grid search in the procedure. The number of layers, the learning rate, and the activation function were all chosen through the automatised hyperparameter search.

The third choice concerns the computation of standard errors. Following this agnostic principle, standard errors are computed using a bootstrapping procedure that does not rely on specific assumptions about data distribution. For this purpose, 2 000 random samples with replacement are drawn from the data. The model is then retrained using each new sample. Next, standard errors are ordered to keep 90% confidence intervals.

Evaluating nowcasting performance

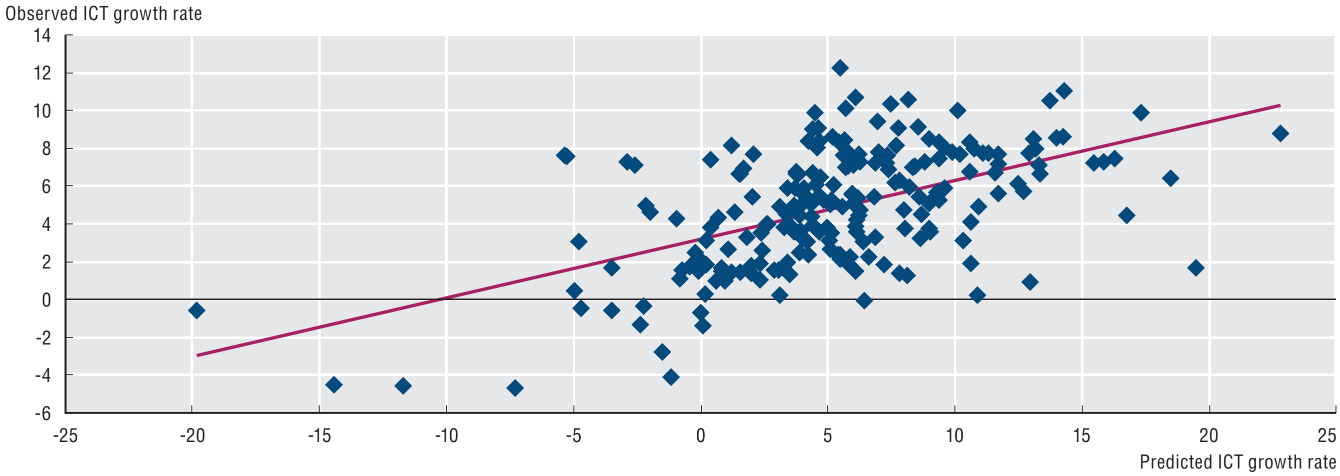
To train and evaluate the artificial neural network, ICT sector growth rates are split into two different samples – training and validation. The training sample comprises data from 2011 to 2018. Data for the last available year in STAN (2019) are chosen for the validation sample.

The performance of the artificial neural network is evaluated using the RMSE of both the training and validation samples. The RMSE can be thought as a measure of the distance separating the values predicted by the neural network and the observed values from the data. For the training sample, the RMSE is 2.9 and for the validation sample it is 2.7. These values can be compared to the very high standard deviation of observed ICT sector growth rates (5.4%).[15]

Figure 1.3 plots ICT sector growth rates predicted by the model against observed growth rates. The figure shows a clear correlation between observed and predicted growth rates of 54% that is statistically significant at the 1% level. This strong positive correlation is in line with obtained RMSE values.

Figure 1.3. The nowcasting model performs strongly

Correlation between the observed and predicted ICT sector growth rates, 2011-19



Notes: ICT = Information and communication technology. The correlation coefficient is 0.54, significant at a 1% level.

Source: Authors' calculations using OECD STAN Database and Google Trends data (accessed on 19 February 2024). StatLink contains more data.

StatLink *https://stat.link/y27lp3*

In comparison, a standard autoregressive model AR (1) using only historical current account data to predict ICT sector growth in the next period yields an RMSE of 4.82. Thus, the predictions using Google Trends are twice as precise as those using a single lag autoregressive model.

The good performance of the neural network could be based on a common seasonality between Google Trends data and growth rates of the ICT sector. For example, Google Trends could hypothetically be capturing the procyclical economic performance of the ICT sector. The neural network used in this chapter captures, however, a number of more complex non-linear interactions rather than a cyclical component between Google Trends data and the ICT sector growth. Effectively, the correlation between Google Trends data and the ICT sector growth rates is negligible (-2.8%). A common cyclical behaviour of Google searches and growth rates in the ICT sector therefore does not explain the predictions of the neural network.

The growth outlook for the ICT sector across countries

The nowcasting model yields measures of economic performance for all the years for which there are no observed data. For most countries this is 2020 to 2023. In a reduced number of cases, the OECD STAN Database only has data up to 2018. In those cases, the nowcasting model measures the growth of the ICT sector from 2019 to 2023.

More precisely, the nowcasting model yields point estimates of the ICT sector growth rates. This chapter uses these estimates to analyse the economic performance of this sector across OECD countries. Along with point estimates, it presents 90% confidence intervals. These confidence intervals should be considered whenever point estimates are presented.

Timely estimates of ICT sector growth

The data obtained from the model are particularly useful in two respects. First, they allow extending the analysis of the whole period by incorporating the most recent performance. The last available year in STAN is 2018 or 2019 depending on the country. Without nowcasted data, the analysis of the last three or four years would not be possible. Second, nowcasted figures depict the current performance of the ICT sector in OECD countries and allow policy makers to draw timely conclusions about the efficacy of ICT-related policies.

Figure 1.4 presents both observed and nowcasted ICT growth rates for all OECD countries for which all required data are available.[16] The results show that COVID-19 marked an end to an era of sustained increases in growth rates that started shortly after the global financial crisis. However, while growth rates decrease, the growth of the sector nevertheless remains strong: in 2020, the average growth rate of the ICT sector in OECD countries was 6.6%. By 2021, in most OECD countries, the impact of the COVID-19 crisis is not visible anymore with growth rates achieving their historical maxima in 2023. However, these results must be nuanced when looking at point estimates within respective confidence intervals.[17] Still, even considering confidence intervals, the nowcasting results show that the COVID-19 crisis had only a moderate impact on the ICT sector.

Figure 1.4. The ICT sector is resilient in the face of economic headwinds

Observed and predicted ICT sector growth rates, 2011-23

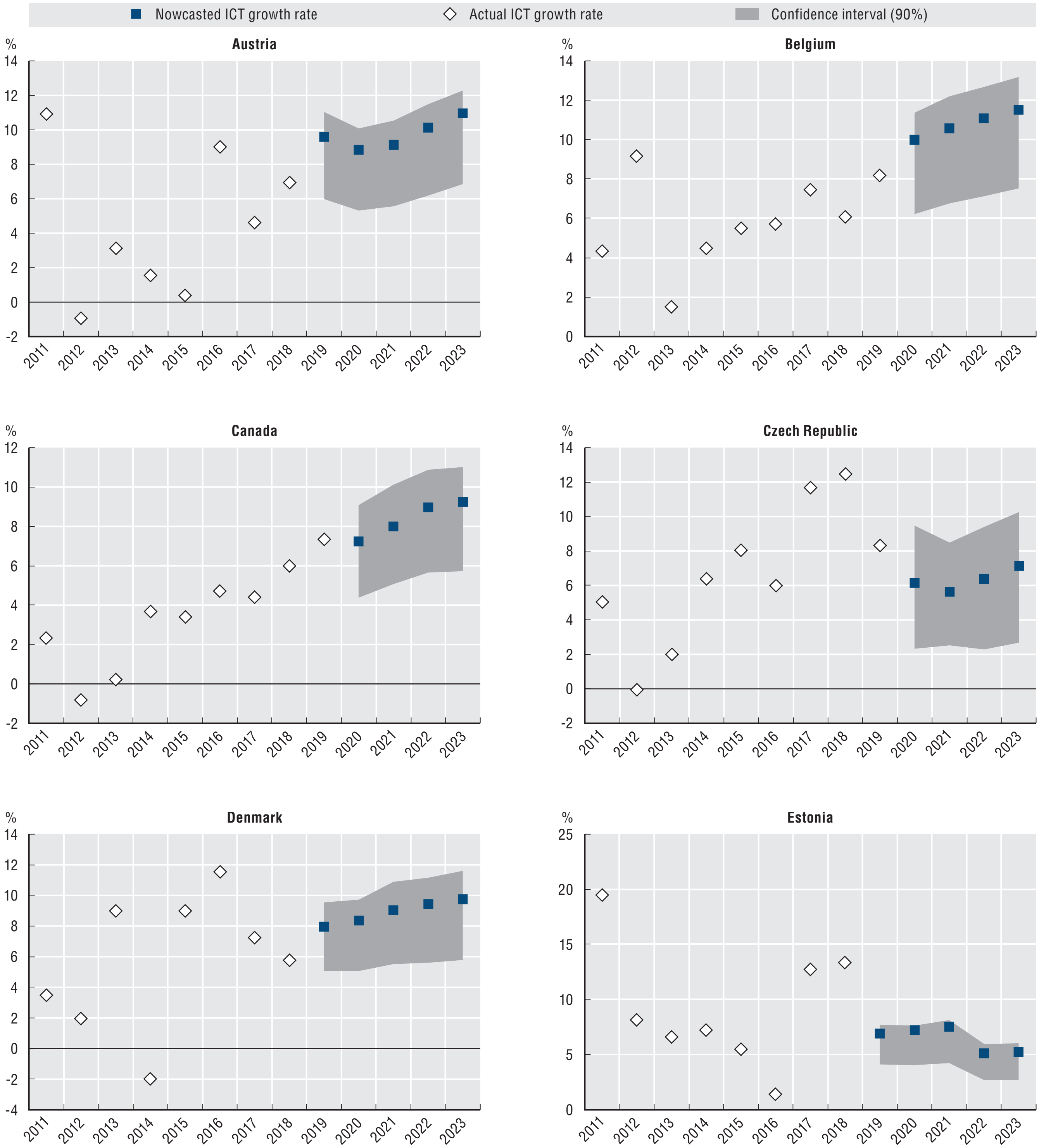


Figure 1.4. The ICT sector is resilient in the face of economic headwinds *(cont.)*

Observed and predicted ICT sector growth rates, 2011-23

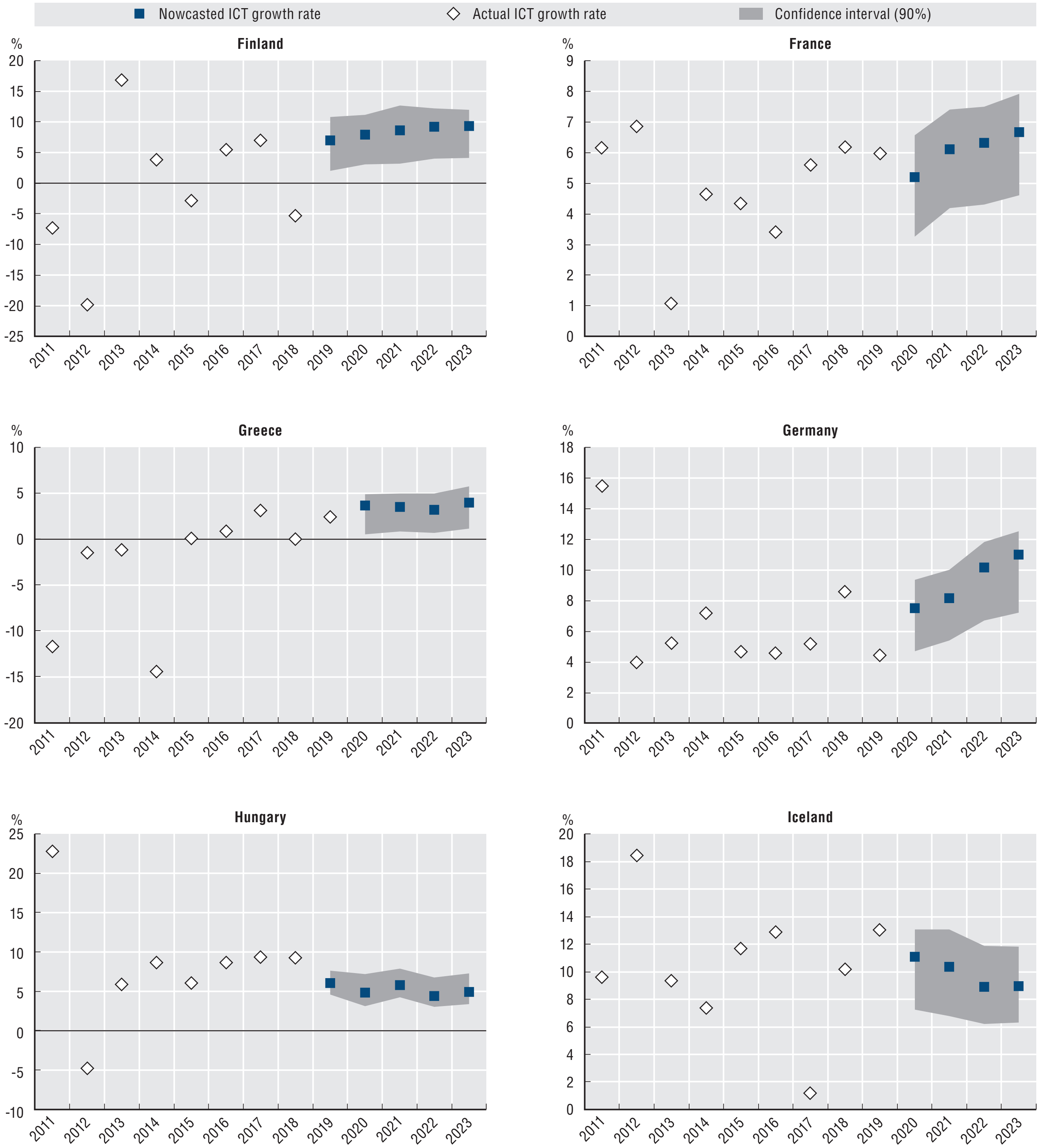


Figure 1.4. The ICT sector is resilient in the face of economic headwinds *(cont.)*

Observed and predicted ICT sector growth rates, 2011-23

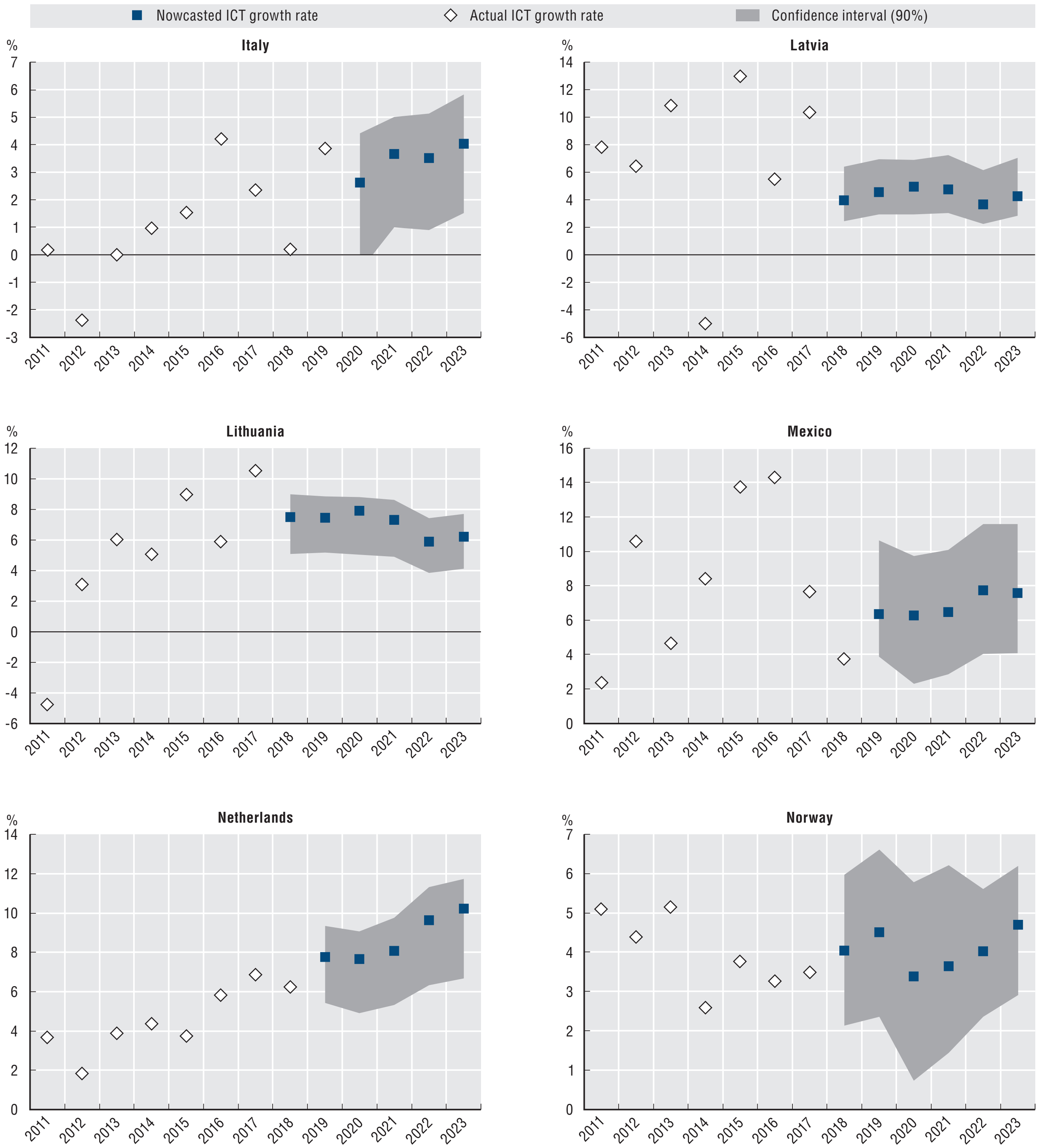


Figure 1.4. The ICT sector is resilient in the face of economic headwinds *(cont.)*

Observed and predicted ICT sector growth rates, 2011-23

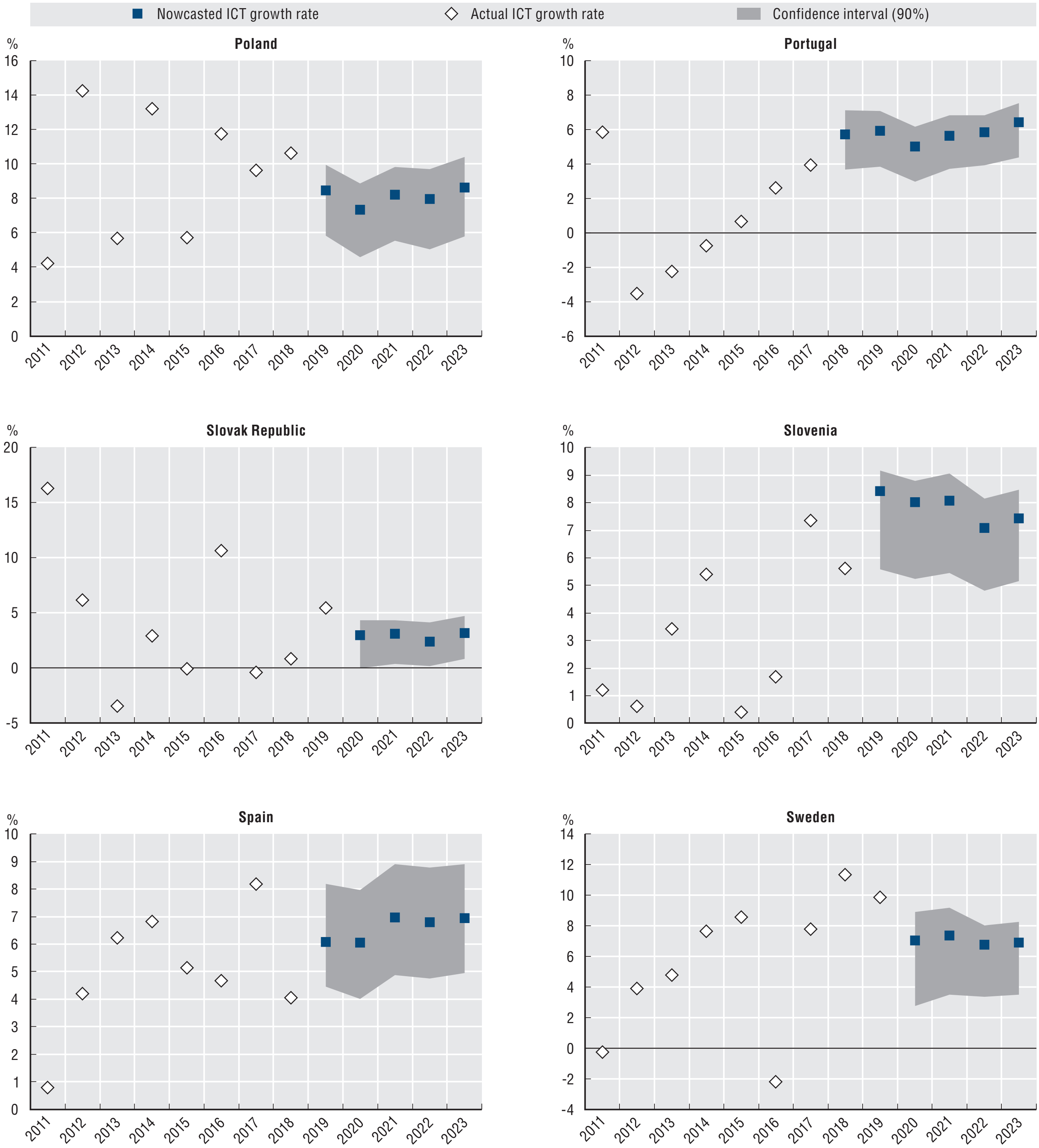
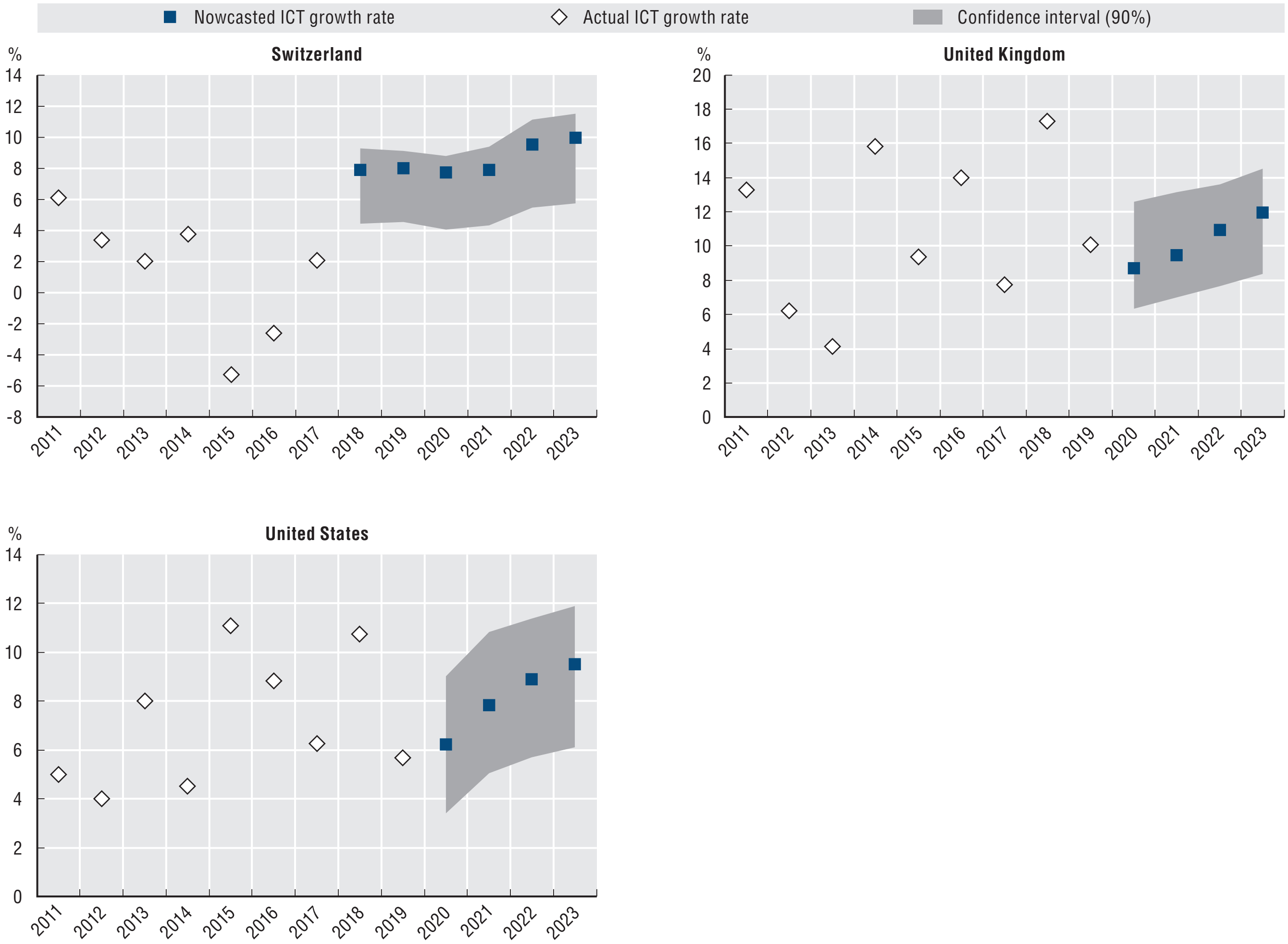


Figure 1.4. The ICT sector is resilient in the face of economic headwinds *(cont.)*

Observed and predicted ICT sector growth rates, 2011-23



Notes: ICT = Information and communication technology. This figure presents observed and nowcast estimates of ICT growth rates in 27 OECD countries from 2011 to 2023 within their 90% confidence interval bands. Depending on the country, nowcast estimates start in 2018 or later. Historical OECD STAN growth rates "Actual ICT growth rate" are represented by white diamonds while nowcast estimates are represented by blue squares.

Source: Authors' calculations using OECD STAN Database and Google Trends data (accessed on 19 February 2024).

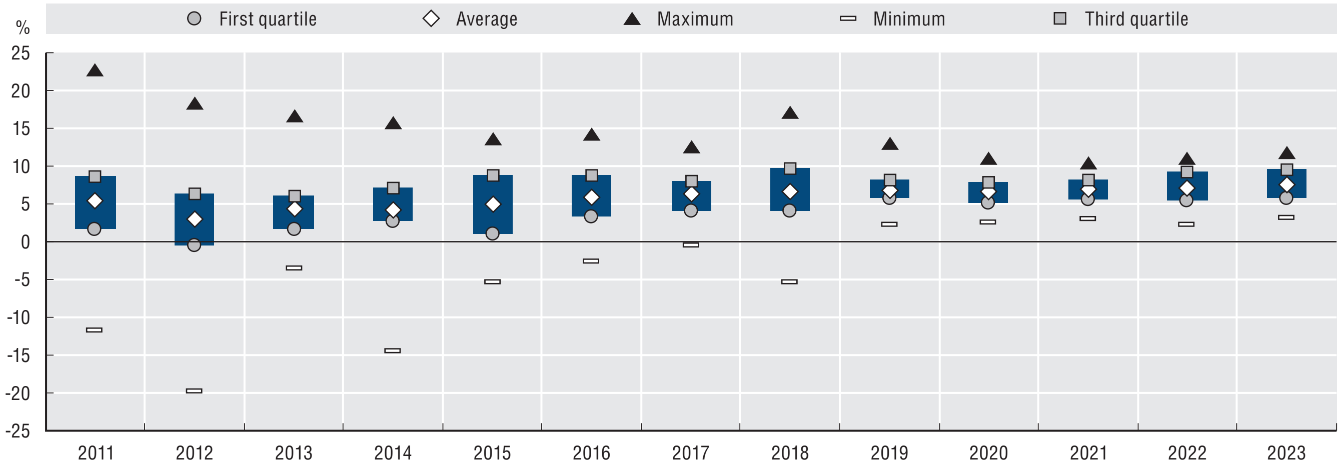
StatLink *https://stat.link/he0zdc*

Average growth rates confirm country-level patterns. Figure 1.5 shows average growth rates of the ICT sector for OECD countries between 2011 and 2023. Average growth rates as of 2011 are computed using observed data provided in STAN. Similarly, average growth rates are computed based on nowcasted growth rates as of 2018 (or later) depending on the country.

Figure 1.5 confirms the remarkable dynamism of the ICT sector.[18] While average growth declined during the global financial crisis, it remained positive throughout the period. After the global financial crisis, the average growth rate increases consistently every year. The sole exception is the emergence of the COVID-19 crisis, where average growth decreased slightly. The ICT sector then continued to grow, reaching its best average growth over the entire period covered in 2023.

Figure 1.5. The ICT sector shows remarkable dynamism

ICT growth rate distribution (observed and predicted), 2011-23



Source: Authors' calculations using OECD STAN Database and Google Trends data (accessed on 19 February 2024). StatLink contains more data.

StatLink https://stat.link/rcbu6h

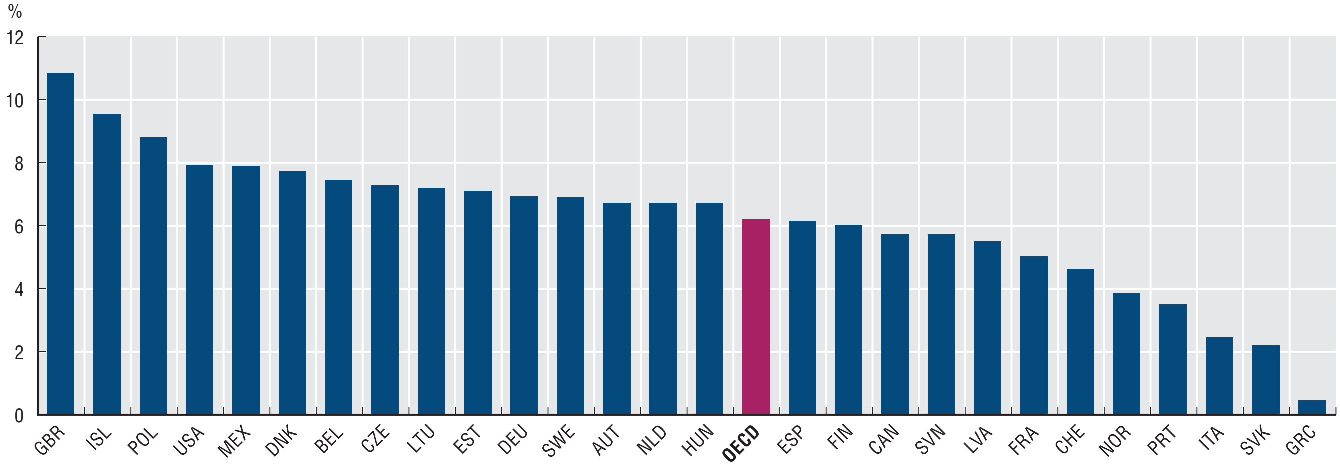
In the past decade, the ICT sector grew in most OECD countries, but not equally

The dynamism of the ICT sector also translated into positive growth rates at the country level. The average growth rate during the period spanning from 2013 to 2023 is positive in every country (Figure 1.6). However, despite the overall positive performance of the ICT sector, a substantial gap separates the top performing economies from those with the lowest ICT sector growth rates. This gap is of more than 10 percentage points between the highest and lowest growth rates.

STAN data, nowcast estimates calculated in this chapter, and nowcast estimates of the total economy from the OECD Weekly Tracker (OECD, 2023[26]) indicate substantial growth in the ICT sector. In the past decade (January 2013 – April 2023), the ICT sector grew nearly three times faster than the entire economy in OECD countries. Over the past decade, the ICT sector had an average growth exceeding 8% in three countries: Iceland, Poland and the United Kingdom. The two countries with the highest ICT sector growth – Iceland and the United Kingdom – had average growth rates during the analysed period above 9%. In turn, Greece, Italy and the Slovak Republic experienced the lowest ICT sector growth, with average growth rates below 3%.

Figure 1.6. ICT growth rates vary markedly across countries

Average ICT sector growth rates (observed and predicted), 2013-23



Note: This figure presents the mean observed and predicted ICT growth rates by country.

Source: Authors' calculations using OECD STAN Database and Google Trends data (accessed on 19 February 2024). StatLink contains more data.

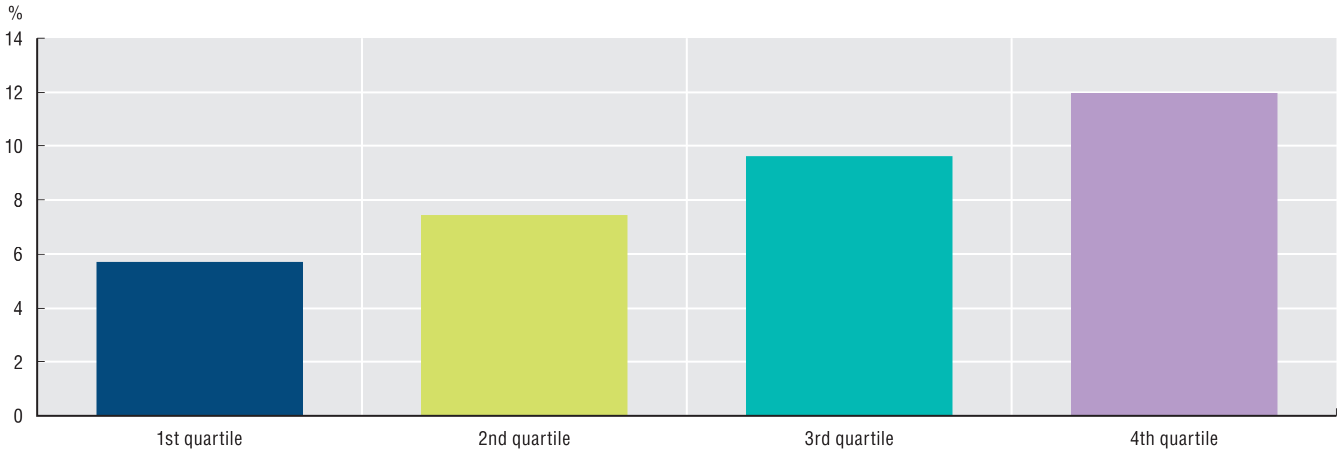
StatLink https://stat.link/q3rcbp

ICT sector growth rates in OECD countries are nevertheless converging

In 2023, countries with the highest ICT sector growth rates (top 25%, or fourth quartile), had an average ICT sector growth rate of 11.9%. That same year, countries with the lowest ICT sector growth rates (bottom 25%, or first quartile), had average ICT sector growth rate of 5.7% (Figure 1.7).

Figure 1.7. Six percentage points separate the top and bottom ICT sector performers

Predicted ICT sector growth rates by quartile, 2023



Note: This figure presents the distribution of predicted ICT growth rates in 2023 by quartile.

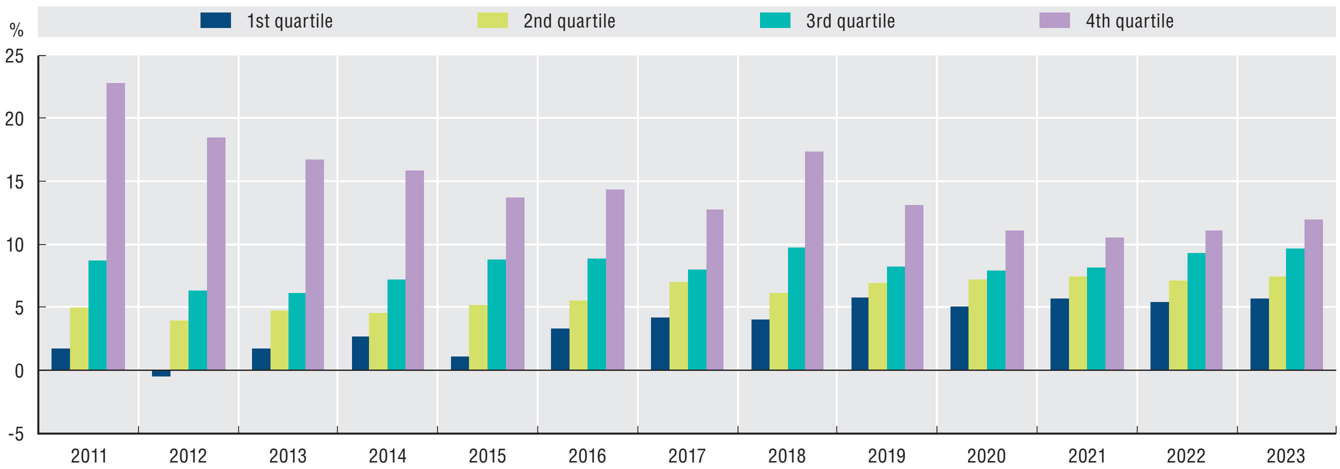
Source: Authors' calculations using OECD STAN Database and Google Trends data (accessed on 19 February 2024). StatLink contains more data.

StatLink https://stat.link/9d7u1a

Figure 1.8 shows that the large difference between countries in the first and fourth quartiles has nonetheless decreased over time. In 2011, the average growth in the fourth quartile was thirteen times higher than in the first quartile. By 2016, average growth in the fourth quartile was only four times higher than in the first quartile. In 2023, average growth in the fourth quartile was only twice as high as in the first quartile. The disparity in ICT sector growth rates across OECD countries has thus continued to narrow.

Figure 1.8. ICT sector growth rates are converging across countries

Average ICT sector growth rates (observed and predicted) by quartile, 2011-23



Notes: This figure presents the distribution of observed and predicted ICT growth rates from 2011 to 2023 by quartile. Values from 2011 to 2018 (earliest) originate from the STAN Database depending on the country, while those from 2019 (or 2020) to 2023 are nowcast estimates.

Source: Authors' calculations using OECD STAN Database and Google Trends data (accessed on 19 February 2024). StatLink contains more data.

StatLink https://stat.link/tdpoly

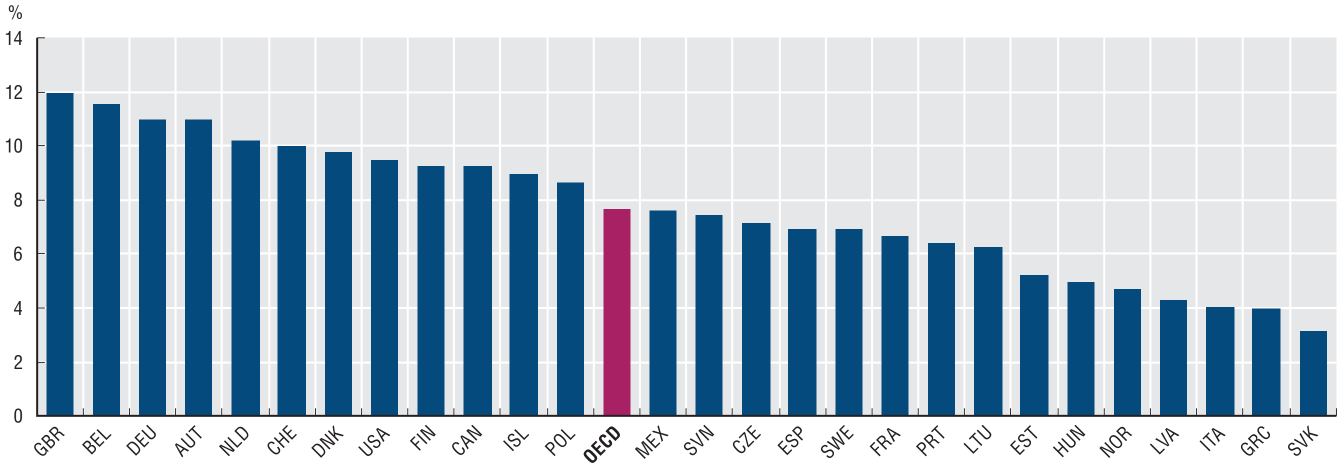
The ICT sector performed strongly in all OECD countries in 2023

Nowcasted figures allow for an up-to-date analysis of the economic growth of the ICT sector in OECD countries. The first key insight from the nowcast predictions is that the ICT sector is performing strongly. While average the growth between 2011 and 2022 was 5.7%, it reached 7.6% in 2023.

In many OECD countries, 2023 marked a significant milestone for the growth of the ICT sector. Ten countries had growth rates above 9%: Austria, Belgium, Canada, Denmark, Finland, Germany, the Netherlands, Switzerland, the United Kingdom and the United States. In Belgium and the United Kingdom, ICT sector growth exceeded 11%. Even countries with the lowest ICT sector growth rates, like Greece and the Slovak Republic, had growth above 3%.

Figure 1.9. ICT sector growth is strong across countries

Predicted ICT sector growth rates, 2023



Source: Authors' calculations using OECD STAN Database and Google Trends data (accessed on 19 February 2024).

StatLink https://stat.link/r82jpz

Measuring the ICT sector is key to evaluating its performance and designing sound policies

The need for evidence-based policies increases as digital transformation intensifies and its societal and economic impact widens. It is crucial to improve the timely measurement of the digitalisation of the economy to design public policies that support an innovative and inclusive digital economy and society, and to evaluate their efficacy. Available statistics on the uptake of digital technologies by businesses and households provide important insights. However, they cannot measure the evolution of the monetary value of the digital economy. DSUTs will provide robust information on this front in the medium term. In the meantime, there is a lack of timely data comparable across countries on the economic evolution of the digital economy.

The "digital economy" touches all sectors. However, the ICT sector remains at the core of digital transformation, and is essential to supporting further digital innovation. When designing digital policy frameworks, governments often focus on rules, regulation, policies, and strategies related to the ICT sector. This can include the computer, electronic, telecommunication, and information technology industries, among others. Timely data on ICT sector performance are essential to evaluate the efficacy of these frameworks. For this reason, the ICT sector estimates complement official statistics in this chapter. By developing a nowcasting model that leverages Google Trends data and machine-learning techniques, it provides governments and policy makers with timely and comparable data on the economic growth of the ICT sector in OECD countries.

The nowcasting model could also be used to measure growth rates of other important sectors beyond the "core" of ICT in real time. For example, real-time estimated growth rates of all digital-intensive sectors would provide a more complete picture of the growth of digital components of the economy. Further, nowcast estimates of growth rates of all sectors would enable policy makers to see in real time how highly digital sectors perform compared to those relatively less digitalised.

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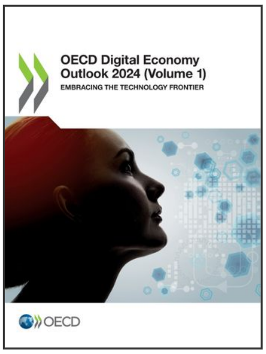
Notes

1. *https://goingdigital.oecd.org*.
2. *https://goingdigital.oecd.org/indicator/08*.
3. More information on STAN is available at: *http://oe.cd/stan*.
4. Recent work suggests that Google Trends data are less useful to measure aggregate gross domestic product (GDP) growth when official data are available (Ferrara, 2022[25]). For aggregate GDP, this lag varies in most countries between one to three months. However, at the sectoral level, this lag is considerably longer, routinely exceeding 12 months. As a result, non-traditional data sources remain a relevant source for information on economic growth at the sectoral level (as opposed to the aggregate level).
5. An alternative model using aggregate GDP growth rates as an input was also tested. However, the model using Google Trends data outperformed it. The results can be found in the accompanying technical paper (Umana Dajud, forthcoming[5]).
6. *https://oecd.ai*.
7. More information on STAN can be found at: *http://oe.cd/stan*.
8. Gross value-added volumes (VALK) from the STAN Database are computed using price deflators. They are presented in terms of the current price value in reference year 2015. More information about how the VALK series is calculated can be found in the STAN Database documentation: *http://oe.cd/stan*.
9. The list of all categories can be found at: *https://serpapi.com/google-trends-categories* (accessed on 19 February 2024).
10. Setting this threshold for the analysis helps reduce excessive variance in the dataset.
11. Dropping observations with a variance larger than ten reduces the sample size from 7 328 880 to 6 186 710 observations (i.e. 1 142 170 observations deleted). Nevertheless, each of the 1 131 categories is still present in the restricted sample.
12. Despite the higher variance of country-categories that were dropped, they exhibit similar statistical properties to the full sample. The mean and standard deviation of the full sample are 35.97 and 25.60, respectively. For the dropped observations, these same figures are 35.52 and 24.78. For the observations used in the nowcasting exercise, the mean is 36.06 and the standard deviation is 24.78.
13. The model is trained using the Scikit-learn 1.2.1 package in Python.
14. Google's definition of hyperparameters can be found at: *https://developers.google.com/machine-learning/guides/text-classification/step-5*. The learning rate and the number of hidden layers are examples of these hyperparameters.
15. The precision of the RSME diminishes the farther one moves from the last observed value used to train the model.

16. STAN does not include VALK for the ICT sector for Australia, Chile, Colombia, Costa Rica, Ireland, Israel, Japan, Korea, Luxembourg, New Zealand and Türkiye.
17. Sectoral growth rates display a considerably larger variance than total GDP growth rates. This feature of sectoral data largely explains the magnitude of the nowcasting model confidence intervals (90%) compared to those using a similar methodology for total GDP growth rates (95%) (Woloszko, 2020[19]).
18. See for example *https://ec.europa.eu/eurostat/statistics-explained/index.php?title=ICT_sector_-_value_added,_employment_and_R%26D* and *www.cbs.nl/en-gb/news/2020/42/ict-sector-growing-faster-than-the-economy*.



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