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Teleworkers' digital up-skilling: Evidence from the spring 2020 lockdown

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Abstract

During the spring 2020 COVID-19 lockdown, the proportion of employees who worked from home increased sharply, which increased the use of digital tools. In this context, we study how teleworkers improved their digital skills. More specifically, we ask whether the lockdown was an opportunity for teleworkers to increase their digital skills and whether some subgroups with traditionally lower digital skills (women, older workers, and less educated) have benefited from a catch-up effect. Using a sample of 438 employees working for firms located in Luxembourg, our empirical analysis shows, first, that three out of ten teleworkers felt that they improved their digital skills during the lockdown and, second, that the lockdown helped to reduce the gender and age digital skill gap but broaden the educational digital skill gap. Third, training and more frequent use of many digital tools during the lockdown are positively related to the digital upskilling feeling, but not for all subgroups of teleworkers studied. Finally, the feeling of digital upskilling is inverted U-shaped in the number of digital tools discovered during the lockdown, but not for all subgroups of teleworkers studied.

Keywords: lockdown; work from home; digital tools; upskilling; catch-up effect

Introduction

The spring 2020 COVID-19 lockdown accelerated remote work from home, which was previously underdeveloped in industrialised countries. For instance, in US, Barrero, Bloom, and Davis's (2020) surveys show that 5% of all full work days were supplied from home before the lockdown, which increased to 50% during May-October 2020. In UK, 4.7% of the employed reported working mainly at home in 2019, which increased to 43% in April 2020 (Felstead and Reuschke 2020). In France, 3% of employees worked remotely in 2017 (DARES 2019), which increased to 32% during the lockdown – 75% of teleworkers engaging in remote work for the first time (Pénard and Coulanges 2020). In the case of Luxembourg, the country studied in this article, STATEC (2020) shows that 20% of residents worked from home over the 2015 - 2019 period, which increased to 52% of residents during the lockdown (for 74% of them, it was a first experience).¹

The increase in remote work from home, anticipated to last after the COVID-19 health crisis (Alipour, Langer, and O’Kane 2021; Bloom, Han, and Liang 2022), is part of long-term and deep mutations of the labour market, which is undergoing substantial changes with the digital transformation, (e.g. Arntz, Gregory, and Zierahn 2016; Frey and Osborne 2017). In fact, most of the jobs are changing with an increased use of digital tools and new jobs are appearing as new opportunities are opened up by Big Data, Artificial Intelligence, Internet of Things, and other technological advances (Brynjolfsson, Rock, and Syverson 2019).²

In this context, it is important that employees develop their digital skills to better their experience of remote work from home as well as increase their access to transformed or newly created jobs in the coming years. This is critical since 15.6% of EU-27 workers were found to be insufficiently skilled in the use of digital technologies to do their job in December 2019 (Eurobarometer 2020). Moreover, some socio-demographic groups generally report a lower level of digital skills, e.g. women, older workers, and less educated people. For example,

Eurostat data³ show that in EU-27, in 2019, 29% of women had digital skills a level above the basic level compared to 33% of men; 16% of individuals aged between 55 and 64 years had digital skills a level above the basic level compared to 36% of individuals aged between 25 and 54 years. This share is 16% for individuals with no or low level of formal education and 54% for individuals with high level of formal education. These differences are reflected in the feeling of being insufficiently skilled in the use of digital tools to do the job more frequently by women workers than men workers (16.8% compared to 14.5%)⁴, for older workers than young workers (23.5% for 55-64 years compared to 13.9% for 25-54 years)⁵, for less educated workers than highly educated workers (CEDEFOP 2017).

The aims of this article are to investigate the factors that help teleworkers improve their digital skills, and identify the potential catch-up by three subgroups – women, older and not highly educated – while testing the “Matthew effect” hypothesis put forward in the literature (Boeren, Roumell, and Roessger 2020). As per the Matthew effect hypothesis, in the realm of training, participation in training widens the gap between the best and the worst individuals. Specifically, in the context of digital skills, e-learning or learning-by-doing imposed by the lockdown would widen the skills gap between the least and most vulnerable groups, leading to a reinforcement of the digital divide.

In this article we contribute to the literature in several ways. First, existing research on the lockdown period(s) focus mainly on the types of jobs that can be performed at home (e.g. Dingel and Neiman 2020), the characteristics of teleworkers (e.g. Barrero, Bloom, and Davis 2020; Eurofound 2020), and the impact of this new work organisation on some labour market outcomes like job productivity (Martin, Hauret, and Fuhrer 2022; Morikawa 2020; Rubin et al. 2020). Second, the huge increase of digital tools during the lockdown has been identified by services providers (e.g. Zoom, Microsoft) and some researchers (e.g. DeFilippis, Impink, Singell, Polzer, and Sadun, 2020) but only at macroeconomic level and their impacts on

teleworkers are largely neglected. Third, while digital skills must be improved to thrive in an increasingly digitally transformed work environment, our article is one of the first to assess the impact of using digital tools on improving teleworkers' digital skills. Fourth, in this article we examine the potential catch-up effect in digital skills of three subgroups and test the Matthew effect hypothesis with regard to the digital skills gap.

Our analyses are based on the "home office" module of the COVID-19 socio-economic impacts (SEI) open-ended non-incentivized online survey realised on the unique strict lockdown implemented in Luxembourg, and collected between end of May and early July 2020 from around 450 employees working in the country. Luxembourg is a small Western European country characterised by the predominance of its service sector, by a multinational and a cross-border working population, and with a level of digitalisation slightly above the level in the European Union. Hence, our study provides new findings about employees working in a service economy and living in the country or in neighbouring countries –Belgium, France and Germany.

The rest of the article is organised as follows. In the following section we review the existing empirical research on the digital skills needs of the labour market, and factors for improving employees' digital skills during the spring 2020 lockdown work from home experience. In the next section we describe our data collection and methods. In the subsequent section we present and discuss our findings. In the final section we bring our discussion to a conclusion.

Related literature

Digital skills needs

In the context of the fourth industrial revolution, having digital skills is important for accessing and maintaining employment (Falck, Heimisch-Roecker, and Wiederhold 2021; Martin 2020). Indeed, the labour market is undergoing substantial changes tied to digital transformation that

affects the occupational and skills structures (e.g. Arntz, Gregory, and Zierahn 2016; Frey and Osborne 2017). Nevertheless, a medium level of digital skills (e.g. using MS office, or online search, see OECD, 2016a for details) and not an expert level of digital skills is currently needed on the labour market, as shown, in training curricula data, by Eggenberger and Backes-Gellner (2021) or in online job offers by Sostero and Tolan (2021). Beyond the lockdown period(s) induced by the COVID-19 health crisis, the demand for remote work from work from home will last and that for digital skills will increase (Alipour, Langer, and O’Kane 2021; Bloom, Han, and Liang 2022). CEDEFOP (2020) indeed shows that, in 2019, digital skills represented 20% of total skills demanded in online job advertisements; this share has increased to 23% in 2020, which is the largest increase among all skills demanded in online job ads. This increased demand for digital skills will continue as workers, even when in the office, appear to increasingly use instant messaging and video call communication to perform their work (Bloom, Han, and Liang 2022).

However, before 2020, OECD (2016b) points out that 56% of adult living in mid 2010s in an OECD country had no digital skills or a very low level of digital skills. More recently, a survey conducted by Eurobarometer (2020) shows that in the EU-27, in December 2019, 15.6% of workers were considered to be insufficiently skilled in the use of digital technologies to do their job. This second level of digital divide (Hargittai, 2002) attracts the attention of public policy and employers (CIPD 2021).

Employees’ digital upskilling

During the lockdown period(s), mandatory shifts from office-based to remote work and from face-to-face to online collaborations may have provided an opportunity to improve digital skills, particularly for disadvantaged groups, and may have resulted in a catch-up effect.

To the best of our knowledge, few studies analyse the impacts of COVID-19 lockdown period(s) on workers' digital upskilling.

Nevertheless, a survey, conducted in late January/early February 2021, on about 30,000 workers in 19 countries shows that 40% of workers declare that their digital skills have increased during the lockdown period(s) (PWC 2021). Pathak and Duggal (2020), based on a survey of Indian population living in the National Capital Region (NCR), found that individuals took advantage of the lockdown periods to acquire new skills: 72.8% of respondents answered that they learned new communication tools during the lockdown period(s). Focusing on older workers during the COVID-19 pandemic, König and Seifert (2022) found that older workers who fully worked at home are, all things being equal, more likely than those who partially worked at home during this period to report having improved their digital skills.

To acquire new skills, including digital skills, individuals can use three different ways. First, some studies show that education provided by firms has been impacted by lockdown period(s). Training was discontinued during these periods (ILO 2021). Further, van Loo, Eiffe, and van Houten (2021) found that the proportion of workers who participated in training offered by firms decreased in 2020 compared to 2019. Firms also focused more their training strategy on supporting individual employees rather than strengthening the training participation overall (van Loo, Eiffe, and van Houten 2021). Moreover, a majority of firms took some actions to pursue the training of their employees, the most common one was to offer online training (Chanana and Sangeeta 2021; ILO 2021).

Second, Kleinert, Zoch, Vicari, and Ehlert (2021), based on German data, show that the individual use of online learning for work purpose increased during the lockdown period(s) compared to before. Nevertheless, they found that the development of online learning during lockdown period(s) does not help to decrease the learning gap between educational groups.

The most highly educated also make more use of online training opportunities than the less educated (Calonge and Shah 2016).

Third, some studies highlight that the do-it-yourself method is efficient to increase digital skills. According to Agrawal, Smet, Lacroix, and Reich (2020), many employees “learned by doing” during the first period of the COVID-19 pandemic. Digital upskilling is supported by the do-it-yourself approach in particular because Internet use at home allows for exploration and experimentation (van Dijk 2005). Kuhlemeier and Hemker (2007), based on a Dutch study of more than 2,500 students, show that Internet and computer skills are positively linked, everything else being equal, to students use of computer at home (for surfing, emailing, chatting, and text processing). Matzat and Sadowski (2012) show that a frequent use of the Internet, through the trial-and-error process, increases individuals’ digital skills. While they observed that it is most beneficial for those who already have digital skills, they identify a catch-up effect in digital skills for older individuals compared to younger ones.

Bjursell, Bergmo-Prvulovic, and Hedegaard (2021) highlight the lack of research on the impact of work from home on employee learning and upskilling. Nevertheless, Dima, Tuclea, Vrânceanu, and Tigu (2019) point out that the autonomy enjoyed by teleworkers can encourage them to develop new skills and thus increase the effectiveness of training programs. Moreover, Saputra, Nugroho, Aisyah, and Karneli (2021) show that, in the context of work from home, development of employee’s digital skills is more influenced by collaboration with colleagues (digital collaboration) than superior asking (digital leadership). Existing research also shows that individuals are willing to make efforts more easily if other employees also adopt these tools and with an external nature of the constraint to use it (Sutan and Vranceanu 2016).

After the COVID-19 pandemic, the return to the office will be associated with some days of work from home per month creating a hybrid work environment (Alipour, Langer, and O’Kane

2021; Bloom, Han, and Liang 2022). The digital upskilling will remain useful, as the use of digital tools will stay at a high level (e.g. instant messaging and video conference, Bloom, Han, and Liang 2022) and the digital transformation of the labour market is underway.

Socio-demographic differences

Some socio-demographic groups report a lower level of digital skills: women (Barbieri et al. 2020; Perifanou and Economides 2020), elderly (Feijao et al. 2021) and less educated people (van Laar et al. 2020). Most of the existing empirical evidence relies on self-assessment measure that may differ from an objective measure (Hargittai and Shafer 2006). Nevertheless, perceived skill level is important to consider because it guides individual choices through the estimated probability of success in an area (Guo et al. 2015).

Gender

Before the COVID-19 pandemic, Barbieri et al. (2020) found that only in six (Finland, Slovenia, Lithuania, Latvia, Cyprus, and Bulgaria) of twenty-eight EU countries, women score higher than men on declared Internet user skills. This finding echoes earlier studies that show that women report fewer Internet skills than men (Cooper 2006; van Deursen and van Dijk 2015; Wasserman and Richmond-Abbott 2005). More recently, Perifanou and Economides (2020) found that, in 2019 in Greece, 44% of women have at least basic digital skills (versus 49% of men); 20% have above digital skills (versus 23% of men); and 50% have at least basic software skills (versus 55% of men).

Few weeks before the lockdown it was observed at the EU-27 level that women are proportionally more likely than men to have lower levels of self-reported digital skills useful in their daily lives (e.g. Eurobarometer 2020).

Nevertheless, as suggested by Hargittai and Shafer (2006), it could be that the perceived skills differ more than the actual abilities: focusing on Internet-use ability and using US data

collected in 2001 and 2002, Hargittai and Shafer (2006) show that men and women differ in their perceived skills but do not differ in their abilities to navigate online. They suggest that it may affect the extent of women online behavior and types of use. For instance, gender differences in self-perceived Internet skills affect contributions to Wikipedia (Hargittai and Shaw 2015).

Age

Peng, Anwar, and Kang (2017) found that the diffusion of information and communication technologies on the European labour markets gradually eroded the skills of older workers over the period 1970-2007. Further, older workers have fewer digital skills than their younger counterparts (Cotten 2021; Francis et al. 2019). According to European statistics from 2020, in the EU-28, 82% of individuals aged 16-24 years report possessing at least a basic level of digital skills compared with only 35% of individuals aged 55-74 years (European Commission 2020; Feijao et al. 2021).

Regarding Internet skills, several studies show that seniors are less likely, than their younger counterparts, to have them (van Deursen and van Dijk 2015; van Deursen, van Dijk, and Peters 2012). Moreover, empirical research shows that older workers think that it is too late in their work career to adjust to new technologies (Ahituv and Zeira 2011), making them less likely to participate in training opportunities (Carmichael and Ercolani 2014). Further, Marquié, Jourdan-Boddaert, and Huet (2002) found that older people have a low confidence in their computer abilities. This lack of confidence can lead older people to invest less in the digital domain. Interestingly, Matzat and Sadowski (2012) and Yao et al. (2021), found that older users benefit more from trial-and-error use of Internet than younger users do to improve their digital skills.

Education level

In the literature review proposed by van Laar et al. (2020), the educational level is frequently reported as significant to explain digital skills level of individuals. Existing empirical research underlines that the level of digital skills is positively linked with education (Gui & Argentin, 2011). Studying the possession of Internet skills among the Dutch population with data collected between 2010 and 2013, van Deursen and van Dijk (2015) report that education appears as an important contributor to all Internet skills. More specifically, van Deursen, van Dijk, and Peters (2011) analyzing Dutch data collecting in 2007, 2008, 2009, found that education positively affects the level of medium-related Internet skills (operational and formal) and the level of content related skills (information and strategic). Calonge and Shah (2016) found that the most highly educated make also more use of online training opportunities (especially Massive Open Online Courses-MOOCs) than less educated that may reinforce the digital gap between the two groups.

Data and methods

Data

We use the first wave of the COVID-19 Socio-Economic Impacts (SEI) survey conducted by the Luxembourg Institute of Socio-Economic Research (LISER) and the University of Luxembourg with the support of the Luxembourg National Research Fund (FNR).⁶ The data were collected between the end of May and the beginning of July 2020 with questions centered on the use of digital tools before, during and after the spring 2020 lockdown. Following Dijkstra et al. (2021), the data were collected through an open-ended non-incentivized online survey and not by drawing on a probability sample. This permitted the collection of data for an initial rapid assessment of the socio-economic effects of the COVID-19 pandemic on a sample of easily contacted individuals. The survey was announced by a press release, in association with

an extensive newspaper and social media campaign. As pointed by Lehdonvirta et al. (2021), such non-probability samples have strengths and weaknesses. As strengths, they enable quick, cheap, and easy access to individuals. As weaknesses, they could suffer from topical and economic self-selection, whereby there are differences between the sample and the studied population. A comparison of the profile of the employed respondents with the profile of the whole working population of Luxembourg indeed shows an overrepresentation of women, residents, and employees working in the tertiary sector. Therefore a weighting procedure was used to ensure that the distributions in the sample by gender, age, status as a resident or a cross-border worker, and sector of activity of the employers were representative of people at work on the Luxembourgish labour market on March 31, 2020.

In the present analysis, we focus on employees who used the opportunity to work from home during the lockdown. The studied sample includes 438 employees who work for firms located in Luxembourg and are residents or cross-border employees. Luxembourg is a small Western European country characterised by the predominance of its service sector and by a multinational and cross-border working population. In spring 2020, foreigners comprised 73.2% of the labour market. Specifically, regarding cross-border workers from Belgium, France, and Germany, they comprised 45.8% of the labour market. It should be noted that the Luxembourgish labour market offers the best employment opportunities for employees (at least in terms of wages and labour market dynamics) compared to other cross-border labour markets (STATEC 2019). According to the Digital Intensity Index (DII)⁷, which measures the use of different digital technologies by enterprises, the level of digitalisation in Luxembourg firms is slightly above the EU-27 level. In terms of digital skills⁸, in 2020, 13% of the enterprises provided training to upgrade ICT skills of their personnel (10% in EU-27). In comparison to home countries of cross-border countries, Luxembourg is quite similar to Germany (12%), higher than France (8%) and lower than in Belgium (18%).

The level of digital skill in the residential population⁹ is significantly higher in Luxembourg than in the European Union: in Luxembourg, 64% of the individuals have basic or above basic overall digital skills compared to 54% in EU-27. In comparison to home countries of cross-border countries, Luxembourg is quite similar to that in France (62%), and higher than in Belgium (54%) and Germany (49%).

Variables of interest

Digital upskilling

Our measure of digital upskilling is an individual self-assessment based on the following question: “If you compare your working conditions in a typical week in April 2020, during the COVID-19 lockdown, to your normal working environment in February 2020, would you say your digital skills have...? 1. Greatly decreased; 2. Decreased; 3. Remain the same; 4. Increased; 5 Greatly increased”. Due to the size of the sample, we group some items together. We observe that 31% of teleworkers have the feeling that their digital skills increased during the lockdown, while 67% believe that their digital skills have not changed, and 2% estimate that their digital skills have decreased. Due to too few observations in the group of teleworkers who feel a decrease of their digital skills, we construct a binary measure: 1 for an increase of digital skills and 0 otherwise.

Socio-demographic variables

We focus on three socio-demographic variables for which statistics and existing empirical evidence show a digital skill gap between groups (e.g. Eurobarometer 2020). It should be noted that most of the evidence, as in this study, are obtained on self-assessment measures. These variables are gender, age, and education level.

Gender: We create a dummy variable "men" indicating if the teleworker is a man.

Age: We create a dummy variable "older" indicating if the teleworker is at least 50 years old.

Educational level: We create a dummy variable "highly educated" indicating if the teleworker has at least a master's degree. The way we dichotomise the education level is constrained by the data: 17% of teleworkers in the studied sample have below a tertiary education, 28% have a tertiary education below master and 55% have a master's degree or more.

Supporting factors

Training

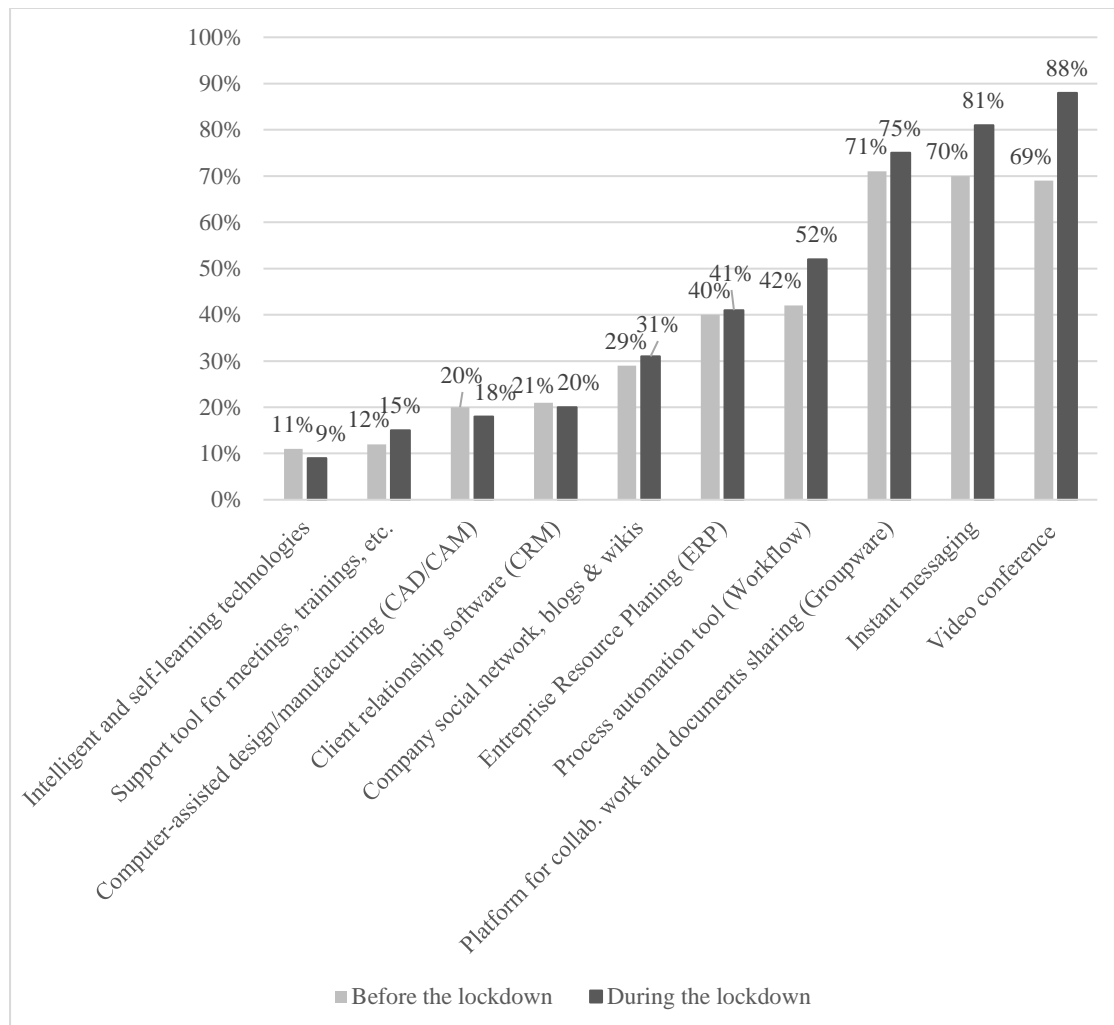
The survey included a question about whether the teleworker received training during the lockdown. We create a dummy variable "training" and observe that 25% of teleworkers benefited from training during the lockdown. We want to analyse if training helps more some subgroups compared to others to increase their digital skills. However, the data do not indicate who paid the training, in which area it took place, and how long did it last.

Evolution of use of digital tools

The SEI survey covers ten digital tools: (1) company social network, internal blogs, and wikis; (2) computer-assisted design/manufacturing (CAD); (3) client relationship management (CRM); (4) Enterprise resource planning (ERP); (5) instant messaging; (6) intelligent and self-learning technologies; (7) platform for collaborative work and documents sharing (groupware); (8) process automation tools (workflow); (9) support tools for meetings, trainings, etc.; (10) video conference tools. For each tool, respondents are asked how often they used it before the lockdown (February 2020) and during the lockdown (April 2020). The answers options are never; less than once a month; at least once a month; at least once a week; a few times a week; every day but limited use; several times a day.

Digital tools that are used to substitute face-to-face interaction (via platform for collaborative work and documents sharing, process automation tools, instant messaging, and video conference) showed an increase in the share of teleworkers using them during the lockdown compared to before (see Figure 1). The strongest growth is in the use of video conference: before the lockdown 69% of teleworkers used this tool compared to 88% during the lockdown. For the other tools studied, the share of users remained relatively stable or even decreased (probably due to a lower demand or a reduced need for high performance computer equipment related to the use of intelligent and self-learning technologies).

Figure 1. Share of teleworkers using digital tools before and during the lockdown

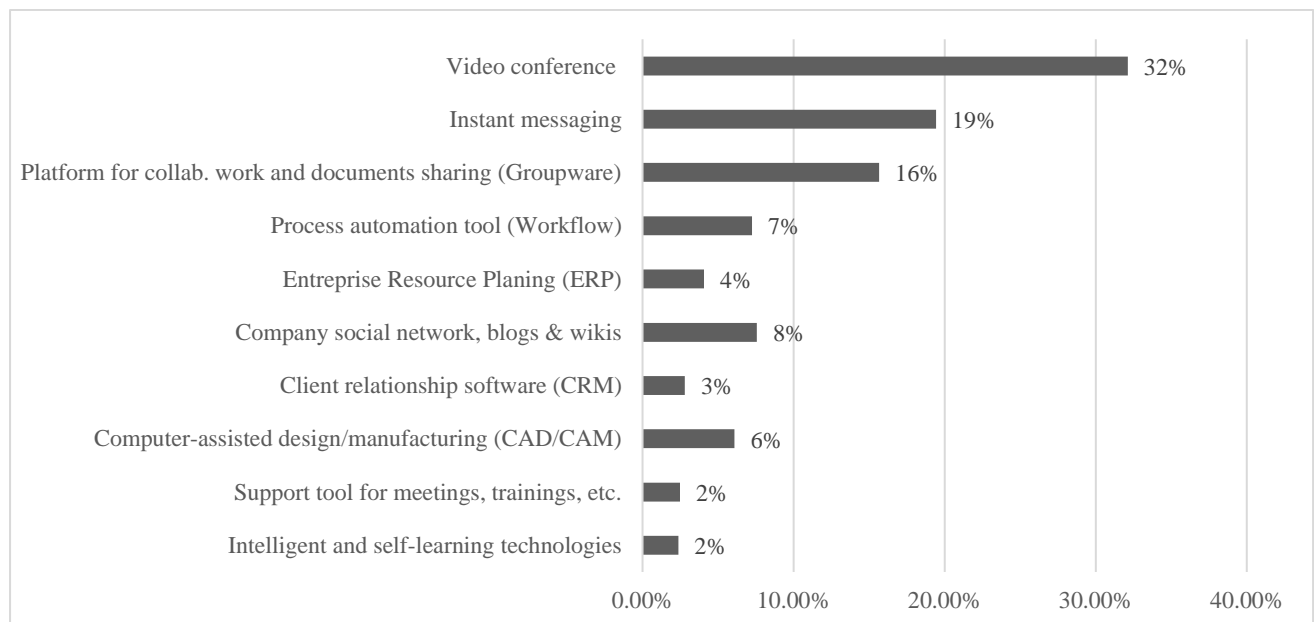


Source: First wave of the Survey on the COVID-19 socio-economic impacts in Luxembourg (SEI), 'home office' module, LISER and University of Luxembourg.

Notes: Weighted figures.

Comparison of teleworkers' digital tools uses before and during the lockdown shows that 57% of teleworkers did not discover any of the digital tools used during the lockdown; 21% discovered one digital tool, 11% discovered two digital tools, and 11% discovered at least three digital tools; 51.5% of teleworkers made a more frequent use of at least one digital tool that they already used before the lockdown. Figure 2 shows that the tool for which the frequency of use increased the most is video conference following by instant messaging and groupware.

Figure 2. Share of teleworkers who increased, during the lockdown, their frequency of use of digital tools they used before the lockdown, by type of tools



Source: First wave of the Survey on the COVID-19 socio-economic impacts in Luxembourg (SEI), 'home office' module, LISER and University of Luxembourg.

Notes: Weighted figures.

To take into account, in our analyses, the evolution of use of digital tools during the lockdown compared to before, we created two continuous variables.

The first variable "nb. digital tools discovered" measures the number of digital tools that the teleworker discovered during the lockdown. This variable ranges from 0 to 8 with a mean of 0.8 and a standard deviation of 1.35.

The second variable "nb. digital tools intensive growth" measures the number of digital tools that the teleworker used more frequently during the lockdown compared to before. This variable ranges from 0 to 6 with a mean of 1 and a standard deviation of 1.24.

Control variables

Finally, we control for a large scale of individual characteristics (e.g. resident/cross border, marital status). We also take into account other information which can have an effect on employees' digital upskilling like job characteristics (e.g. full time or not, permanent contract or not) and workplace characteristics (business sector). We also control for the work environment of the home workplace, the fact of having a previous experience of work from home, the level of digital skills requested to perform the job before the spring 2020 lockdown, the perceived degree of autonomy in the work, the perceived managerial support and the perception of actions implemented by the firm. The descriptive statistics of all variables are presented in Table 1.

Table 1. Descriptive statistics.

Variable	Mean	Std. dev.
Digital up-skilling	0.31	
Men	0.63	
Older (50+ years)	0.23	
Highly educated (Master, Doctoral level or equivalent)	0.55	
Training	0.25	
Nb. Digital tool discovered	0.86	1.35
Nb. Digital tool intensive growth	1.00	1.24
Previous experience of telework	0.17	
Resident	0.52	
Finance and insurance sector (Ref. primary, secondary, trade, horesca sectors)	0.16	
Non-financial service sector	0.32	
Public administration and education	0.16	
Human health and social work activities	0.08	
Part-time	0.13	
Decrease in working hours during the lockdown	0.18	
Increase in working hours during the lockdown	0.16	

Team work – remained the same (Ref. decreased)	0.65	
Team work - increased	0.07	
Autonomy (z-score of the sum of the items)	0.09	1.04
Working for a firm concerned by its staff wellbeing (z-score of the sum of the items)	0.17	0.99
IT skills level – Basic or moderate low	0.24	
Moderate medium	0.18	
Moderate high	0.22	
Complex/advanced	0.36	
Household income less than 4,000€	0.14	
Household income 4,000-6,000€	0.35	
Household income 6,000-8,000€	0.28	
Greater than 8,000€	0.23	
Correct environment (a) (Ref. So-so manageable environment (d))	0.19	
Challenging environment (b)	0.34	
Optimal environment (c)	0.33	
Alone without child(ren) below 13 years old (Ref. have child(ren) below 13 years old but not worried about their school achievement)	0.21	
In couple with a partner working during the lockdown without child(ren) below 13 years old	0.31	
In couple with a partner not working during the lockdown without child(ren) below 13 years old	0.09	
Alone or in couple with child(ren) below 13 years old and being worried about their school achievement	0.25	
Observations	438	

Notes: Weighted figures. Standard deviation are only reported for non-binary variables.

(a) The correct environment is characterised by alone without child, living in an apartment where the surface area per inhabitant is correct and without access to outside area.

(b) The challenging environment is characterised by the presence of small child(ren) below 3 years and/or 3-6 years, living in an apartment where the surface area per inhabitant is small but enjoy an outside area.

(c) The optimal environment is characterised by leaving in a (detached) house where the surface area per inhabitant is large and enjoy an outside area (access to a garden, a terrace, and to a nearby public park), and when employees have (a) child(ren) between 7 and 12 years.

(d) Ref.: The so-so manageable environment is characterised by the presence of child(ren) between 3-6 years and/or 7-12 years, leaving in a non-detached house, with access only to a garden.

Source: First wave of the Survey on the COVID-19 socio-economic impacts in Luxembourg (SEI), "home office" module, LISER and University of Luxembourg.

Empirical strategy

To identify the factors related to our binary measure of the feeling of digital upskilling during the lockdown (Y), we run a binary Probit regression.

To deeply analyse the phenomenon of digital upskilling, we estimate three models that introduce step-by-step various independent variables. In a first model (Model 1), the independent variables introduced are the socio-demographic variables of interest (gender, age,

educational level), training and use of digital tools ("tools discovered" for the number of digital tools discovered, "intensive growth" for the number of digital tools intensive growth). In a second model (Model 2), we add the control variables (X). In the third model (Model 3), we introduce all the variables and we include the squared term of the two variables that capture the use of digital tools (tools discovered², intensive growth²), to take into account a potential non-linear effect of the number of digital tools discovered and intensively used. All models include α as the constant and ε as the error term.

We estimate the following Probit regression on the whole population of teleworkers for the Model 3:

$$\begin{aligned}
 Y = & \alpha + \beta' men + \delta' older + \gamma' highly\ educated + \Omega' training + \theta' tools\ discovered \\
 & + \vartheta' tools\ discovered^2 + \pi' intensive\ growth + \varphi' intensive\ growth^2 \\
 & + \zeta' X + \varepsilon
 \end{aligned}$$

In a first stage, we run the three models on the whole population of teleworkers. In a second stage, to evaluate the potential catch-up of vulnerable groups, we run the models 2 and 3 on subgroups of teleworkers (excluding socio-demographic variables that characterise the subgroup studied). The subgroups are defined according the three socio-demographic variables for which statistics and existing evidence show a self-assessed digital skill gap between groups (women, older workers, not highly educated).

Results

Digital upskilling during the lockdown across the whole population of teleworkers

Table 2 shows the main results (the full results of the Model 2 and Model 3 are presented in Appendix Table A1). The first column is dedicated to the first model (Model 1). The second

column shows the results of the second model (Model 2). The third column provides the results of the third model (Model 3).

In the three different models, the results for the socio-demographic variables of interest and variables for training and uses of digital tools are similar. We observe that neither the introduction of control variables nor the introduction of squared values for the use of digital tools changes the sign or significance of the results (except for one variable in Model 3: the number of digital tools with an intensive growth).

The three models underline that the three socio-demographic characteristics of interest are positively related to the feeling of digital upskilling during the lockdown: being a woman, being at least 50 years old, and being highly educated (at least having a master's degree).

Having attended training is positively related to the feeling of digital upskilling.

The number of digital tools whose frequency of use increased during the lockdown is positively related to digital upskilling feeling (Model 1 and 2). This result highlights a positive relation between learning-by-doing and teleworkers' digital skills but no non-linear relationship (Model 3). According to Model 3, the digital upskilling feeling is inverted U-shaped in the number of digital tools discovered during the lockdown.

Table 2. Digital up-skilling and catch-up effects: results on the whole population of teleworkers.

	Probit regression	Probit regression	Probit regression
	Model 1	Model 2	Model 3
Men	-0.349** (0.145)	-0.375** (0.187)	-0.440** (0.190)
Older	0.546*** (0.171)	0.530** (0.227)	0.547** (0.231)
Highly educated	0.339** (0.149)	0.456** (0.188)	0.402** (0.188)
Training	0.679*** (0.156)	0.823*** (0.198)	0.807*** (0.200)
Nb. digital tools discovered	0.275*** (0.051)	0.279*** (0.065)	0.683*** (0.150)
Nb. digital tools discovered squared	-	-	-0.092*** (0.032)
Nb. digital tools intensive growth	0.112** (0.056)	0.177** (0.071)	0.273 (0.187)
Nb. digital tools intensive growth squared	-	-	-0.031 (0.049)
Control variables	No	Yes	Yes
Observations	438	438	438
Pseudo R-squared	0.127	0.273	0.294

Notes: Weighted estimations. Standard errors in parentheses. *Statistically significant at the 0.10 level; ** at the 0.05 level; *** at the 0.01 level.

Source: First wave of the Survey on the COVID-19 socio-economic impacts in Luxembourg (SEI), "home office" module, LISER, and University of Luxembourg.

Digital upskilling during the lockdown across different subgroups of teleworkers

Table 3 shows the main results across different subgroups of teleworkers. For each subgroup, the first column is dedicated to the second model (Model 2) with training, the two digital tools use variables (the "nb. digital tools discovered", and the "nb. digital tools intensive growth") and the control variables. The column 2 provides the results of the third model (Model 3) that adds the squared values for the two digital tools use variables.

Differences appear according to subgroups. Having attended training during the lockdown is positively linked to the feeling of digital upskilling for female, male, below 50 years old teleworkers, and not highly educated.

The feeling of digital upskilling is inverted U-shaped in the number of digital tools discovered during the lockdown for men, younger, and highly educated or not teleworkers. The discovery of digital tools is positively linked to the improvement of females' digital skills. For older teleworkers, the number of digital tools discovered is not linked to their upskilling feeling.

The number of digital tools whose frequency of use increased during the lockdown is positively linked to the feeling of digital upskilling for female teleworkers and teleworkers below 50 years old. The feeling of digital upskilling of older teleworkers is not linked to the number of digital tools that they used more frequently during the lockdown. For male teleworkers and for not highly educated teleworkers, the feeling of digital upskilling is inverted U-shaped in the number of digital tools that teleworkers used more frequently. Highly educated teleworkers see their likelihood of feeling upskilled increases only when a threshold of three digital tools is exceeded.

Table 3. Digital up-skilling and catch-up effects: results on subgroups.

	Men	Men	Women	Women	Younger	Younger	Older	Older	Not highly educated	Not highly educated	Highly educated	Highly educated
	Model 2	Model 3	Model 2	Model 3	Model 2	Model 3	Model 2	Model 3	Model 2	Model 3	Model 2	Model 3
Training	1.568*** (0.382)	1.633*** (0.393)	0.685** (0.330)	0.622* (0.334)	0.739*** (0.236)	0.761*** (0.241)	1.831 (1.928)	2.00 (2.01)	1.552*** (0.455)	1.665*** (0.478)	0.333 (0.312)	0.463 (0.322)
Nb. digital tool discovered	0.615*** (0.151)	1.772*** (0.434)	0.219** (0.089)	0.560** (0.222)	0.250*** (0.073)	0.708*** (0.173)	1.108 (0.679)	0.732 (1.479)	0.358*** (0.111)	0.947*** (0.273)	0.351*** (0.125)	1.066*** (0.279)
Nb. digital tool discovered squared	-	-0.340*** (0.123)	-	-0.065 (0.039)	-	-0.099*** (0.035)	-	0.116 (0.430)	-	-0.091* (0.044)	-	-0.211*** (0.069)
Nb. digital tool intensive growth	0.144 (0.136)	0.791** (0.376)	0.370*** (0.130)	0.497 (0.305)	0.247*** (0.091)	-0.032 (0.256)	0.464 (0.654)	0.964 (1.60)	0.528*** (0.173)	1.650** (0.044)	0.349*** (0.125)	-0.348 (0.348)
Nb. digital tool intensive growth squared	-	-0.179* (0.097)	-	0.497 (0.305)	-	0.088 (0.080)	-	-0.167 (0.562)	-	-0.325** (0.126)	-	0.235** (1.00)
Control variables	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	136	136	302	302	347	347	91	91	212	212	226	226
Pseudo R-squared	0.470	0.517	0.265	0.283	0.262	0.288	0.840	0.841	0.504	0.565	0.341	0.379

Notes: Weighted estimations. Standard errors in parentheses. *Statistically significant at the 0.10 level; ** at the 0.05 level; *** at the 0.01 level.

The full results are available upon request.

Source: First wave of the Survey on the COVID-19 socio-economic impacts in Luxembourg (SEI), "home office" module, LISER, and University of Luxembourg.

Robustness check

For the robustness check of our results, we, first, ran binary Logit models instead of binary Probit models. The results obtained for the whole sample and for the subgroups remain the same.

Second, instead of splitting the dependent variable in two categories (digital skills increased versus digital skills decreased or remained the same), we divided into three categories: decreased or remained the same (69%), increased (27%), greatly increased (4%). For the estimate of this variable, we ran Ordered Probit models. The links observed, in the Model 3 for the whole population, between the evolution of digital skills, on the one hand, and the gender, the age and the educational level, on the other hand, remain the same. The feeling of digital upskilling is still inverted U-shaped in the number of digital tools discovered during the lockdown. Having received training during the lockdown remains positively related to the feeling of digital upskilling. However, the relationship between the number of digital tools whose frequency of use increased during the lockdown and the digital upskilling feeling is no longer significant at the 10% threshold. The small proportion of teleworkers who have seen a greatly increase of their digital skills during the lockdown (4%) prevents us from carrying out a similar robustness test on the three subgroups.

Discussion

The COVID-19 pandemic and the resulting mobility restrictions in many countries have brought back into focus the importance of addressing the digital divide (Aissaoui 2021). During this period, having access to digital tools (first level digital divide) and being able to use them (second level digital divide) were essential to maintain health, social links, schooling, and employment (Li 2022; Stelitano et al. 2020;). While the consequences of the digital divide

during the COVID-19 pandemic are highlighted in the literature, few studies exist on the consequences of the COVID-19 pandemic on the digital divide. However, this period may have had an impact on the second level digital divide by acting as a push factor to improve digital skills.

Based on a unique survey conducted in May-early July 2020 in Luxembourg, our analyses show that employees who worked from home during the lockdown changed their behaviour regarding the use of digital tools. Indeed, the lockdown was an opportunity for a majority of teleworkers, working for firms located in Luxembourg, to experiment with new digital tools or to increase their use. This finding echoes those of other studies previously conducted at a macroeconomic level (e.g. DeFilippis et al. 2020). This experimentation with new digital tools or the use digital tools more frequently than before was facilitated, during this period, by, at least, three factors identified in earlier studies: i) other employees also adopt these tools, ii) the external nature of the constraint, and iii) these tools can help to improve the experience of working from home by maintaining social relationships with co-workers (e.g. Saputra et al. 2021; Sutan and Vranceanu 2016).

During the spring 2020 lockdown, for almost one out of three teleworkers working in Luxembourg, the lockdown acts as a push factor to expand their digital skills. This push factor was also observed by König and Seifert (2022) in the specific case of older workers. The growth in digital skills during the pandemic did not, however, according to our findings, affect all subgroups of teleworkers in the same way. Indeed, some socio-demographic groups benefited more than others did. In our study, women, older workers, and highly-educated teleworkers reported having increased their digital skills more than others.

According to their self-assessment, female teleworkers took more advantage of the lockdown period to increase their digital skills than male teleworkers did. This finding, which is also the

finding of König and Seifert (2022), suggests that before the lockdown, female teleworkers were less likely to choose to invest in their digital skills that are strategic in a competitive job market (Eggenberger and Backes-Gellner 2021; Sostero and Tolan 2021) maybe because they underestimate their ability to succeed. The lockdown acts indeed as a push factor in the improvement of women's digital skills and can activate a catch-up effect. In particular, the number of digital tools that women have discovered or used more frequently during the lockdown and the training they have taken are linked to their feeling of digital upskilling. This catch-up effect, however, can be limited to their perceived digital skills (Hargittai and Shafer 2006; Hargittai and Shaw 2015). Nevertheless, the lockdown has helped women gain confidence in their digital skills.

While a gradual de-skilling of older workers in association with the spread of information and communication technologies on labour markets has been identified on nine European countries over the 1970-2007 period by Peng, Anwar, and Kang (2017), our findings suggest that the learning-by-doing engendered by the lockdown helped older workers to improve their digital skills more than their younger counterparts. Our findings suggest that this catch-up does not rely on the effective use of discovered or an increased use of digital tools. Nevertheless, while older workers were found to have low confidence in their computer abilities in earlier research (Marquié, Jourdan-Boddaert, and Huet 2002), they could have gained in confidence using digital tools they already used before the lockdown. Although they were found to be reluctant to take training (Carmichael and Ercolani 2014), the learning-by-doing or the do-it-yourself approach underlined by Matzat and Sadowski (2012) and Yao et al. (2021) for Internet usage seem to be effective.

A catch-up effect is not observed regarding educational level. On the contrary, the digital skill gap between highly educated teleworkers and the others expands during the lockdown. This is consistent with the findings of the survey conducted by PWC (2021) that employees with a

post-graduate qualification are more likely to report an improvement in their digital skills (46% compared to 32% for undergraduates and 28% for school leavers). As underlined by Calonge and Shah (2016), due to a mismatch of useful skills obtained by students through higher education institutions, graduated employees habitually use available technology to upskill for a competitive job market. However, training appears to narrow the skill gap between not highly educated and highly educated workers. Indeed, while participation in training during the lockdown period is positively linked to the upskilling feeling of not highly educated teleworkers, it is not the case for highly educated teleworkers. Participation in Massive Open Online Courses (MOOCs) by highly educated before the lockdown, as highlighted by Calonge and Shah (2016), may have enabled the highly educated workers to get ahead in training, and the training they took during the lockdown had no add-on effect on their feeling of digital upskilling. It should be noted that incentives must be put in place to ensure participation in training by low educated workers. Low educated were indeed found to participate less in training than highly educated people (Kleinert and Wölfel 2018). Moreover, Kleinert et al. (2021) found that during the lockdown period(s) the difference in the use of online learning opportunities widened between high and low educated workers, at the expense of low educated. Our findings provide interesting lessons for the future of the work from home practice. As shown by Bloom, Han, and Liang (2022), employees value the work from home experience of 2020 and a long-lasting impact of working from home on working patterns appears likely. Alipour, Langer, and O’Kane (2021) underline that the COVID-19 pandemic shock led to an unprecedented work from home boom in job ads. Bloom, Han, and Liang (2022) point out that even when employees are in the office, they increased their use of instant messaging and video call communication to work. As such, the digital skills acquired during the lockdown period(s) will remain useful in the new hybrid work environment. However, even if employees increase their digital skills by themselves, organizations should provide digital training to reduce the

digital skill gap among teleworkers. Managers should especially focus on increasing the participation in training of the lower educated to prevent the widening of the second digital divide. The hybrid format could provide employees with increased informal support in their use of digital tools that can influence their digital upskilling. For instance, they can easily stop by the IT office ask another employee to show them directly to their computer. Nevertheless, König and Seifert (2022) show that during the COVID-19 pandemic, older teleworker improved their digital skills more when they teleworked completely than when they teleworked partially. In addition, managers should provide training to upskill teleworkers in cybersecurity while teleworkers potentially use their own digital tolls (computer, smartphone, tablet) and their own cyber security protections (Wang and Alexander 2021).

Conclusion

The lockdown period(s) induced by the COVID-19 health crisis increased significantly the remote work from home. During these periods, teleworkers had to change the way they work and interact with their colleagues, in particular, by increasing their use of digital tools as our study shows. While prior to 2020 employees were reluctant to use certain digital tools especially when imposed by their management, during the lockdown the external constraints on mobility and interpersonal interactions, the fact that other employees also adopt digital tools, and the fact that these tools can help to improve the experience of remote work from home acted as push factors that increased the use of digital tools.

For some teleworkers, with the above-mentioned push factors in play, during this learning-by-doing period they were prompted to improve their digital skills. This was more the case for women (relatively to men), older workers (relatively to younger), and the highly educated (relatively to not highly educated). These findings suggest that there has been a catch-up effect

in terms of self-assessed digital skills for female and older teleworkers during the lockdown. They may have gained confidence in using digital tools. This could lead them to change their perception about their abilities to use digital tool and give them incentive to pursue their efforts to learn how to use and master new digital tools. Conversely, the digital skills gap widened during the lockdown between the highly educated and the others. To ensure that vulnerable groups of workers, such as the not highly educated, are not increasingly disadvantaged and given that they benefit from training to improve their digital skills, managers should offer training programs dedicated to digital tools use along with cybersecurity and find mechanisms that encourage them to actually participate in the training.

Our study remains subject to certain limitations. First, it is based on a small sample size which does not allow for further divisions according to, for example, the age or educational level of teleworkers. Second, the survey does not contain information on the purpose of the training followed by the teleworkers. In particular, we do not know if the training was related to digital skills. Third, we do not know which type of digital skills really improved during the lockdown which prevents us from assessing whether the newly acquired digital skills sufficiently match the digital skills in demand in the labour market. Fourth, the results are based on a single country study. Further research should deepen the analyses of the impacts of the work from home practice and of the induced increase of digital tools uses on teleworkers' skills. With the advent of hybrid work, a follow-up study needs to be conducted to examine whether the increase in digital skills observed in 2020 continues thereafter and whether the second digital divide continues to narrow between socio-demographic groups.

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1 Appendix

Table A1. Digital up-skilling: Results on the whole population of teleworkers.

	Model 2	Model 3
Men	-0.375** (0.188)	-0.440** (0.190)
Older	0.530** (0.227)	0.547** (0.231)
Highly educated	0.456** (0.188)	0.402** (0.188)
Training	0.823*** (0.199)	0.807*** (0.200)
Nb. digital tool discovered	0.279*** (0.0653)	0.684*** (0.151)
Nb. digital tool discovered squared	-	-0.092*** (0.0326)
Nb. digital tool intensive growth	0.178** (0.0710)	0.273 (0.187)
Nb. digital tool intensive growth squared	-	-0.0312 (0.0495)
Previous experience of telework	-0.269 (0.229)	-0.205 (0.230)
Resident	0.534*** (0.199)	0.562*** (0.204)
Finance and insurance sector (Ref. primary, secondary, trade, horesca sectors)	0.761*** (0.284)	0.696** (0.288)
Non-financial service sector	0.0716 (0.252)	0.0821 (0.257)
Public administration and education	0.466 (0.296)	0.444 (0.300)
Human health and social work activities	0.225 (0.342)	0.226 (0.348)
Part-time	0.493** (0.246)	0.487** (0.247)
Decrease in working hours during the lockdown	0.460** (0.227)	0.400* (0.230)
Increase in working hours during the lockdown	0.507** (0.228)	0.479** (0.231)
Team work – remained the same (Ref. decreased)	0.148 (0.191)	0.208 (0.197)
Team work - increased	-0.0041 (0.351)	0.0183 (0.354)
Autonomy (z-score of the sum of the items)	-0.0291 (0.0814)	-0.0102 (0.0833)

Working for a firm concerned by its staff wellbeing (z-score of the sum of the items)	-0.0324 (0.0863)	-0.0370 (0.0881)
Moderate medium	0.0849 (0.245)	0.0993 (0.249)
Moderate high	0.195 (0.256)	0.148 (0.261)
Complex/advanced	-0.133 (0.255)	-0.0833 (0.257)
Household income 4,000-6,000€	0.989*** (0.332)	0.911*** (0.333)
Household income 6,000-8,000€	0.822** (0.362)	0.736** (0.363)
Greater than 8,000€	0.826** (0.401)	0.727* (0.402)
Correct environment (a) (Ref. So-so manageable environment (d))	0.376 (0.360)	0.221 (0.370)
Challenging environment (b)	0.234 (0.316)	0.123 (0.325)
Optimal environment (c)	0.626* (0.320)	0.496 (0.327)
Alone without child(ren) below 13 years old	-0.471 (0.326)	-0.484 (0.325)
In couple with a partner working without child(ren) below 13 years old	-0.361 (0.221)	-0.371* (0.223)
In couple with a partner not working during the lockdown without child(ren) below 13 years old	-0.342 (0.369)	-0.307 (0.374)
Alone or in couple with child(ren) below 13 years old and being worried about their school achievement	-0.451** (0.220)	-0.466** (0.221)
Constant	-3.05*** (0.556)	-2.986*** (0.558)
Observations	438	438
Pseudo R-squared	0.2943	0.2736

Notes: Weighted estimations. Standard errors in parentheses. *Statistically significant at the 0.10 level; ** at the 0.05 level; *** at the 0.01 level.

The results of the Model 1 are available upon request.

Source: First wave of the Survey on the COVID-19 socio-economic impacts in Luxembourg (SEI), "home office" module, LISER, and University of Luxembourg.

Notes

¹ It should be noted that, in Luxembourg, telework was mandatory between mid-march and June 2020, recommended between June 2020 and July 2022, and allowed afterwards.

² For instance, for the analysis and exploitation of big data generated by the users of digital tools (e.g. internet browsing, online shopping, use of social networks).

³ Source:

https://ec.europa.eu/eurostat/databrowser/view/ISOC_SK_DSKL_I__custom_2144242/default/table?lang=en

⁴ Authors calculation based on data from Eurobarometer 92.4, December 2019 (Eurobarometer 2020).

⁵ Authors calculation based on data from Eurobarometer 92.4, December 2019 (Eurobarometer 2020).

⁶ The SEI survey was approved by the LISER's ethics committee in April 2020. All participants provided appropriate informed consent before replying to the SEI survey.

⁷ <https://digital-strategy.ec.europa.eu/en/policies/desi>.

⁸ https://ec.europa.eu/eurostat/databrowser/view/isoc_ske_itn2/default/table?lang=en

⁹

https://ec.europa.eu/eurostat/databrowser/view/ISOC_SK_DSKL_I21/default/table?lang=en&category=isoc.isoc_sk.isoc_sku