11. Innovation, research and creativity[1]

Investments in scientific research and technological innovation, the human capital available and actually employed in knowledge economy, and the diffusion of ICT technologies are key drivers of well-being and economic growth.
The pandemic crisis has clearly highlighted the relevance of research, innovation, and the dissemination of digital technology; the new reforms envisaged by the National Recovery and Resilience Plan (NRRP) will focus on these aspects in the coming years, aiming, among other objectives, to foster the recovery of investments and, in particular, of the intangible ones (research and development, software, etc.), bridging the gap between Northern and Southern Italy in terms of capacity to produce and apply new knowledge. Digital transition is also one of the NRRP's three strategic axes, with measures aimed at the digitalisation of the public administration, the judicial system, and the health system; the modernisation of businesses; and enhancement of citizens and workers' ICT skills[2].
The indicators in the domain account for the slow progress made by Italy over the years, and for its lagging behind the main European countries and the EU average, attesting to the strong territorial disparities and the weakness of the South and Islands, all aspects that structurally characterise the Italian system of research, innovation and digitalisation.
The impact of the COVID-19 crisis on the processes of intangible capital accumulation has been strong, with the immediate collapse of firms' investments in research and development.
In the labour market crisis triggered by the pandemic, higher-skilled employment had a protective effect, and the weight of knowledge workers in total employment, traditionally lower than the European average, did not decline. In contrast, cultural employment was hit hard already in 2020 and showed no signs of recovery in 2021. The Country's low capacity to retain qualified human resources was confirmed, even in 2020, by the migration of young graduates, which continued despite uncertainty and travel restrictions.
The pandemic has accelerated the spread of ICT. In 2020 and 2021, the regular use of the Internet increased, even among older people; the number of enterprises selling via the web to end customers also increased; the availability to municipalities of those digital technologies that are necessary for the development of online services increased considerably. However, the digital divide remains large.

There is confidence in science, but the territorial picture is complex

The global challenge of the pandemic has brought to the attention of citizens that scientific research is a strategic tool for finding answers to needs and problems that could not otherwise be solved.
The trust of Italian citizens aged 14 and over in scientists, monitored for the first time in the

1 This chapter was edited by Stefania Taralli, with contributions from: Francesca Licari, Valeria Mastrostefano, Alessandra Nurra and Laura Zannella. The focus on "The technological evolution of Municipal administrations between 2017 and 2020" is by Elisa Berntsen and Alessandra Nurra.

2 About 25% of the resources allocated by the NRRP are earmarked for the digital transition. About one-third of the resources allocated to Mission 1 of the NRRP are earmarked for research and development activities. See: https://italiadomani.gov.it/it/home.html

2021 edition of ISTAT's survey on Aspects of daily life, is quite high: the average score, on a scale from 0 to 10, is 7.3, similar to the score assigned to physicians and health personnel, and in line with the levels of trust in the police and the fire brigade. More than half of the respondents (52.9%) assign a score of 8 or higher.
As observed for other trust indicators, high scores prevail among young and better-educated people. The gap between those with low educational qualifications and the better educated is particularly wide: among the former, the average mark is 7.2 out of 10 and the proportion of marks equal or higher than 8 does not reach half of the respondents; on the other hand, among those with a university degree, the average mark rises to 7.7 and marks equal or higher than 8 are two out of three.
The territorial distribution is varied, with eight regions, both in the Centre-north and in the South and Islands, on levels below the Italian average. The absolute minimum is in the autonomous province of Bolzano, where the average score is 6.7 and just 41.0% of citizens aged 14 and over gave a score of 8 or higher. Lower levels are also recorded in Friuli-Venezia Giulia, Molise and Marche (Figure 1).

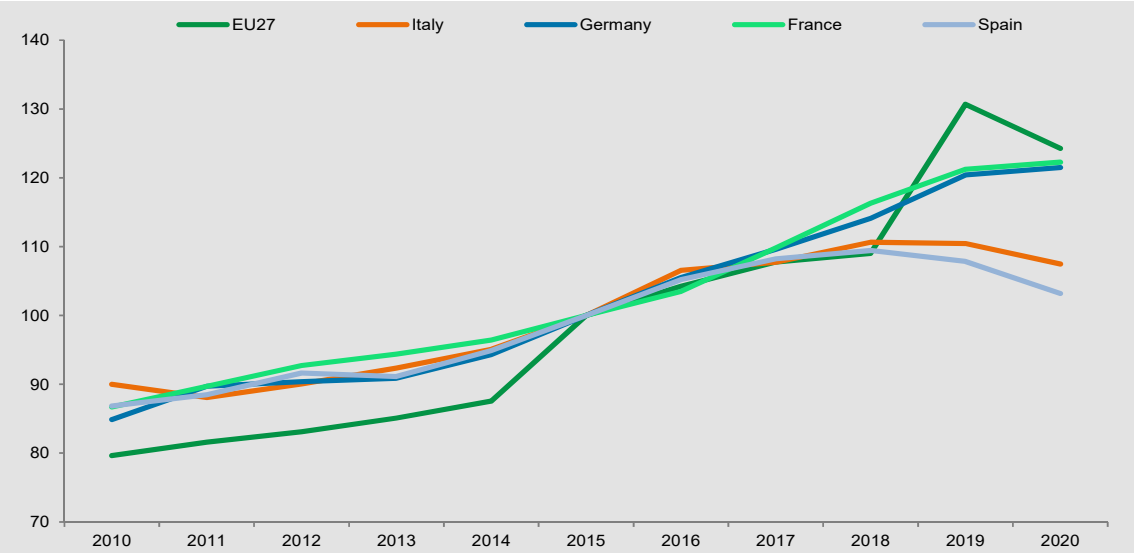
Figure 1. People aged 14 and over who gave a high score (8-10) **on trust in science** (left) **and average score** (right)**. Year 2021. Percentages and average score in tenths**

Source: Istat, Survey on Aspects of daily life

Investments in intangible capital fell back in the first year of the pandemic

After the strong acceleration recorded in Europe between 2018 and 2019, in 2020 the index of investments in intellectual property products (IPP) marked a sharp decline of the process of intangible capital accumulation, falling by -4.9% for the 27 European countries as a whole and -5.9% for the 19 eurozone countries. The setback was more modest for Italy (-2.7%), which, however - unlike France and Germany - had not fully caught up with the previous expansionary phase and showed a more moderate growth trend (Figure 2).
The dynamics of the latest available figures should be read in the context of the dramatic economic situation that characterised 2020, with the fall in GDP and the even more severe

Figure 2. Intellectual property products (as part of gross fixed capital formation) **in selected European countries - Years 2010-2020. Chain values, index numbers 2015=100**



Source: Eurostat database

contraction in overall gross capital formation[3]. In this context, the weight of IPP investments in relation to GDP and total investments remained at similar levels in 2019 for both the average of the 27 EU countries (5.0% and 22.8% respectively) and for Italy (3.2% and 18.1%). Therefore, the wide gap between Italy and the European average remains unchanged, confirming Italy's structural delay in intangible capital investments.
In Italy, 1.47 million Euro less was invested in intellectual property products in 2020 comparing to 2019; two-thirds of this loss is due to lower spending on research and development, one of the two main items of the aggregate, accounting for 45.8% of the total in 2020. On the other hand, investments in software and databases, which accounted for 51.2% of total IPP investments in 2020, had a smaller decline (-1.5%)[4].

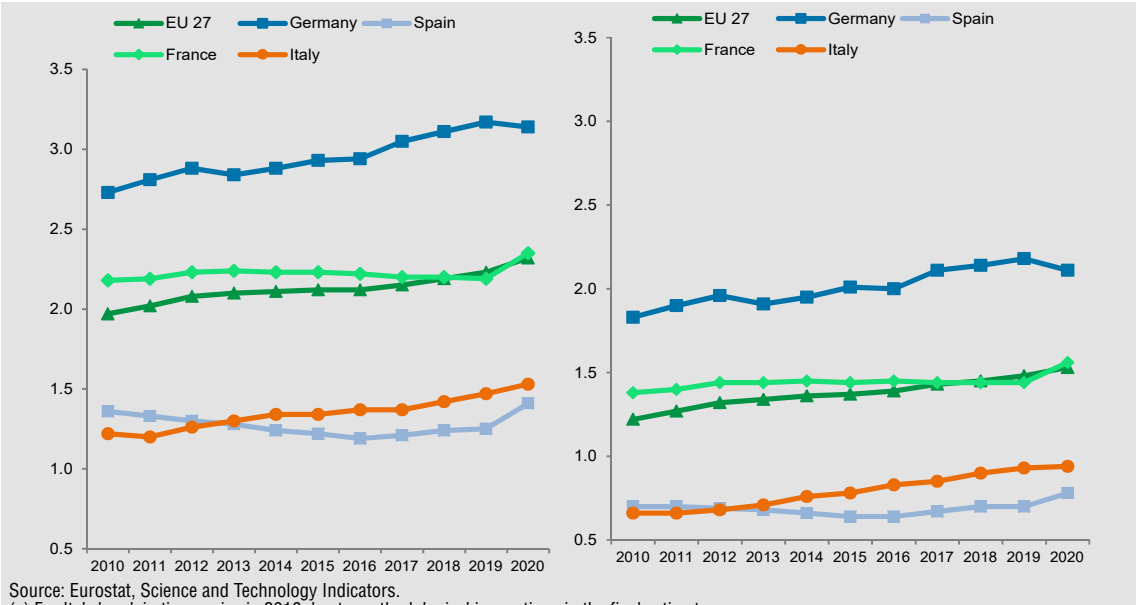
Private investment in research and development (R&D) collapsed in 2020

The investment crisis triggered by the pandemic, in Italy, has impacted on a system already characterised by a R&D intensity, that is much lower than in other major European economies, even though it has grown steadily over the years, both in the public and private sectors.
Based on the most recent results of the R&D surveys, in 2019 in Italy the total expenditure carried out by enterprises, public institutions, non-profit institutions and universities, amounting to around 26.3 billion Euro, increased by 4.1% compared to 2018 and also recorded an increase in terms of incidence on GDP, settling at 1.46% (+0.04 percentage points)[5]. The growth, recorded in all sectors, was most pronounced in the non-prof-

3 The annual contraction of GDP, measured at current prices, was -7.8% in Italy and -4.4% on average in the EU27. The change in total gross investment was -8.5% in Italy and -5.4% in the EU27 average.
4 The aggregate also includes expenditure on mineral exploration and evaluation, original artistic, literary or entertainment works, which in 2020 was worth 3.0% of the total.
5 For the national GDP data, the time series of the economic accounts updated to March 2022 were used.

it (+17.2%) and the public sector (+5.1%). In the business sector, the overall increase (+4.1%) was due to both the higher expenditure incurred during the year by companies that were already performing R&D and the start of R&D investments by new enterprises, whose R&D expenditure accounted for 3.0% of the 2019 total.
The year marked a sudden reversal of the positive trend. Preliminary data indicate an overall decrease in R&D expenditure of -3.4% compared to 2019, due entirely to the negative dynamics of business investment. The sharp contraction in the sector (-6.9%), however, was offset by increases in the non-profit sector (+10.8%), public institutions (+2.3%) and universities (+2.0%). The weight of the sectors has not changed substantially: the main share of *intra-mural* R&D expenditure continues to be that of companies, which, according to preliminary data, has invested 15.4 billion Euro in 2020, equal to 60.9% of total expenditure and 0.94% of GDP. Another important component was universities (23.7% of total expenditure); the public sector - excluding universities - had a lesser weight (13.3%), and the non-profit sector was residual (2.0%).
Compared to the general European picture, from the 2020 forecast data[6], Italy with 1.53% seemed to reach the national target defined within the Europe 2020 Strategy. The indicator's gain over the past year (+0.07 percentage points) is all due to the collapse recorded by GDP, which was greater than the fall in R&D investments.
Despite the different weight and composition of the indicator's assets, Italy's distance from the main European countries and the EU average remained substantially unchanged. Italy's gap can be especially seen in the low level of R&D investment financed by the private sector: although R&D intensity in this latter sector has grown steadily in Italy over the *Europe 2020* reference decade (from 0.66% in 2010 to an estimated 0.94% in 2020), at the end of the period it was still just over half of the European average (1.53%) and less than half of Germany (2.11% - Figure 3). However, Italy does not appear too far behind the major Eu-

Figure 3. Total expenditure on research and development (left) **and of companies** (right) **in Italy** (a)**, in the European Union and in selected European countries. 2010-2020** (b)**. Values as a percentage of GDP**



Source: Eurostat, Science and Technology Indicators.
(a) For Italy,break in time series in 2016 due to methodological innovations in the final estimates.
(b) 2020 data are preliminary.

6 The 2020 forecast data are the most recent available at European level. See https://ec.europa.eu/eurostat/databrowser/view/tsc00001/default/table?lang=en; consultation date 15 March 2022.

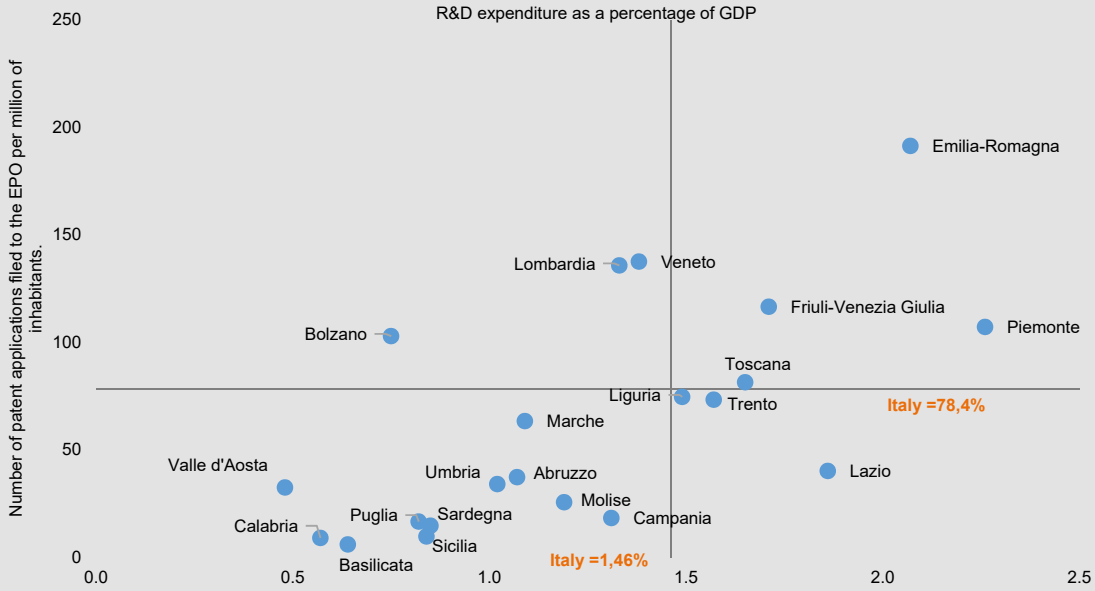
ropean countries in terms of the share of the enterprises spending on R&D on the total, and the weight of private R&D investment, which is indispensable for bridging the structural and long-term gap with the main European economies and for fostering a healthy economy with good growth prospects, has increased significantly compared to 2011, when it accounted for just over half of total spending (54.6 % against 60.9 % in 2020).
Forecasts for 2021[7] indicate a significant recovery in business R&D expenditure, with an increase of 6.2% compared to 2020, which, however, would not be enough to return to pre-pandemic levels. In fact, the R&D expenditure of businesses forecast for 2021 stopped at 16.4 billion Euro (-1.1% compared to 2019). On the other hand, in the public and the non-profit sector, the upward trend in R&D expenditure is expected to continue in 2021, with increases of 2.7% and 2.9% respectively compared to 2020.

Southern Italy lags far behind in investment in research and development

One of the cross-cutting goals of the National Recovery and Resilience Plan is to reduce territorial gaps in terms of economic growth and employment. R&D expenditure has always remained higly concentrated in the North. In 2019, the latest year for which regional data are available, more than 60% of investment was in the North, while South and Islands contributed 14.5%. Six regions made up three-quarters of the total expenditure (around EUR 20 billion): Lombardia (20.2%), Lazio (14.2%), Emilia-Romagna (12.9%), Piemonte (11.9%), Veneto (8.7%) and Toscana (7.5%). The territorial concentration was even greater for business R&D expenditure: more than 80% of the activities were carried out in the six regions just mentioned; the regions of Southern Italy, on the other hand, accounted for just 9.9%. Concerning R&D expenditure of the public sector (excluding universities), Lazio holds the record and accounted for 42.8% of the whole sector, while more than half of the R&D expenditure of universities is in just five regions (Lombardia, Lazio, Emilia-Romagna, Toscana and Veneto). Finally, the share of non-profit institutions involved in R&D activities is higher in Lombardia, Lazio and Piemonte, where 60.9% of the sector's R&D expenditure is concentrated.
Considering the ratio of R&D expenditure to GDP[8], in 2019 the value for the South and Islands (0.96%) was around two-thirds of the Italian figure (1.46%). R&D intensity did not exceed the national level in any region of the South and the Islands (Figure 4).
The lower R&D intensity is also clearly associated with the limited patent propensity. All the southern regions together with Valle d'Aosta, Umbria and Marche are in the group of regions lagging furthest behind on both indicators. At the far opposite of the distribution, the patterns are more articulated: Lombardia and Veneto, for example, have higher patenting rates than Piemonte and Friuli-Venezia Giulia and a lower R&D intensity; Lazio, with one of the highest R&D expenditures, shows a patent propensity well below the Italian average. These differences are also explained by the different weight of institutional sectors, scientific disciplinary field and type of research prevailing in the different regional systems, since patents are only one of the possible means of protecting intellectual property rights on the results of research and innovation activities.
In terms of patent propensity, Italy also continues to remain at much lower levels than the

7 *Intra-mural* R&D expenditure in 2021 was estimated on the basis of forecasts expressed by the surveyed enterprises and institutions during the survey period. Data on universities are not available.
8 The regional GDP data refer to the territorial economic accounts series published by Istat in December 2021.

Figure 4. Expenditure on research and development as a percentage of GDP (a) **and patent applications filed to the European Patent Office** (Epo) **per million inhabitants** (b)**, by region. Years 2018 and 2019**



Source: (a) Istat, Survey on R&D in companies; Research on R&D in non-profit organizations; Research on R&D in public bodies; (b) OECD, Regpat database, December 2021 edition (OECD)
(a) Year 2019.
(b) Year 2018.

EU27 average and the main European countries. In 2018, the indicator calculated for Italy was 78.4 applications per million inhabitants, about half European average[9] of 148.2, less than half the figure recorded for France (156.0 applications per million inhabitants), less than a quarter of Germany's indicator (321.6).

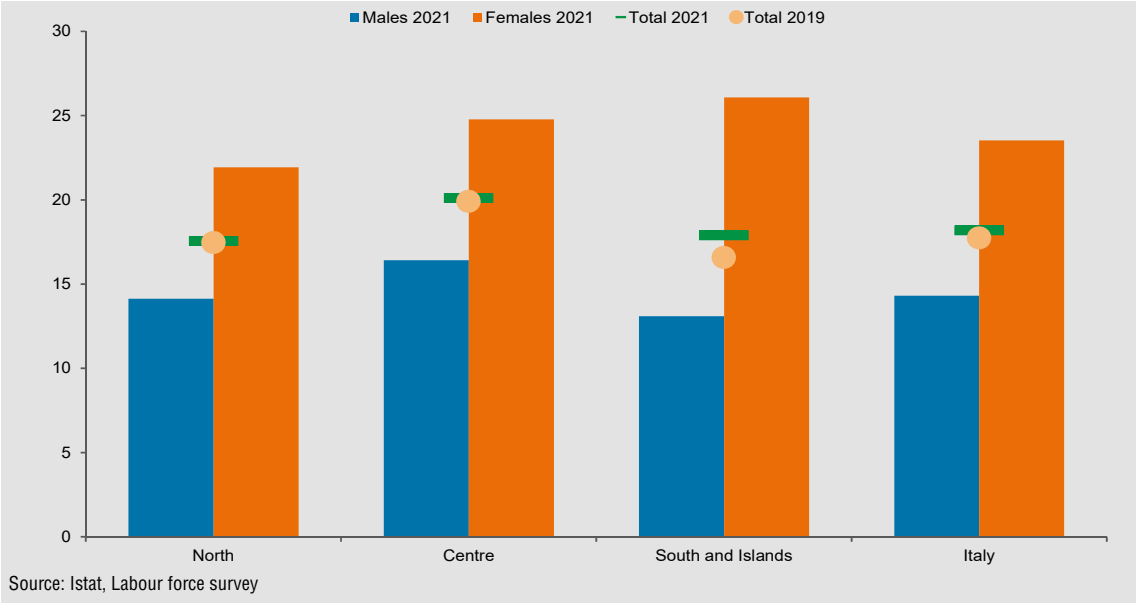
Knowledge workers increased during the COVID-19 crisis in Southern Italy

The employment downturn caused by the pandemic did not stop the growth of knowledge workers impact on employment, that has continued, albeit slowly, for years[10]. In 2020, the percentage of workers in scientific-technological professions and with a university qualification reached 18.3% of total employment (+0.6 percentage points compared to 2019), a level that is confirmed in 2021. The indicator's trend in the last two years is determined by the stability of the most qualified segment of the labour market facing the drop in the total number of employed persons in 2020 (about -3% compared to 2019), only partially recovered in 2021 (+0.75% compared to 2020).
The indicator continued to mark wide gender differences, with much higher levels for women, and particularly for those in the South and Islands, where more than one in four women employed (26.1% in 2021) was a knowledge worker (Figure 5).
The territorial differences, on the other hand, have become less pronounced because the

9 Eurostat data updated on 20/04/2021.
10 Starting in 2021, there is a break in the series due to the innovations introduced in the Labour Force Survey. For the years 2018-2021, analysed in this chapter, a reconstruction of the historical series has been carried out; the longer-term trend (2004-2020) is documented by the historical series previously disseminated.

growth of the last two years was all concentrated in the South and Islands, where the indicator, compared to 2019, gained +1.1 percentage points for men and as much as +2.1 points for women, reaching an overall level in 2021 (17.9%) that is almost in line with the national average and with the value for the North.

Figure 5. Employees with tertiary education (ISCED 6-7-8) **in scientific-technological occupations** (ISCO 2-3) **by gender and geographic area. Years 2019 and 2021. Values per 100 employees with the same characteristics**



Source: Istat, Labour force survey

The decline in cultural and creative employment is concentrated in the North-west and the South

The impact of the two-year pandemic restrictions on cultural and creative employment is strong and evident, most intense in the first year. In 2020, the number of employed fell by -8.0%, equal in absolute terms to a net loss of about 66,000 compared to 2019. The negative trend reversed in 2021, in line with the slight recovery in overall employment. The total balance at the end of the two-year period was -55 thousand employed, a relative loss of -6.7%, more than double the contraction in overall employment.

The weight of cultural and creative employment in total employment dropped from 3.6% in 2019 to 3.4% in 2021 (Figure 6).

The impact of the first year of the COVID-19 crisis was particularly strong on women employed in this sector, who accounted for 43.3% of total employment in 2019; over 31,000 lost their jobs in 2020, thus contributing to about half of the overall decline in cultural and creative employment in the first year. However, 2021 saw a recovery of more than a third of the female employment lost the previous year, in contrast to men. The overall loss between 2019 and 2021 for women stood at -5.3%.

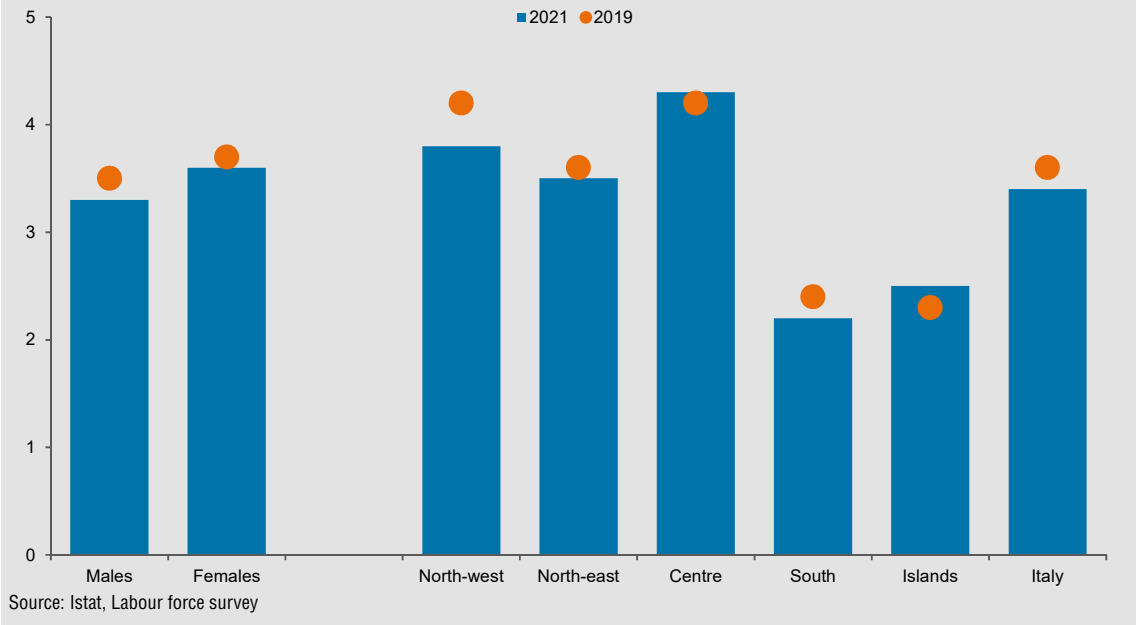
Men were thehardest hit over the two-year period, recording a -7.7% loss of employment in this sector between 2019 and 2021.

Territorial differences became more accentuated. In 2021, the gap between the Centre (4.3%), which remains the most vocated area, and the South (2.2%) was 2.1 percentage points.

The areas most affected by the employment crisis in the cultural and creative sector were

the North-west and the South, which between 2019 and 2021 recorded reductions in the number of people employed in the sector of 12.2% and 10.4% respectively. In the North-west the indicator went from 4.2% to 3.8%; in the South from 2.4% to 2.2%.

Figure 6. Employees in cultural and creative professions or sectors of activity by gender and age group. Years 2019 and 2021. Values per 100 employees with the same characteristics



Source: Istat, Labour force survey

Migration of young Italian graduates continued in the first year of the pandemic crisis

Despite the restrictions on mobility imposed during the first year of the pandemic and the uncertainty that characterised 2020, emigrations abroad by young Italian graduates have intensified compared to 2019, in stark contrast to the transfers of residence of the population as a whole, which instead recorded declines of varying magnitude[11].

The main directions of the flows of young graduates did not change, which continue to be towards foreign countries and from the South and Islands to the Centre-north.

At the national level the indicator, which considers the migration balance of young Italian citizens (25-39 years old) with a university qualification[12], was also negative in 2020: -5.4 per 1,000 residents of the same age and education level, a higher loss than in 2019 (-4.9 per 1,000), which is equal to a balance of residence transfers to and from abroad of -14,528 units (Figure 7).

Outflows abroad determined negative rates in all areas of the country, slightly decreasing compared to 2019 in the South (-5.3 per 1,000) and the Islands (-6.1), increasing in the North-west and North-east (-5.9 and -6.1 respectively).

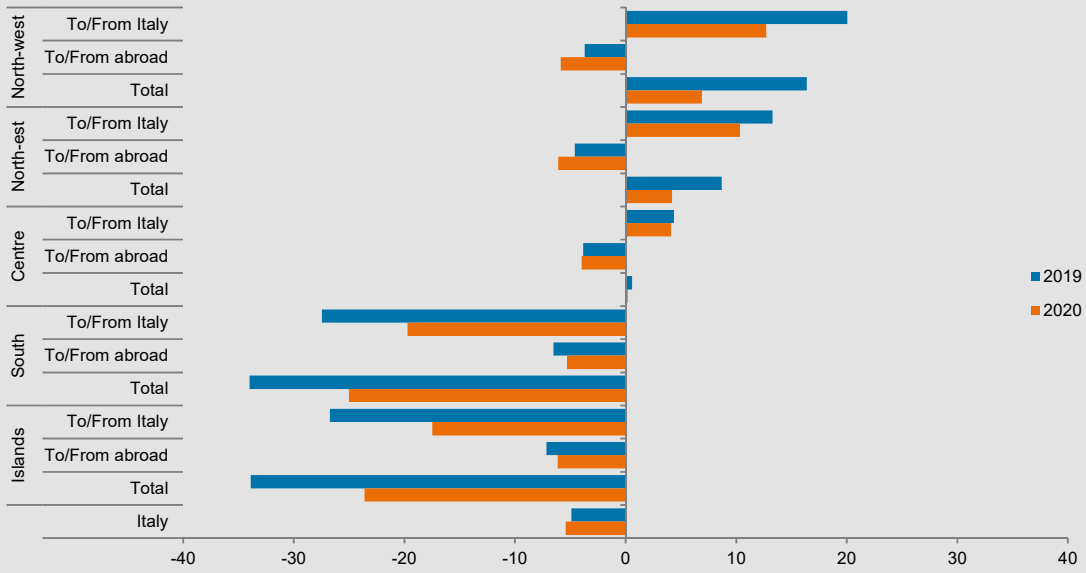
In the Centre-north, however, outflows abroad were fully compensated by internal migration, which, instead, accentuated the penalisation of the South and Islands. The South and

11 Compared to 2019, the following changes were recorded: - 10.2% for internal mobility, - 25.6% for immigration from abroad, - 10.9% for emigration. Expatriations of Italian citizens decreased by 0.9%. For more details see: https://www.istat.it/it/files//2022/02/REPORT_MIGRAZIONI_2020.pdf

12 The indicator is limited to young Italian with a tertiary degree of qualification because data on educational qualification of foreing migrants is not yet of adequate quality.

the Islands, in fact, retain the negative sign even in the total balance, which in 2020 was equal to -25.0 per 1,000 and -23.6 per 1,000 respectively. Conversely the overall balance was breakeven in the Centre and largely positive for the North, an area that acquired about 7,000 more young Italian graduates net of emigrants in 2020.

Figure 7. Net migration rate of Italian graduates (aged 25-39 years) **by origin/destination and geographic area. Years 2019 and 2020. Values per 1,000 residents with the same characteristics**



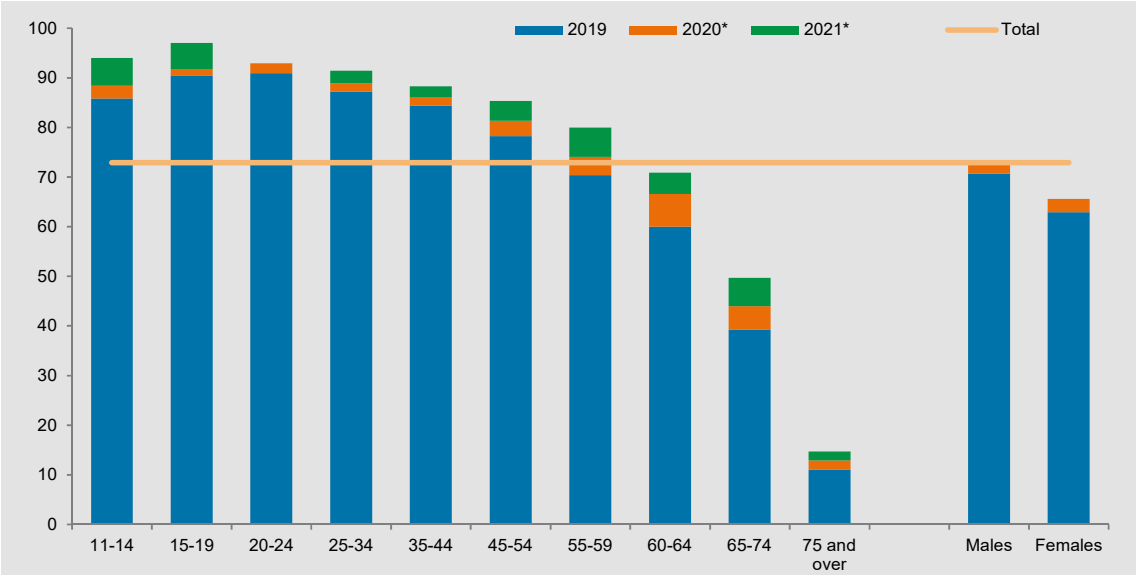
Source: Istat - Registrations and cancellations from the registry for residence transfer and Permanent census of population.

On the other hand, the South and Islands, lost 21,782 young graduates (net of returns) during 2020 only. Of these, more than three out of four have transferred their residence to the Centre-north (16,882; 77.5%).
The internal flows were all smaller than in 2019 but continued to confirm the different attractiveness of the Centre-north and the South and Islands for younger and more qualified human resources. The territorial gap also emerges in migration choices/opportunities: more than half of the young Italian graduates who moved abroad in 2020 came from Northern Italy, less than one in three from Southern Italy. Among those who returned to reside in Italy in the same year, less than one in four settled in the South and Islands and more than one in two in the North.

Women and the elderly were more connected during the two years of the pandemic, but the digital divide is still wide

The restrictions of the pandemic crisis have pushed towards more widespread and frequent Internet use. In 2021, the share of people aged 11 and over who used the Internet at least once a week in the three months prior to the interview rose to 72.9%; the overall growth compared to 2019 was more than 6 percentage points.
Also due to the continuation of distance learning, the indicator reached very high levels among school-age children: 94.0% in the 11-14 age group, 97.0% in the 15-19 age group; in 2019 it was 85.8% and 90.5% respectively (Figure 8).

Figure 8. People aged 11 and over who used the Internet at least once a week in the 3 months prior to the interview. Years 2019-2021. Percentages



Source: Istat, Survey on the use of ICT in the Households and by individuals
(*) difference on the previous year

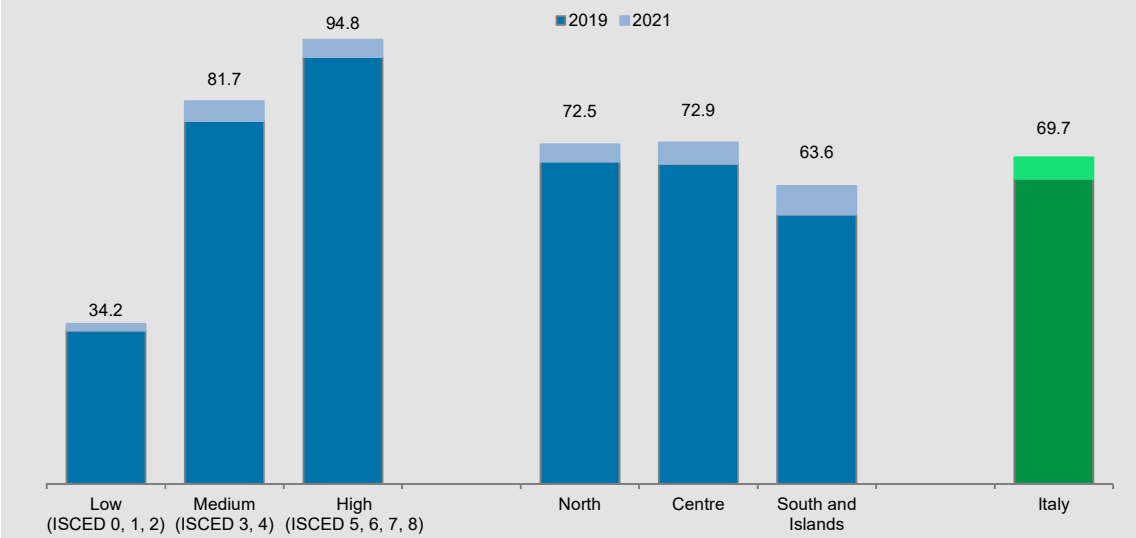
The values gradually decreased for the subsequent age groups. Among those aged 55-59, the share of Internet users was 80.0%; it dropped to just under 50% among those aged 65-74. However, it is precisely in these age groups that regular Internet use has grown the most, around 10 percentage points in the last two years.
Compared to 2019, therefore, the gap between young and the elderly in using the Internet has narrowed. However, people aged 75 and over (14.7%) still lag behind, despite the increase between 2019 and 2021 (+ 3.7 percentage points).
The interaction with ICT is significantly different between males and females. In 2021, 76.1% of men said they regularly used the Internet, compared with 69.8% of women. However, it should be noticed that it is among women of all age groups (with the exception of 11-14-year-olds) that the greatest growth occurred over the last two years. The gender gap has thus narrowed to zero for those aged between 20 and 54. However, among the elderly the disparities remain wide: from the age of 65 onwards, the female disadvantage is about 10 percentage points.
In the two years analysed, the territorial gaps also narrowed. The difference between the North-west and the South is 7.2 percentage points in 2021, it was 10.7 percentage points in 2019.

Great access barriers to internet use for families composed only of elderly and less educated people

The digital divide tends to add up to and exacerbate socio-cultural and economic inequalities. For example, the level of education is associated with differences in the availability and access to ICT technologies and equipment. Despite the increase in working from home, the continuation of distance learning, and the intensification of Internet use following the

restrictions during the COVID-19 epidemic, in 2021 three out of ten Italian households still do not have a PC and a home connection.
Behind this average value, there is a very wide gap (more than 58 percentage points) between households composed only of elderly people and those where there is at least one child (91.8%). The gap is equally wide between households where at least one member has a university qualification and those where the highest educational qualification is the lower secondary school diploma. Only 34.2% of the latter group, that are to a very large extent elderly-only families, have a PC and home connection compared to 94.8% of the former (Figure 9).

Figure 9. Households with Internet connection and at least one personal computer by highest educational qualification in the family, by geographic area. Year 2021. Percentages



Source: Istat, Survey on the use of ICT in the Households and by individuals

The most discriminating element is having a PC or similar device[13], because if one considers only the availability of an Internet connection at home, the gap between households with higher educated members (98.1%) and those with lower qualifications (52.8%) narrows, although it remains wide.
In the two years of the emergency, the level of the indicator grew, from an average value of 65.1% in 2019 to 69.7% in 2021, but the growth did not affect all households equally, and the differences by household type or level of education did not narrow.
Instead, the territorial gaps have narrowed. The gap between Northern and Southern Italy in 2021 is 8.9 percentage points; in 2019 it was 11.3 points.

13 The following technological devices are considered in the calculation of the indicator: desktop computer, laptop, notebook, tablet. Smartphones, PDAs with phone functions, e-book readers and game consoles are excluded.

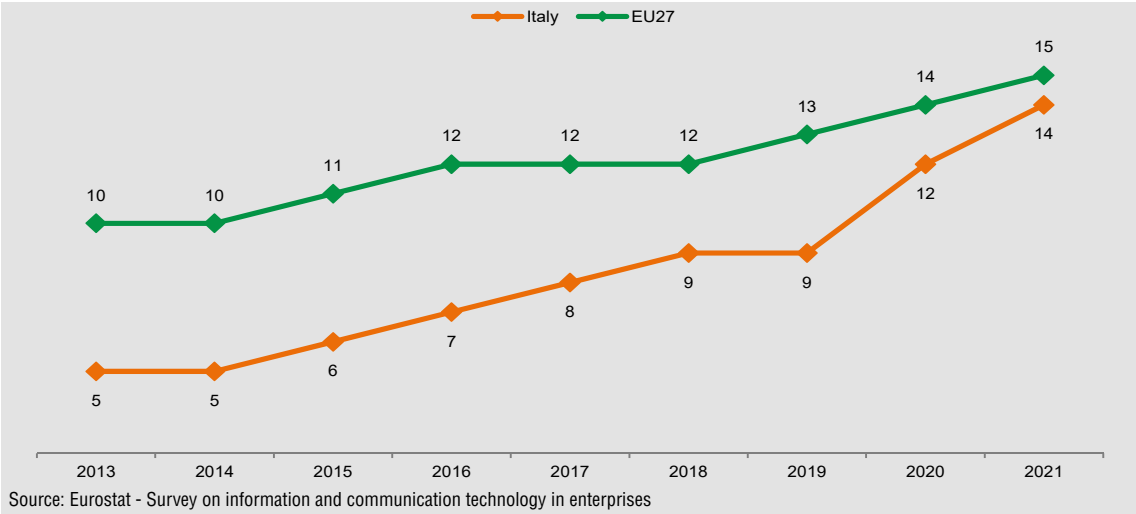
E-commerce continued to accelerate in the 2020 sales year. Still relatively few small and medium-sized enterprises involved

In 2021, the share of Italian enterprises with at least 10 employees that in the previous year made sales to end customers (B2C) through their own web channels, digital platforms or *e-commerce*[14] intermediaries reached 14%. This confirms the acceleration in the use of this sales channel recorded as early as 2019. In the first year of the COVID-19 crisis, Italy almost reduced its gap with the average of the 27 EU countries that is equal to 15% in 2021 (sales year 2020) (Figure 10).

As a response to the difficulties caused by the pandemic, 18.9% of Italian enterprises with at least 10 employees stated[15] that they had started or increased online sales during 2020. This strategy was mainly implemented by enterprises operating in the sectors that were most impacted by the closures and restrictions to contain the epidemic, such as the hospitality sector (41.8%), travel agencies and tour operators (39.3%), publishing (38.0%) and retail (36.0%), with varying results in terms of sales actually realised.

In contrast, the percentage of enterprises that actually sold via the web in 2020 grew especially in the restaurant industry, where it rose to 24.7% (it was 10.3% in the 2019 sales year), in the audiovisual industry (22.5%; +13 percentage points compared to 2019) and in the textile and clothing industries (15.0%; +8.7 percentage points).

Figure 10. Enterprises with 10 or more persons employed that during the previous year sold via web to end customers (B2C) in Italy and in the European Union. Years 2013-2021. Percentages



Source: Eurostat - Survey on information and communication technology in enterprises

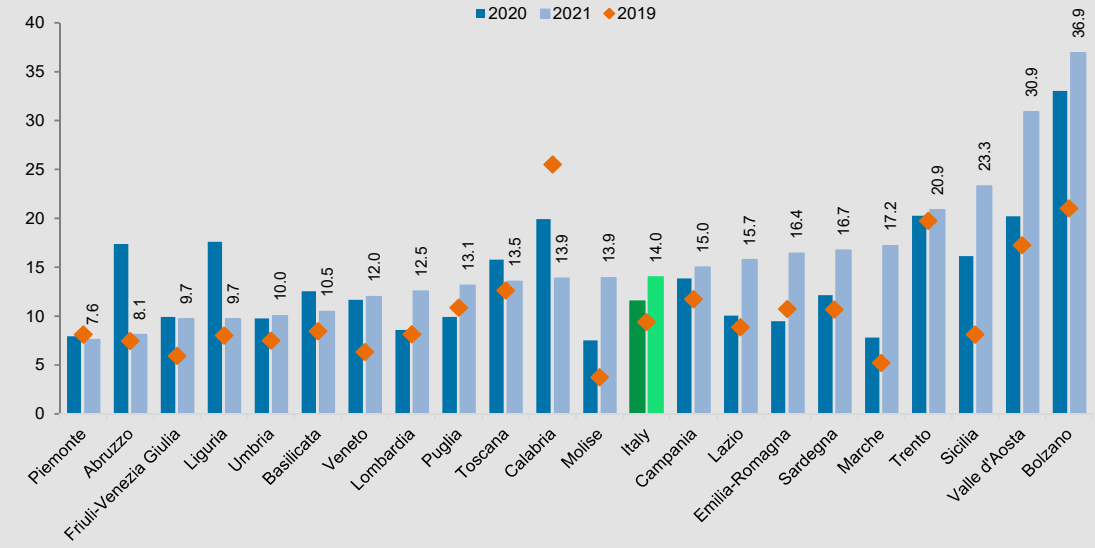
Growth was particularly significant among Italian large enterprises (24%; +4 percentage points). In 2021, these were 4 percentage points higher than the average for European companies of the same size (20%), which grew by just 1 percentage point over the same period. The propensity of small Italian enterprises to use the B2C web sales channel increased, but is still lower (13.8% in 2021; 11.3% in 2020).

14 The indicator does not consider sales made via the web to other enterprises or to the public administration, with the additional contribution of which it reached 16.2% in 2021 (it was 6.1% in 2013).

15 A section dedicated to the impacts of COVID-19 in the year 2020 was introduced in the Survey on ICT use in enterprises in the year 2021.

All Italian regions showed increases in the last year, with the only exception of Calabria, which lost 6 percentage points (Figure 11). Compared to the pre-pandemic data (referring to 2020), the largest increases were in Valle d'Aosta (+11 percentage points), Sicilia (+7), Marche (+9); generalised increases concerned the regions of the Centre. However, territorial differences remain wide, from 7.6% of enterprises in Piemonte (more characterised by *business-to-business* exchanges) to 36.9% of those in the autonomous province of Bolzano.

Figure 11. Enterprises with 10 or more persons employed that during the previous year sold via web to end customers (B2C) by region.Years 2019-2021. Percentages



Source: Eurostat - Survey on information and communication technology in enterprises

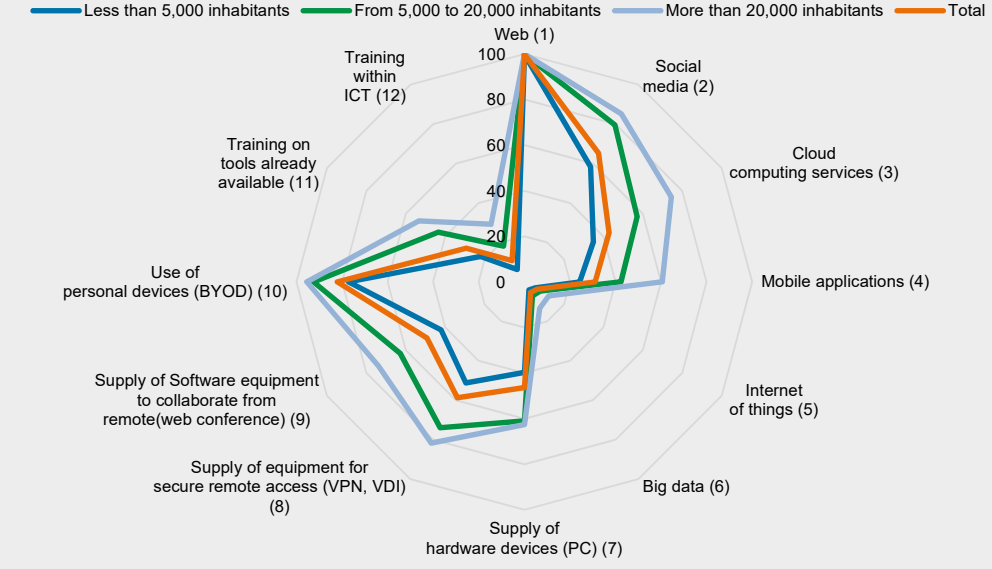
THE TECHNOLOGICAL EVOLUTION OF MUNICIPAL ADMINISTRATIONS BETWEEN 2017 AND 2020

The diffusion of ICT technology has long been the focus of public administration modernisation policies, but in Municipalities - especially the smallest ones - it has remained rather limited. According to estimates by the Sample survey on the use of ICT in public administrations, in 2018 only 25% of Italian Municipalities managed entirely online at least one service for households. Among Municipalities with up to 5 thousand inhabitants, the percentage dropped to 16.5%.

In 2020, the COVID-19 emergency, with the widespread of working from home, impacted on the digital transformation processes of services, procedures and work organisation that were already underway, leading to different effects depending on the characteristics of the administrations. The results of the two latest multi-purpose surveys of the Permanent Census of Public Institutions[1] make it possible to assess the technological evolution of a panel of Municipalities[2] compared to the pre-pandemic picture.

The 12 digitalisation indicators considered (Figure A), relating to technologies for data management and service delivery (indicators 1-6), technological endowments necessary to perform work remotely (7-10), and training (11-12), describe different profiles depending on the technologies and measures adopted and highlights wide gaps between the levels of technological endowment of the largest and smallest Municipalities.

Figure A. Digital profile of municipalities by demographic dimension. Year 2020 (a)**. Percentages**



Source: Istat, Permanent census of public institutions
(a) Provisional data

1 The preliminary results of the third edition of the multi-purpose survey of the Permanent Census of Public Institutions were presented on 15 December 2021 with the virtual event "Health Emergency and Resilience of Public Institutions" (https://www.istat.it/it/archivio/264396). In order to prioritise the timeliness of the dissemination of information on agile working and digitalisation, the data have been disseminated on a provisional basis, without subjecting them to the full process of checking and correction, including the estimation of partial and total non-response, which will be carried out before the final data are disseminated, scheduled for late 2022 and early 2023.

2 The panel consists of 7,370 Municipalities responding to both editions of the census survey (69% belong to the class of small Municipalities with less than 5,000 inhabitants, 24% have between 5,000 and 20,000 inhabitants, 7% have more than 20,000 inhabitants).

Among the technologies for data and online services management, the web is the most widespread by far, and in 2020 it concerned almost all Municipalities; compared to 2017, its availability increased by 12.4 percentage points on average and by 15 points in small Municipalities, which have now almost completely closed the gap from the medium-sized and large Municipalities. The use of social media in communication between administrations and citizens or businesses has also grown significantly, reaching 65.2% in 2020 (+22.6 percentage points); it remains far more widespread in the largest Municipalities (85.2%) despite the progress of the smallest Municipalities (58.3% in 2020; +25.1 points). In correspondence with more advanced digitalisation tools and strategies, the percentages tend to decrease and the gap between large and small municipalities increases. Driven by smartworking and working from home the use of cloud services reached 42.9% of Municipalities in 2020 (+14.4 percentage points); it rises to 74.5% among those with more than 20 thousand inhabitants and falls to 35% among the smallest ones. There is also a wide gap in the use of mobile applications, which involves just under one in four small Municipalities and grows to six in ten for Municipalities with 20,000 inhabitants or more. Between 2017 and 2020, the deployment of these technologies grew more in medium-sized and large Municipalities.

Small Municipalities experienced greater difficulty in acquiring the technology needed to support remote working, which is necessary to guarantee the continuity of institutional activities even in periods of greater restrictions, and recorded less investment in the development of staff IT competencies, in a general framework of low levels of training for all types of Municipalities.

Despite the gaps highlighted, the pandemic crisis marked a considerable acceleration in the digitalisation of small Municipalities, and in particular, in the diffusion of the most enabling technologies of online service management - web, mobile applications and cloud computing services - creating the fundamental requirements for increasing the offer of digital services.

An integrated reading of the data from the survey on ICT use in public administrations with the results of the Censuses [3]shows, remarkable advances in the availability of enabling technologies made by those small Municipalities that before the pandemic did not reach the minimum level of offering online services[4]: between 2017 and 2020, the weight of those with neither web, cloud or mobile technology reduced (-12 percentage points compared to 2017), and the share of those using two or three grew more than proportionally (+13 points overall - Figure B).

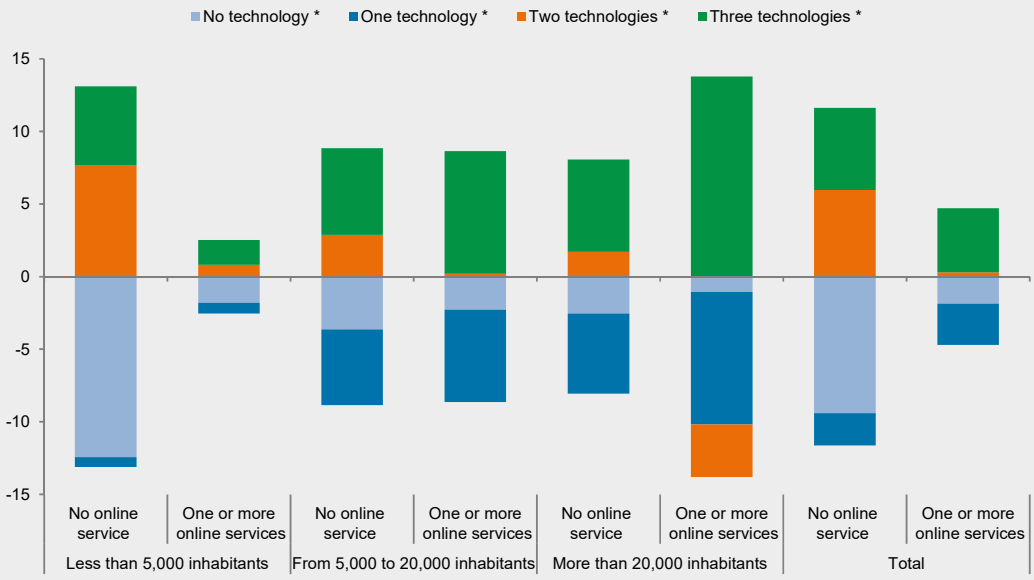
In 2020, the data show a broader endowment of enabling technologies for all Municipalities. Larger municipalities, which were already better equipped before the pandemic crisis and were on a more advanced level of online service management, proved to be more resilient and adaptive to the COVID-19 crisis. In the emergency phase, driven by the increasing demand for remote services and the wider use of working from home, they moved mainly to the joint adoption of all three technologies considered. This growth was very high for the group of Municipalities with at least 20,000 inhabitants and with online services (+14 percentage points), but it was appreciable in all the other groups of medium-large Municipalities.

Even the smallest Municipalities, which before the pandemic were less technologically equipped, and further behind in the provision of online services, increased the availability of enabling technologies, but stopping at two in many cases. Although the use of cloud computing services in small Municipalities increased compared to 2017, in 2020 two out of three small Municipalities still do not have this critical tool to integrate the information and data so to be able to deliver and manage remote or online services.

3 The panel obtained by integrating the micro-data from the two sources consists of a subset of 5,755 Municipalities which, in terms of size, are similarly distributed to the original panel.

4 The indicator of ICT diffusion in local administrations included in the Bes *framework* is defined as "the percentage of Municipalities that provide online at least one service to family or individuals at a level that allows the entire process (including any online payment) to be initiated and concluded electronically".

Figure B. Municipalities by number of enabling technologies adopted, demographic dymension and number of online services provided to households (a). Years 2017 and 2020. Differences in percentage points on 2017



Source: Istat, Permanent Census of public institutions and Survey on information and communication technology in public administrations
(a) Year 2018.
(*) Web, mobile, cloud.

Indicators

1. **R&D intensity:** Percentage of expenditure for intramural research and development activities performed by business enterprise, government, higher education (public and private) and non-profit sector on GDP. Expenditure and GDP are considered in current prices, million euro.
   Source: Istat - R&D survey in companies; R&D survey in non-profit organizations; Survey on R&D in public bodies
2. **Patent propensity:** Number of patent applications filed to the European Patent Office (EPO) per million of inhabitants.
   Source: OCSE, Database Regpat
3. **Impact of knowledge workers on employment:** Percentage of employees with tertiary education (ISCED 6-7-8) in scientific-technological occupations (ISCO 2-3) on total employees.
   Source: Istat - Labour force survey
4. **Innovation rate of the national productive system:** Percentage of firms that have introduced technological (product or process), organizational or marketing innovation in a three-year period on total number of firms with at least 10 persons employed.
   Source: Istat, Cis (Community Innovation Survey)
5. **Intellectual property products (as part of gross fixed capital formation):** The value of expenditure on research and development, mineral exploration and evaluation, computer software and database, entertaiment literary or artistic originals and other intellectual property procucts intended to be used for more than one year. Chained values with reference year 2015 (millions of euro), Indexed 2015 = 100.
   Source: Istat - National Accounts
6. **Cultural employment (% of total employment):** Percentage of employees in cultural and creative professions or sectors of activity (ISCO-08, Nace rev.2) out of the total number of employees (15 years and over).
   Source: Istat - Labour force survey
7. **Brain circulation (italians, 25-39 years old):** Net migration rate of holders of a tertiary degree: (immigrants-emigrants) / total resident population * 1,000. Both numerator and denominator refer to Italian holders of a tertiary degree, 25-39 years old.
   Source: Istat - Registrations and cancellations from the registry for residence transfer and Permanent census of population
8. **Regular internet users:** Percentage of individuals aged 11 and over who used the internet at least once a week in the 3 months prior to the interview.
   Source: Istat - Survey on the use of ICT in the Households and by individuals
9. **Availability of at least one computer and Internet connection in the household:** Percentage of households with internet connection and at least one personal computer (including desktop computers, laptops, notebooks, tablets; excluding smartphones, PDAs with phone functions, e-book readers and game consoles).
   Source: Istat - Survey on the use of ICT in the Households and by individuals
10. **Municipalities with online services for families:** Percentage of Municipalities that provide on line at least one service for families or individuals at a level that allows the electronic start and conclusion of the entire process (including any on line payment).
    Source: Istat - Survey on information and communication technology in public administrations
11. **Enterprises with at least 10 persons employed with web sales to end customers:** Percentage of enterprises with 10 or more persons employed that during the previous year sold via web to end customers (B2C). From the survey year 2021 economic activities from division 10 to 82 are included according to Ateco 2007 nomenclature (excluding section K - Financial and insurance activities). From the same survey year, estimates refer to the unit of analysis “enterprise”, i.e. a statistical unit that may consist of one or more legal units.
    Source: Istat - Survey on information and communication technology in enterprises
12. **Employed persons with basic or above basic overall digital skills (20-64 years):** Percentage of employed people (aged 20-64) who have at least basic digital competences in all the four specific areas (information, communication, problem solving, software competences) identified by the “digital competence framework”. For each area, a number of activities related to the use of the Internet or software (from 4 to 7) were selected and, depending on the number of activities carried out, a rating is attributed to the area, ranging from 0= no competence, 1= basic level, 2= above basic level.
    Source: Istat - Survey on the use of ICT in the Households and by individuals

Indicators by region and geographic area

REGIONS GEOGRAPHIC AREAS	R&D intensity (a)(*)	Patent propensity (b)	Impact of knowledge workers on employment (c)	Innovation rate of the national productive system (d)	Intellectual property products (e)	Cultural employment (c)
	2019	2018	2021	2018	2020	2021
Piemonte	2.27	107.2	16.5	54.8	....	3.5
Valle d'Aosta/Vallée d'Aoste	0.48	32.5	14.9	41.8	....	2.9
Liguria	1.48	74.6	18.8	47.7	....	2.7
Lombardia	1.33	135.8	18.1	60.5	....	4.0
Trentino-Alto Adige/Südtirol	1.10	88.0	15.3	54.1	....	3.7
Bolzano/Bozen	*0.74*	*102.9*	*13.0*	*51.4*	....	*3.1*
Trento	*1.54*	*73.3*	*17.8*	*57.8*	....	*4.3*
Veneto	1.38	137.6	16.7	62.4	....	3.9
Friuli-Venezia Giulia	1.69	116.6	16.1	56.0	....	3.3
Emilia-Romagna	2.08	191.4	18.9	61.4	....	3.0
Toscana	1.60	81.4	17.3	56.9	....	4.2
Umbria	1.03	34.1	16.6	48.7	....	3.5
Marche	1.08	63.4	17.3	45.1	....	3.5
Lazio	1.85	40.2	23.4	51.1	....	4.7
Abruzzo	1.07	37.3	18.4	56.0	....	2.5
Molise	1.18	25.6	18.7	42.7	....	2.2
Campania	1.29	18.3	18.9	47.1	....	2.6
Puglia	0.82	16.6	17.0	49.1	....	1.8
Basilicata	0.65	6.0	16.4	48.9	....	2.9
Calabria	0.57	9.0	18.2	45.6	....	1.6
Sicilia	0.84	9.7	17.3	47.6	....	2.5
Sardegna	0.85	14.7	17.7	44.2	....	2.3
North	1.59	133.9	17.6	59.4	....	3.6
North-west	1.55	121.3	17.7	58.4	....	3.8
North-east	1.65	151.4	17.3	60.7	....	3.5
Centre	1.64	55.5	20.1	52.2	....	4.3
South and Islands	0.96	15.7	17.9	48.1	....	2.3
South	1.01	11.0	18.1	48.6	....	2.2
Islands	0.84	18.0	17.4	46.7	....	2.5
Italy	1.46	78.4	18.2	55.7	107.5	3.4

(a) Percentage of R&D expenditure on GDP;
(b)Per million of inhabitants;
(c) Per 100 in employment;
(d) Per 100 enterprises with at least 10 employees;
(e) Chain-linked values with reference year 2015 (million Euro), index-linked 2015=100;
(f) Per 1,000 inhabitants aged 25-39 with tertiary education (bachelor's degrees, AFAM, PhD);

Brain circulation (italians, 25-39 years old) (f)	Regular internet users (g)	Availability of at least one computer and Internet connection in the household (h)	Municipalities with online services for families (i)	Enterprises with web sales to end customers (c)	Employed persons with basic or above basic overall digital skills (20-64 years) (l)
2020	2021	2021	2018	2021	2019
0.8	72.8	70.2	15.0	7.6	54.4
-11.0	75.6	67.2	21.6	30.9	58.1
-3.9	75.6	71.2	13.2	9.7	56.0
10.5	76.7	73.4	41.3	12.5	58.5
0.2	77.3	74.4	17.1	30.3	57.4
-4.9	*77.3*	*74.0*	*22.5*	*36.9*	*56.5*
3.7	*77.4*	*74.7*	*13.6*	*20.9*	*58.3*
-3.4	74.3	73.1	43.4	12.0	53.6
-0.8	73.7	70.5	20.0	9.7	58.3
14.4	74.6	73.0	45.6	16.4	56.0
1.4	75.3	72.7	39.1	13.5	55.3
-11.4	74.6	70.1	28.3	10.0	52.1
-9.8	72.1	67.7	17.5	17.2	50.5
3.6	76.7	74.8	20.9	15.7	53.0
-15.6	70.9	68.1	12.5	8.1	50.6
-31.4	65.0	63.2	5.9	13.9	51.3
-22.6	70.4	66.0	18.5	15.0	45.1
-24.7	65.8	61.7	25.2	13.1	44.7
-40.5	68.8	61.4	15.3	10.5	44.4
-33.4	66.8	59.3	8.7	13.9	44.8
-25.4	65.3	60.9	12.3	23.3	44.5
-17.6	74.4	70.3	21.8	16.7	50.3
5.8	75.2	72.5	30.4	13.2	56.4
6.9	75.6	72.2	28.2	11.4	....
4.2	74.6	72.9	34.9	15.4	....
0.2	75.5	72.9	25.9	14.7	53.3
-24.6	68.2	63.6	15.6	15.5	45.8
-25.0	68.4	63.7	15.0	13.3	....
-23.6	67.6	63.4	16.9	21.4	....
-5.4	**72.9**	**69.7**	**25.1**	**14.0**	**52.9**

(g) Per 100 persons aged 11 and over;
(h) Per 100 households;
(i) Per 100 Municipalities;
(l) Per 100 employed aged 20-64 years.
(*) For 2020 year only the Italian figure, equal to 1,53, is available as a provisional estimate.