Digitalization During the COVID-19 Crisis Implications for Productivity and Labor Markets in Advanced Economies

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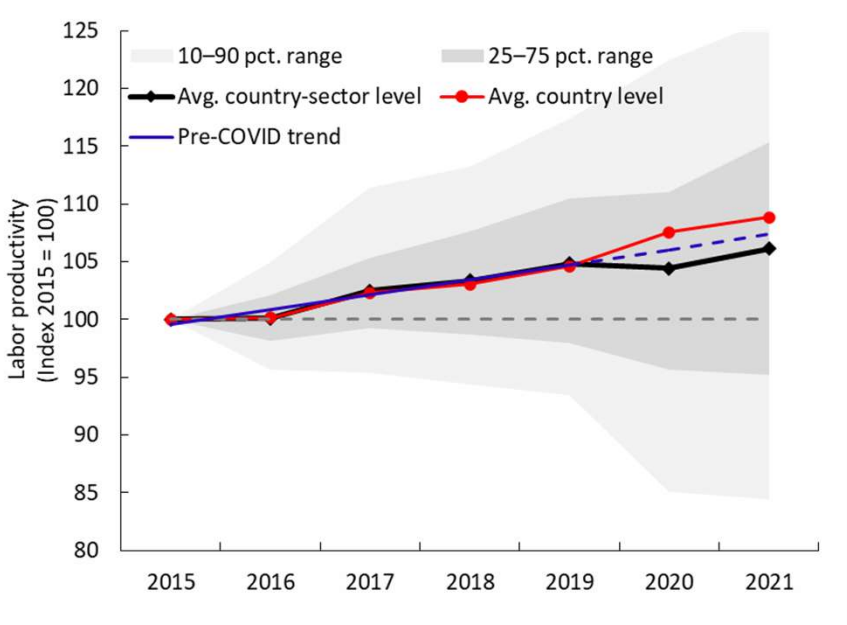
Two puzzles emerged in the aftermath of the pandemic in advanced economies

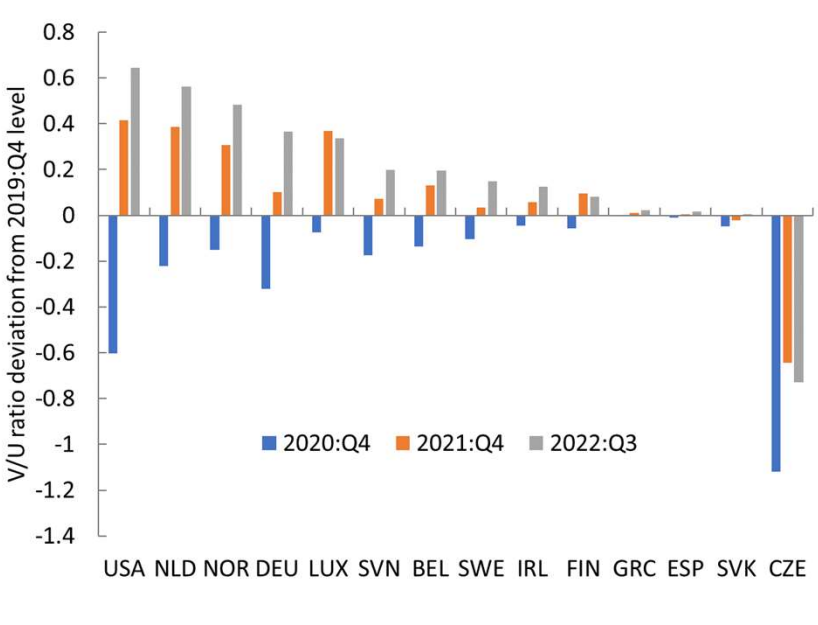
Labor productivity remains below pre-COVID trend in many sectors even as aggregate productivity recovered. Labor markets are very tight and particularly so in more low-skill occupations and industries.

Labor Productivity by Countries and Sectors



Labor Market Tightness (V/U)

(Deviation from 2019:Q4)



Sources: Eurostat, US BEA and BLS, UK ONS, and IMF staff calculations.
Note: Countries sample: advanced European economies and US.

Key questions

- **What was the state of digitalization before the pandemic and how has it been impacted by the crisis?**

- **What has been the impact of digitalization on productivity?**

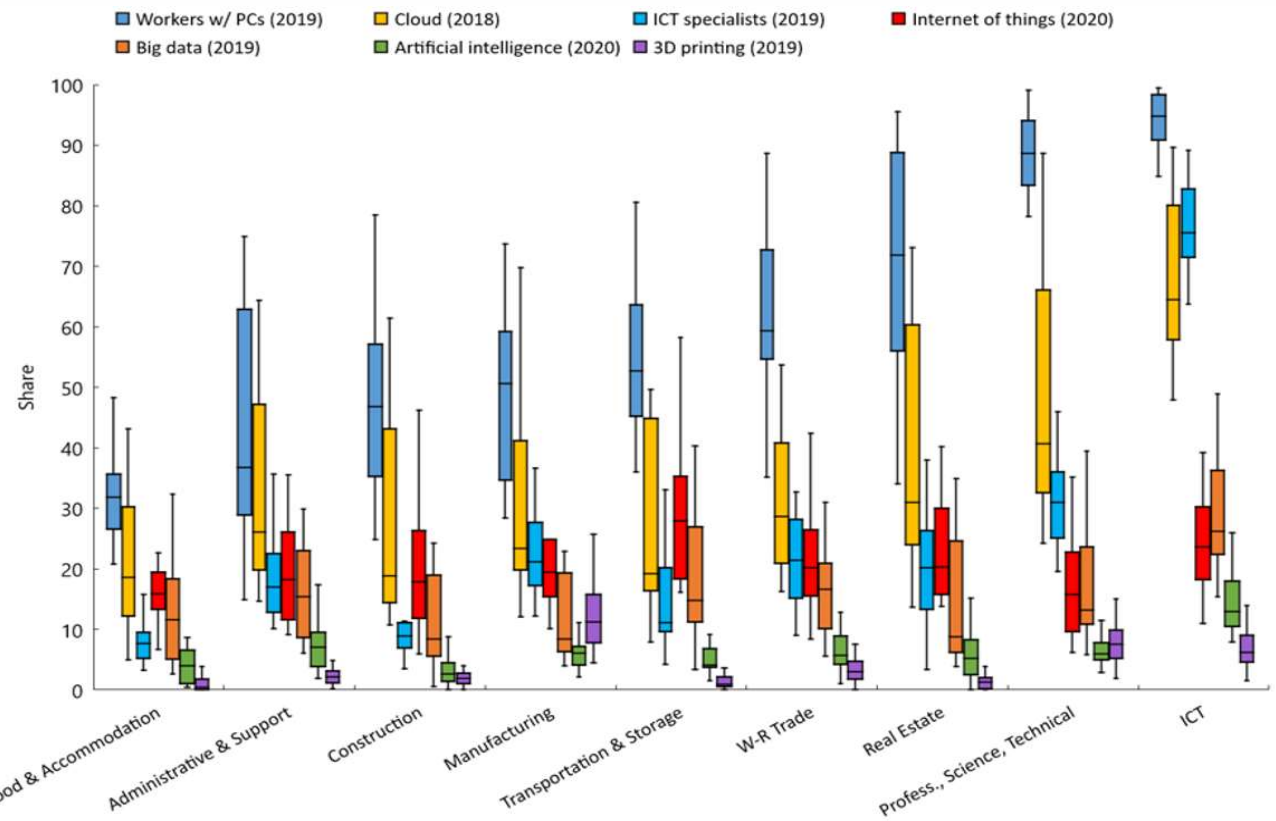
- **What has been the impact of the COVID-19-induced digitalization on labor markets?**

Caveat: with only two years of data available, proper caution should be applied in interpreting the permanence of the results.

Evolution of Digitalization

Measuring digitalization at the sector level

Alternative Digitalization Measures by Sector across Countries Prior to COVID-19



Share of workers using a PC connected to the internet is the preferred measure

- Longer time sample: 2009-2021
- Relevant to all sectors
- Reflective of broader digital infrastructure

Other measures focus on penetration of individual digital technologies

- More sector-specific and less widespread

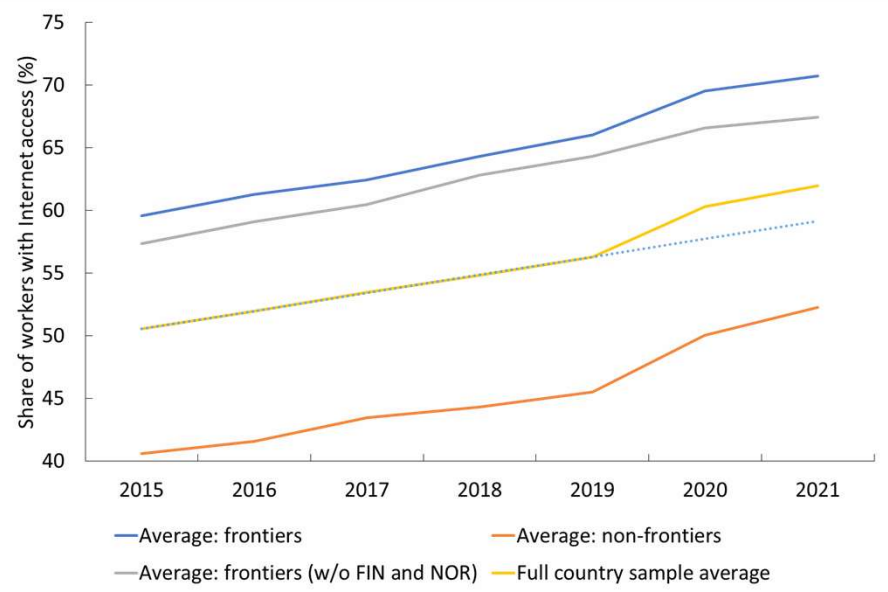
Sources: Eurostat and IMF staff calculations.
Note: Country sample includes AUT, BEL, CZE, DEU, DNK, ESP, EST, FIN, FRA, GBR, GRC, IRL, ITA, LTU, LUX, LVA, NLD, NOR, PRT, SVK, SVN, SWE and USA.
ICT = information communication technology, W-R Trade = wholesale and retail trade

COVID-19 has accelerated digitalization

Digitalization measured as the share of workers using a computer with internet access increased during COVID-19, particularly in countries that were less digitalized.

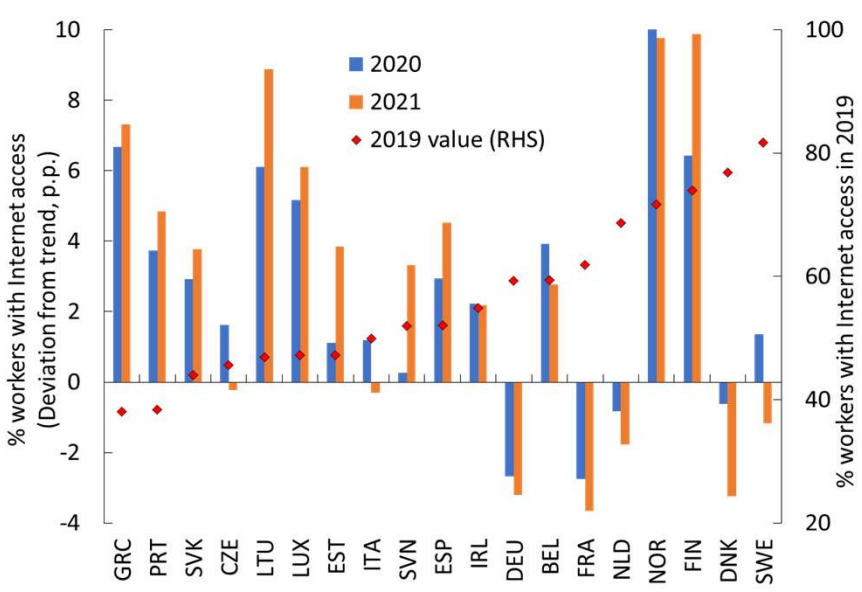
Trend in Workers Using a Computer with Internet Access

(Percent)



Deviation from the Trend: Workers Using a Computer with Internet Access

(Deviation from 2015–2019 trend, p.p.)

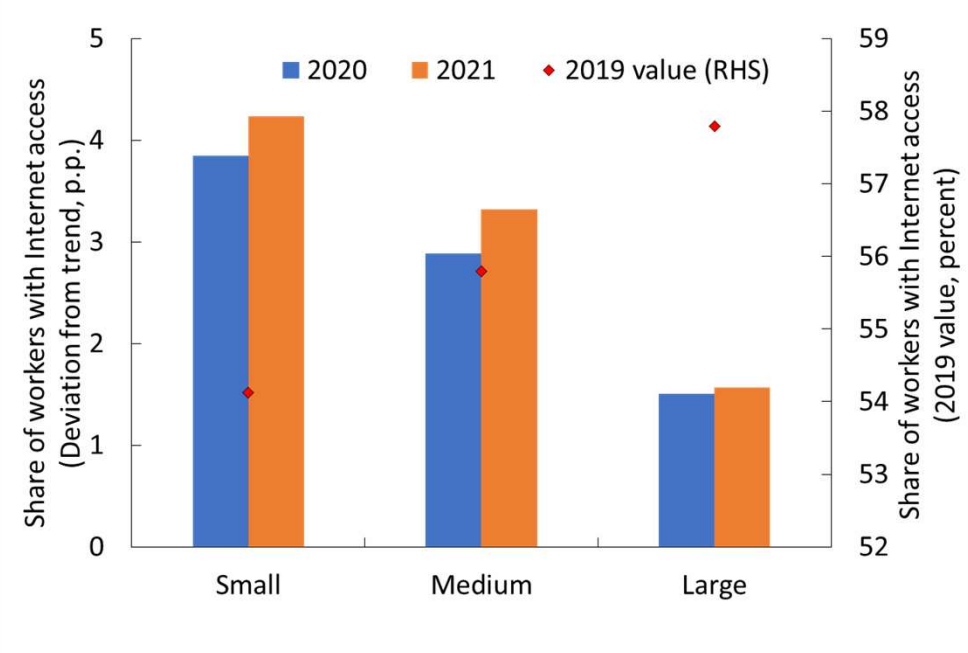


Sources: Eurostat and IMF staff calculations.
Note: Countries included: BEL, CZE, DEU, DNK, ESP, EST, FIN, FRA, GRC, IRL, ITA, LTU, LUX, NLD, NOR, PRT, SVK, SVN and SWE.
Frontier = BEL, DEU, DNK, ESP, FIN, FRA, IRL, NLD, NOR and SWE.

This phenomenon was strong among small firms and firms in contact-intensive sectors…

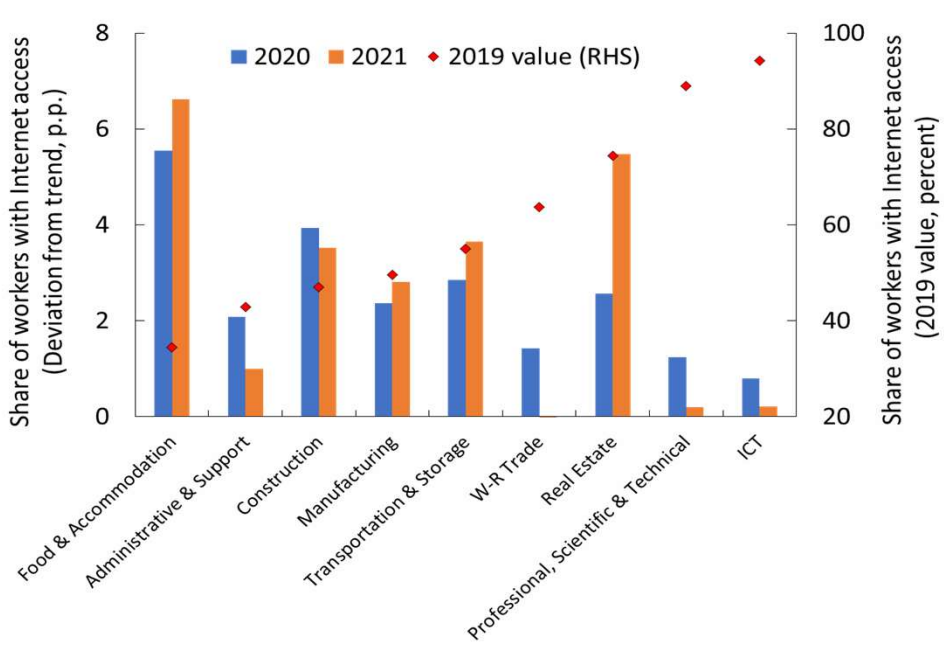
Trend in Workers Using a Computer with Internet Access by Firm Size

(Deviation from 2015-2019 trend, p.p.)



Trend in Workers Using a Computer with Internet Access by Sector

(Deviation from 2015-2019 trend, p.p.)

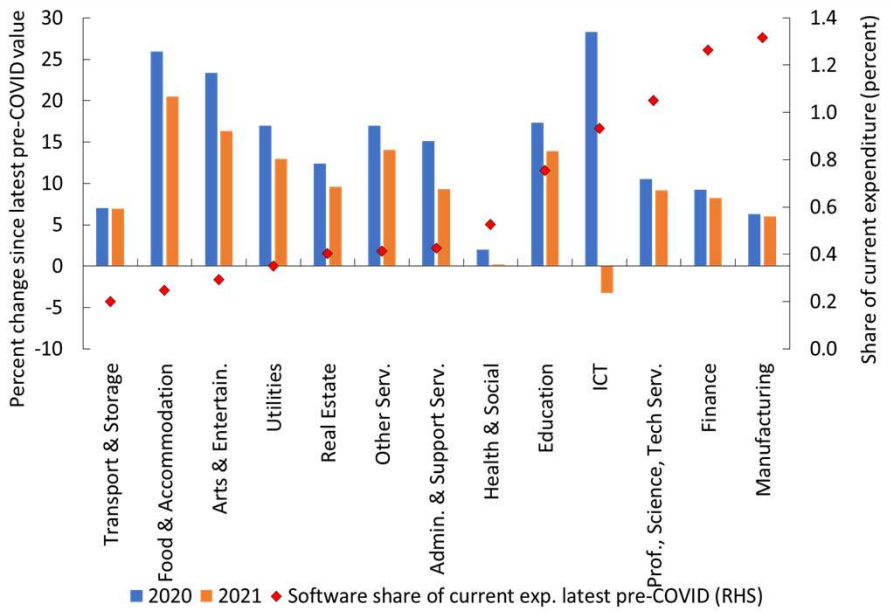


Sources: Eurostat and IMF staff calculations.
Note: Countries included: BEL, CZE, DEU, DNK, ESP, EST, FIN, FRA, GRC, IRL, ITA, LTU, LUX, NLD, NOR, PRT, SVK, SVN and SWE

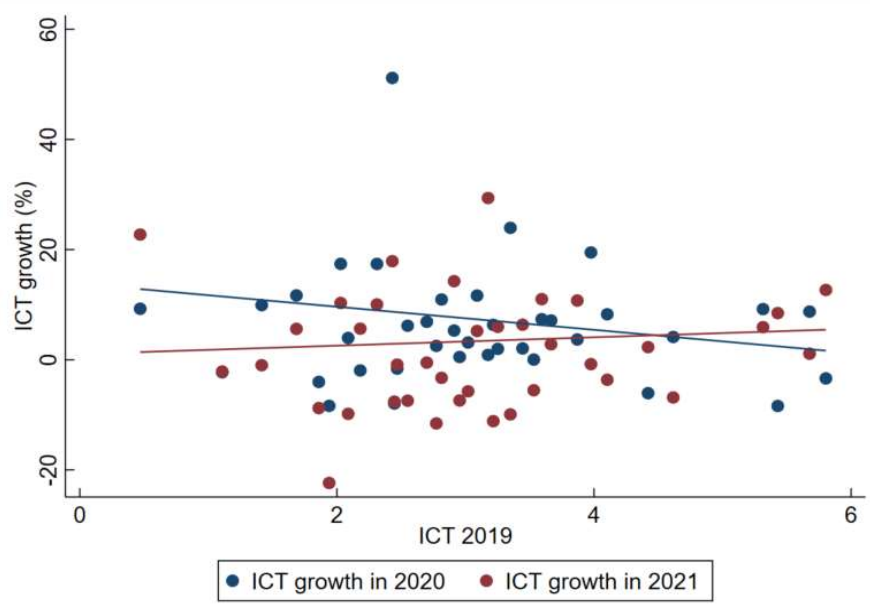
A similar pattern emerges in the US

In 2020, less digitalized US firms and sectors invested relatively more in computers and software per worker, but this pattern reversed in 2021.

US: Software Spending per Employee by Sector
(Percent change relative pre-COVID level)



US: Change in Firm-Level ICT Growth Rate
(Relative to 2019 ICT level)



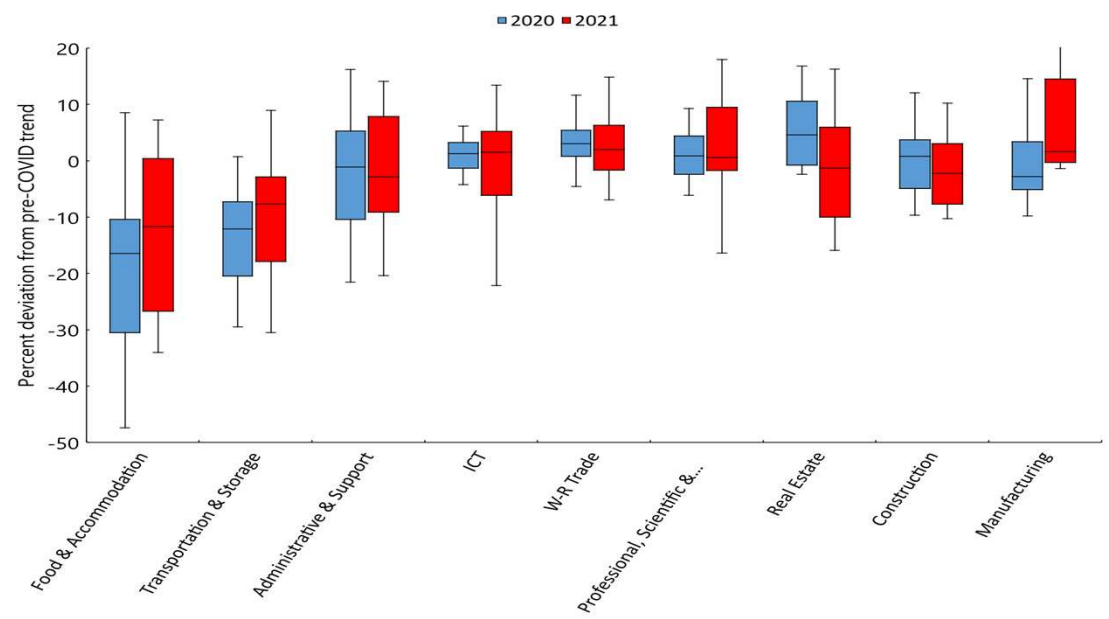
Sources: Worldscope; US Census Bureau Annual Survey of Manufactures and Service Annual Survey; and IMF staff calculations.
Note: Left figure: Latest available pre-COVID year is 2017 for most sectors. The percentage changes from the pre-COVID period to 2020 are turned into annual rates for comparability. The variable on the LHS y-axis is the percent change in software spending per employee while the variable on the RHS y-axis is the share of software expenditure as a share of total current expenditure in the sector. Right figure: Balanced sample 2015 onwards for the United States which includes 640 publicly traded firms reporting non-missing ICT. ICT intensity is defined as the log of the ratio of computer equipment and software assets to workers.

Digitalization and Productivity

The COVID-19 pandemic had a heterogeneous impact on productivity across sectors

Some of the sectors with the largest contractions in productivity are those with lower average levels of digital intensity, such as Food & Accommodation and Transport & Storage. But there is also substantial variation across countries for each sector.

Cross-Country Labor Productivity Deviation from Pre-COVID Trend by Sector

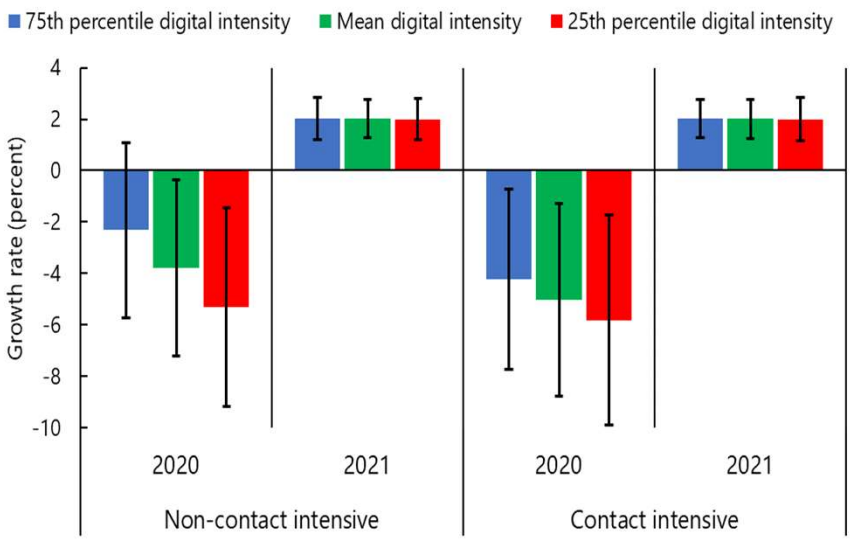


Sources: Eurostat; US Bureau of Economic Analysis and Bureau of Labor Statistics; UK Office of National Statistics; and IMF staff calculations.
Note: Labor productivity is defined as real value added per hour worked. The figure shows the distribution of percent deviations from pre-COVID-19 trends within each sector. The horizontal line within the box represents the median, the box edges are the 25th and 75th percentiles, the whiskers report the upper and lower adjacent values. The country sample is: AUT, BEL, CZE, DEU, DNK, ESP, EST, FIN, FRA, GBR, GRC, IRL, ITA, LTU, LUX, LVA, NLD, NOR, PRT, SVK, SVN, SWE, and USA.

The role of digitalization: a higher digitalization for a given sector led to milder labor productivity losses in 2020.

Higher levels of digital intensity in a sector reduced sectoral labor productivity losses at the height of the pandemic. This was particularly pronounced in the non-contact intensive sectors.

Sector-Level Regression: Labor Productivity Growth by High and Low Digital Intensity and Contact Intensity Based on Estimated Coefficients



- Regression using 9 individual sectors in 22 advanced European economies over the period 2020-2021,
- The variable used to reflect the COVID-19 shock is the year-over-year change in the Google mobility indicator at the country level.
- Control variables: countries' demographic characteristics, the coverage of job retention programs in 2020, sector fixed effects, the un-interacted digital intensity, and countries' fiscal support in 2020.

Sources: Eurostat; Organisation for Economic Cooperation and Development; and IMF staff calculations.

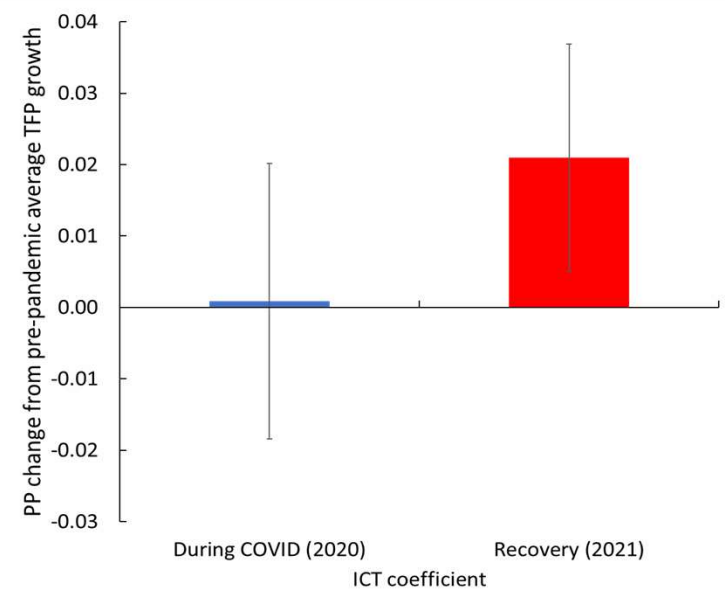
Note: The figure plots a linear combination of the estimated regression coefficients representing the predicted labor productivity growth rate, in a country experiencing an average change in mobility, for a sector with high (75^{th} percentile, blue bar), average (green bar), or low (25^{th} percentile, red bar) digital intensity based on a sector-adjusted distribution (i.e., abstracting from differences across sectors in the average level of digitalization) separately for non-contact intensive and contact-intensive sectors. Country sample: AUT, BEL, CZE, DEU, DNK, ESP, EST, FIN, FRA, GBR, GRC, IRL, ITA, LTU, LUX, LVA, NLD, NOR, PRT, SVK, SVN, and SWE. Annex 2 describes the regression specification and the data in detail.

TFP for publicly listed firms: highly-digitalized firms left the crisis faster than less-digitalized firms

Within-firm TFP growth in 2021 was relatively larger for the ex-ante more digital-intensive firms in both US and advanced European countries.

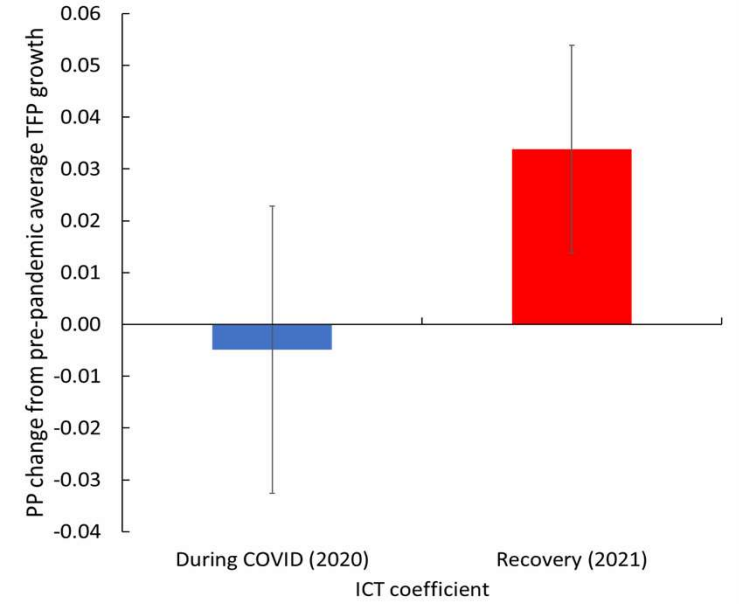
US: ICT's Impact on TFP Growth

(Percentage point deviation)



Advanced Europe: ICT's Impact on TFP Growth

(Percentage point deviation)



Sources: Worldscope; Eurostat; and IMF staff calculations.

Note: The left figure plots the ICT coefficient multiplied with the ICT standard deviation from regressing the within-firm difference between the TFP growth in 2020 and 2021 and the average pre-COVID TFP growth for a sample of US publicly listed firms. The measure of ICT intensity is the log of deflated computer equipment and software assets over workers. Standard errors are clustered at the state-industry level, and the whiskers denote 95% confidence intervals. The right figure plots the ICT coefficient multiplied with the ICT standard deviation from a similar regression using a sample of advanced European publicly listed firms. Countries included are AUT, BEL, DEU, DNK, ESP, FIN, FRA, GBR, GRC, IRL, ITA, LUX, NLD, PRT and SWE. Due to data limitations, it is not possible to employ an ICT intensity measure at the firm level for the European sample. Instead, the measure employed is at the country-sector level and is the pre-pandemic average of the share of workers with PC that has internet access for each country-sector cell. Standard errors are clustered at the country-sector level and the whiskers denote 95% confidence intervals.

Historical link between digitalization and TFP

A positive but moderate relationship between the ratio of gross computer equipment and software assets to workers and long-term TFP

Firm-Level Regression on TFP Growth Rate Differences for US
(percentage points)

Dependent variable:	TFP growth rate	LP growth rate
Frontier firm' TFP growth	0.1480***	0.0815*
	(0.033)	(0.0410)
Lagged productivity gap	0.052***	0.0494***
	(0.004)	(0.0102)
Lagged Computer & Software/Workers (log)	0.003***	0.00529***
	(0.001)	(0.00104)
Total Assets (log)	0.00171***	0.00278*
	(0.0004)	(0.00130)
Age	-0.202*	-0.00685***
	(0.0006)	(0.0005)
Observations	6,799	7,084
R-squared	0.08	0.0891
Sector FE	YES	YES
Year FE	YES	YES
Root mean square error	0.0879	0.1662

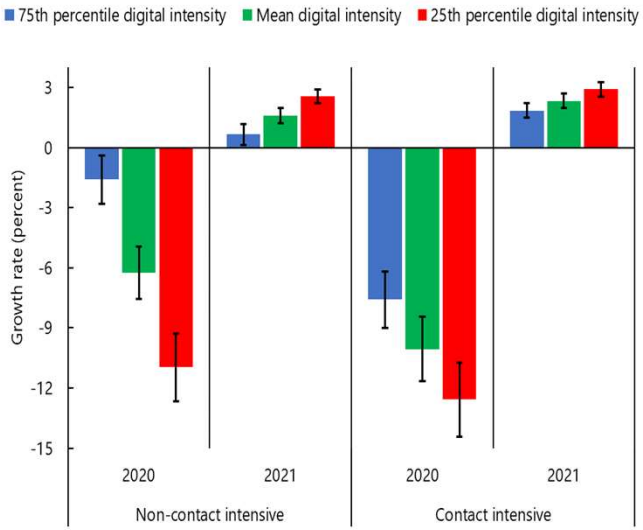
Sources: Worldscope; Organisation for Economic Co-operation and Development; and IMF staff calculations.
Note: Standard errors are clustered at the state-sector level. *** p<0.01, ** p<0.05, * p<0.1

Digitalization in Labor Markets

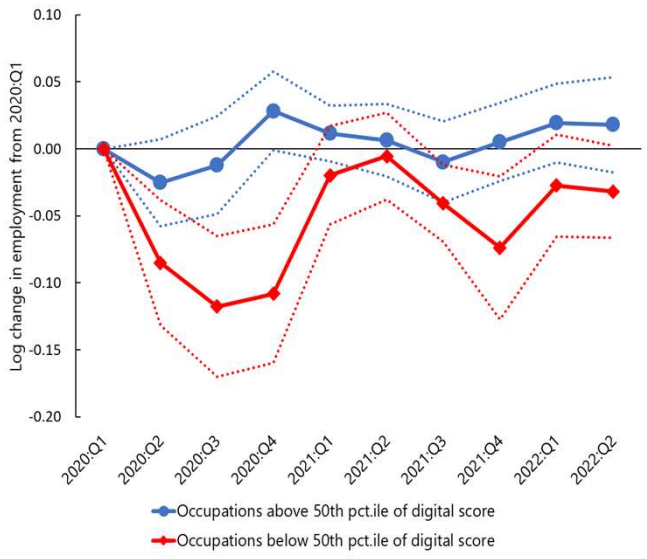
Digitalization shielded employment, but there is no evidence so far of a structural change in the composition of labor demand

Higher levels of digital intensity in a sector reduced losses in hours worked at the pandemic peak. Region-level regressions suggest a temporary "shielding" of employment in digital occupations in the US/UK but no structural change in the composition of labor demand.

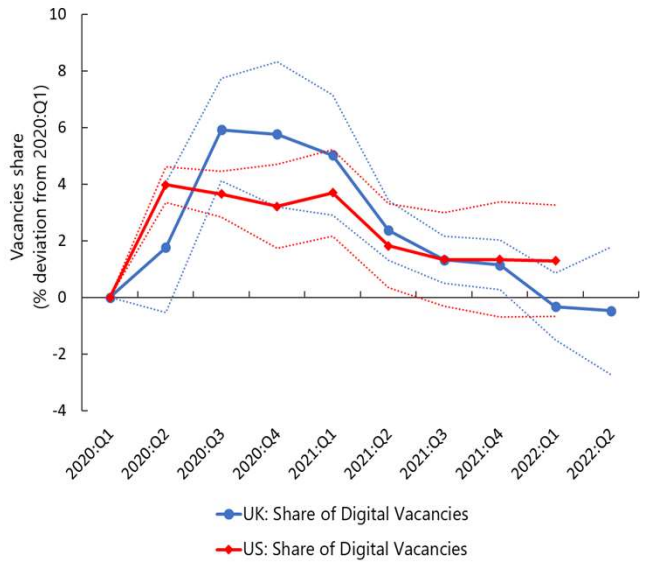
Sector-Level Regression: Hours Worked by High and Low Digital Intensity and Contact Intensity Based on Estimated Coefficients



US: Employment of Digital and Non-Digital Occupations



US, UK: Share of Digital Occupations in Vacancies

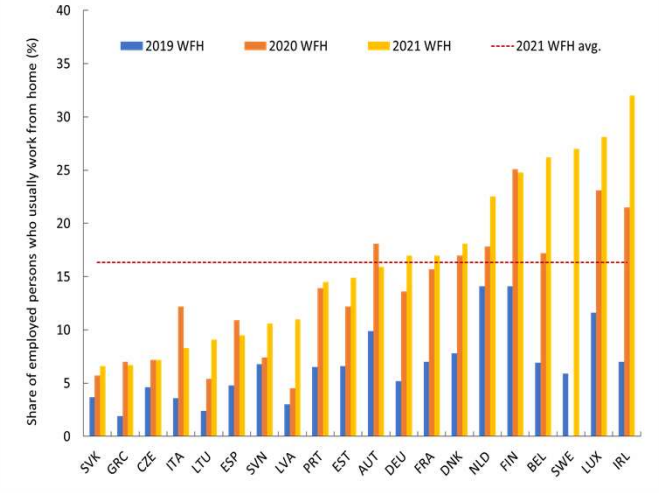


Sources: Eurostat; Organisation for Economic Cooperation and Development; US BLS, UK ONS, Indeed, and IMF staff calculations.
Note: Panel 1 plots a linear combination of the estimated regression coefficients representing the predicted growth rate of hours worked, in a country experiencing an average change in mobility, for a sector with high (75th percentile), average, or low (25th percentile) digital intensity based on the sector-adjusted Country sample: advanced European economies. Panel 2, 3: region-level regression of level of employment in digital occupations and share of digital occupations in total vacancies regressed on measures of regional exposure to the COVID-19 shock. Digital occupations are defined as those with an O*NET digital score above the 50th percentile.

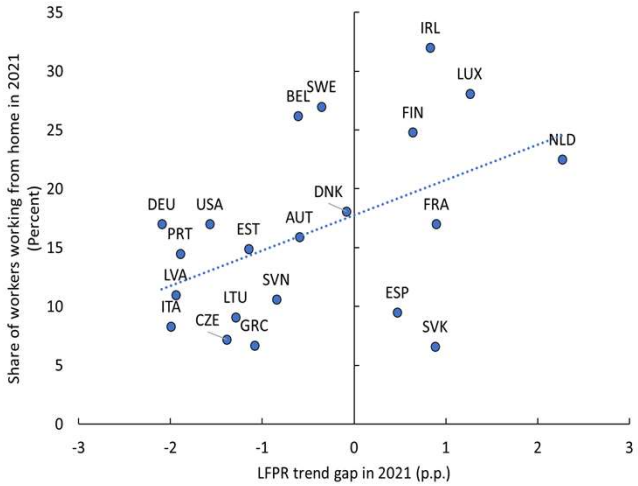
The increase in work from home appears to be a more persistent trend and could potentially boost labor supply

Working from home rose further in 2021, possibly suggesting a more persistent trend. This shift may ultimately increase labor market attachment and labor supply. The UK case shows that in 2022 transitions from employment to inactivity for workers who mostly work from home have been converging to those of on-site workers, while in the US they were already lower.

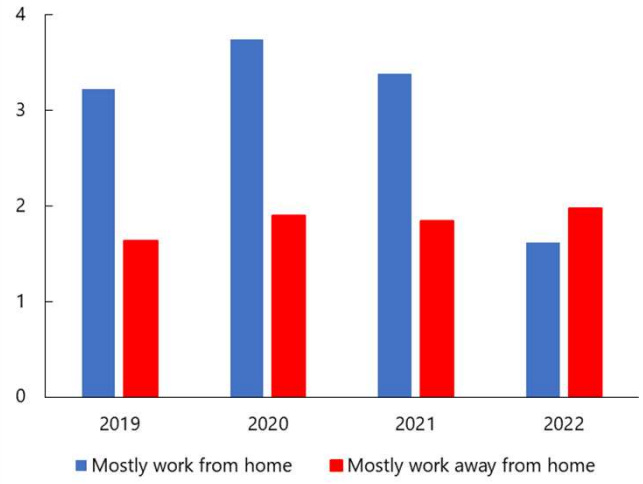
Share of Workers Who Usually Work from Home



Changes in Labor Force Participation and Digitalization



UK: Quarterly Transition Rate into Inactivity by Work from Home Arrangements for Female Workers



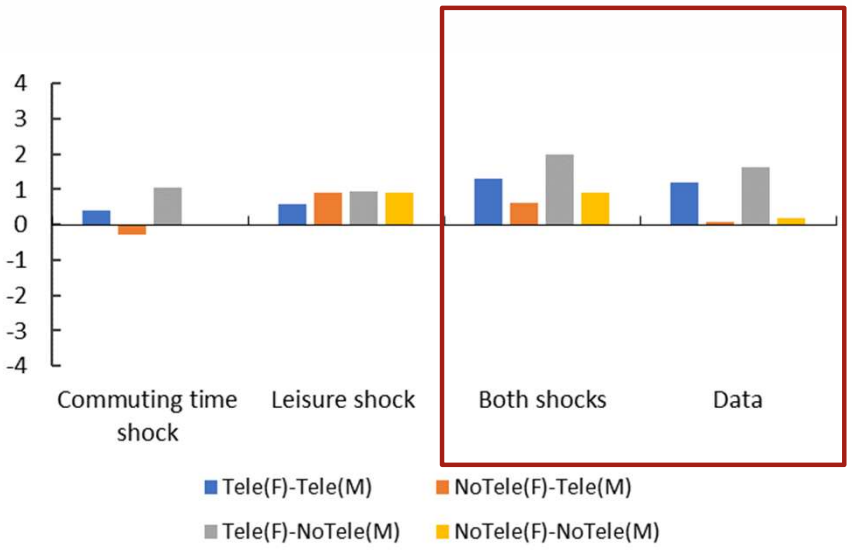
Sources: Eurostat; UK Labour Force Survey; and IMF staff calculations.

Note: Left figure: The blue bars report the average change in the share of those working from home from 2019 to 2022 across countries. The center figure plots the deviation in labor force participation from its pre-COVID-19 trend against the change in the share of workers usually working from home from 2019 to 2021. The right figure plots the probability that an employed worker transitions into inactivity (out of the labor force) from one quarter to the next.

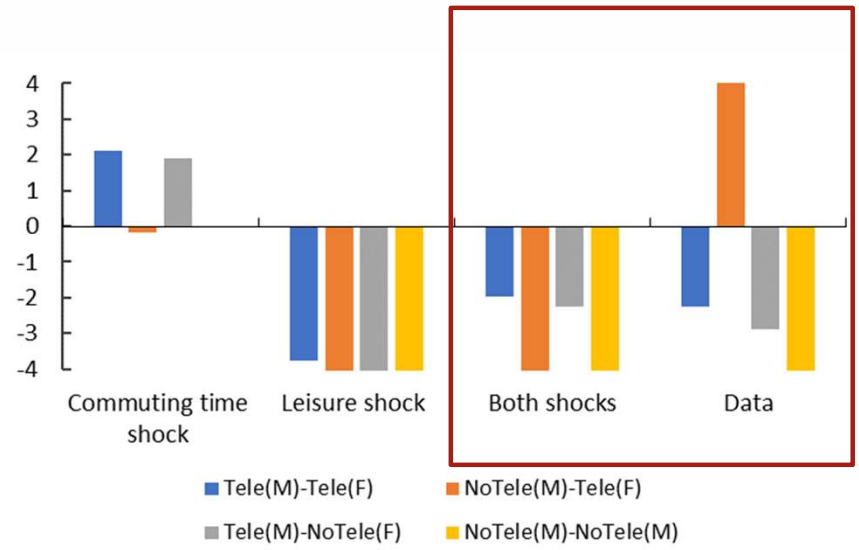
Working from home can stimulate labor supply

To disentangle the potential channels through which the pandemic may have impacted working hours, a model of household labor supply is developed. Working from home reduces commuting time allowing workers to spend more time enjoying leisure and working. The data, however, also suggest an acceleration of the trend toward larger preference for leisure among men during the pandemic, offsetting the gains in men's labor supply.

Female Changes in Hours Worked



Male Changes in Hours Worked



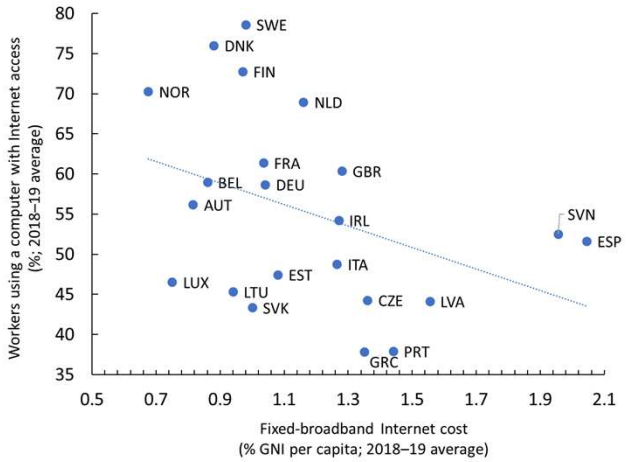
Sources: American Time Use Survey (ATUS) and IMF staff calculations.

Note: Panel 1 and 2 present the results from the model simulation and the actual data. The simulaions show the results of: (i) a shock that reduces commuting time among workers in teleworkable occupations (Tele), (ii) a shock that increases men's preference for leisure in teleworkable and nonteleworkable occupations (NoTele), and (iii) the combination of the two shocks. Panel 1 plots the changes in weekly hours worked for women and Panel 2 for men.

Conclusion and policy recommendations

- The pandemic triggered an increase in digitalization, especially in less digitalized entities.
- Digitalization shielded labor productivity and hours worked during the pandemic, and shielded digital occupations
- While it is still early to tell what the long-term consequences for productivity and labor markets will be, the evidence so far points to:
  - Possible gains in TFP
  - No structural shift in the composition of labor demand
  - Persistent increase in work from home, which could increase workers' welfare and labor market attachment
- There are still large differences in digitalization across countries and the pandemic-induced digitalization was possibly more focused on basic forms of digitalization rather than transformational ones
- Government policies can support a more digitalized economy and ensure gains are broadly shared by investing in infrastructure, fomenting competition in the ICT sector, and investing in human capital.
- Labor laws and regulations must adapt to changing working environments to facilitate fair telework.

Digitalization Cost and Penetration



Sources: International Telecommunication Union; Organisation for Economic Cooperation and Development; and IMF staff calculations.

WORLD ECONOMIC OUTLOOK

Staff Discussion Note:

THANK YOU!