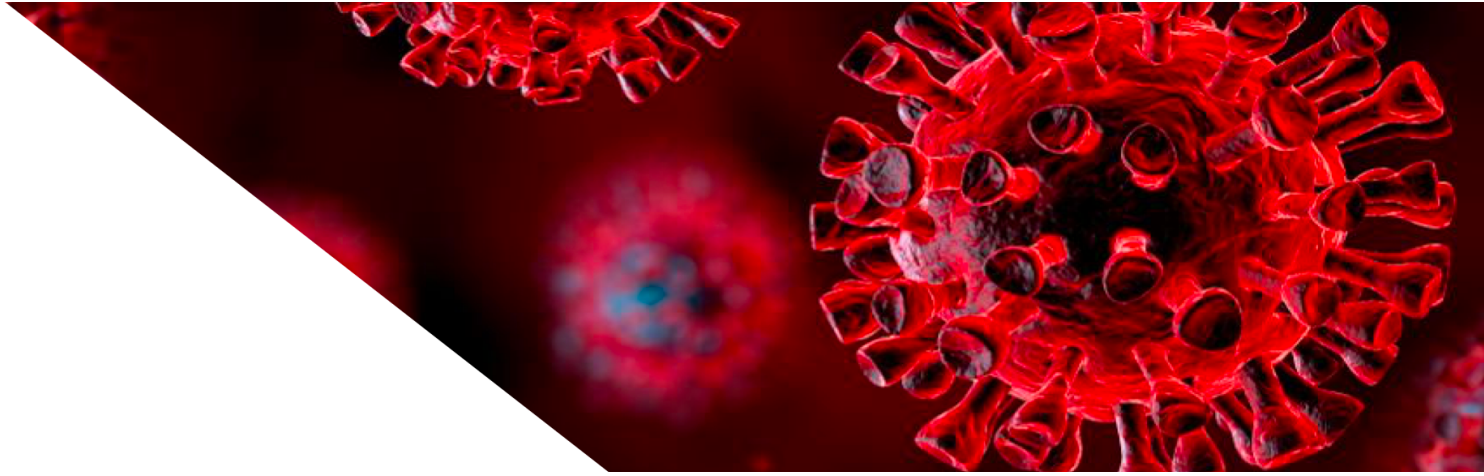

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Who does work from home? Probability of teleworking in the Spanish labor market before and throughout the pandemic

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December 22, 2021

Abstract

We use the Spanish Labor Force Survey annual data from 2017 to 2020 in order to compute the probability of teleworking each year by the main characteristics of the individuals. We explore both National and regional Andalusian data and fit a logistic regression on teleworking taking into account a set of relevant socio-demographic controls. Our descriptive statistics underline a potential, short run, upward trend of teleworking routines across Spain between 2017 and 2019, and capture the sudden spike in work at home policies during 2020. In Andalusia, no clear upward trend is visible between 2017 and 2020, and the sudden positive jump in 2020, due to the adoption of work at home policies, appears to be slightly below the national average. Results of the probabilistic regressions, aimed at calculating the likelihood of teleworking given the covariate set, show that family composition (being childless or having at least one child) only slightly skews up the probability of teleworking, while, albeit with no clear causation mechanism and lacking any sort of clear short run trend, only in 2020 women would appear to have been more likely to undergo work at home practices when compared to men. In terms of occupation, high skilled, more educated workers with jobs and tasks naturally allowing for teleworking saw the majority of the increase in probability between 2020 and the previous periods: the likelihood of being a teleworker based on sex alone in Spain is not enough to explain the gender gap effects, and is more likely related to other relevant aspects of the occupation, such as contract length, private or public ownership, full-time or part-time commitment, and so forth. Our estimates allow us to identify three different occupational categories: occupations which involve duties that can be naturally carried out teleworking; occupations that, given the current state of technology, can only be carried out at the workplace; finally, occupations which, given their duties and current state of technology, would present the largest room for improvement towards a higher level of teleworkability. Our data shows that regional differences in teleworking likelihood were all but negligible before the Covid 19 outbreak, when all communities followed a similar path of convergence to higher levels of teleworking, and only during 2020 autonomous communities such as Madrid or Catalonia distanced themselves notably from the rest of Spain.

Keywords: Teleworking, work-from-home, spatial heterogeneity, Spain, Autonomous Regions.

1 Introduction

1.1 Teleworking: context and definitions

According to the historical recap by Allen et al. (2015), teleworking policies started taking the scene of the U.S. first world economy in the seventies, when the National Aeronautics and Space Administration decided to introduce it in order to reduce energy expenditures and limit traffic jams

around its centers. From there on, telecommuting was successfully introduced to tackle a variety of issues: in the same period, IBM thought of it as a way to create an optimal work/life balance in families, while a revision of the Clean Air Act in the nineties aimed at reducing air pollution and car emissions explicitly included the adoption of telecommuting schemes and plans by private firms as a specific mean to achieve the main goals of the reform. Again in the nineties, the approval of the Americans with Disabilities Act spawned new interest in work at home practice as a way to balance and expand the employment of that share of workforce with manifested disabilities.

Nowadays, with the arrival of an unprecedented crisis following the coronavirus outbreak, many economic actors had to resort to different employment policies in order to reduce systemic risks related to the virus transmission mechanism. Aside from industrial policy choices related to profitability and economic survival (short time work schemes, furloughs and dismissals on the labor side, asset adjustments and shutdowns on the capital and managerial side), firms from all over the world had to consider once more how much work from home policies would be an optimal choice to counteract the widespread diffusion of the virus. Our work employs annual data sourced from the Spanish Labour Force Survey at the national and regional level to check for short term trends in work at home in both Spain and Andalucía during the 2017-2020 interval. Through the use of weighted probabilistic regressions, we estimate the probabilities of being a teleworker conditional on a set of relevant controls (sex, age, education, economic sector).

It is important to point out that past and present research does not agree on a single definition for work at home practices, and that the terms telecommuting, teleworking, remote work, distributed work, virtual work, flexible work, flexplace, distance work and work at home have been used equivalently across the relevant literature (Allen et al., 2015). As various punctual definitions of it have been offered across the years, the important point to make is its conditionality on the availability of survey data that exactly matches the definition. Definitions in literature range from Mokhtarian (1991), who defined telecommuting as the "Use of telecommunications technology to partially or completely replace the commute to and from work", thus focusing on the initial aim of telecommuting as a way to control and reduce actual commute load, to Tworoger et al. (2013), who define "Virtual teams" as "spatially or geographically dispersed work arrangements that are generally characterized by a relatively short life span, technology-enhanced communications, and a dearth of face to face interaction". Our definition of teleworking is as such based on the accomplishment of past literature, but mainly focused on our own, data-based definition. This will be describe in better detail in our Data Section.

The article is organized as follows: Section 2 shows in detail the data and methods employed. Section 3 contains a descriptive analysis followed by the results of the predicted probabilities derived from the logit estimations. Finally, section 4 concludes the article.

1.2 Previous literature

In the past, work from home (teleworking) measures have been undertaken in order to understand the sign and magnitude of the relationship between productivity and working environment: far from asking what the underlying mechanism describing the relationship is, given the issues in retrieving a correct measurement for productivity, past literature has been focusing on finding and proving the internal validity of the causal relationship between working at home and productivity. As the last three years economies have been have been plagued by a worldwide epidemic and its subsequent economic, social and health effects, current literature is currently focusing on untangling the relationship between health effects and work at home in order to check whether or not a healthier status is somehow related to teleworking during epidemics. Everything else equal, as

researchers control for demographic, educational and labor related variation across individuals and/or households, we would expect to find an (obviously) positive and significant set of probability coefficients conditional on all of the covariates mentioned above, with specific attention to year by year and sector variations. As a matter of fact, recent reports and studies have tried to measure the extent of the gap between potential and current work-at-home labor allocation. In a relatively influential and recent discussion paper, Dingel and Neiman (2020) exploit the O*NET database from the US department of labor, containing accurate, four digits descriptions of almost 1000 occupation types in the United States. Once results are aggregate at the two digit level, they find that 37% of the Jobs of the nation could be performed by working at home, with values ranging from 25% in the case of Mexico and Turkey to more than 40% in countries such as the United Kingdom or Sweden, while Spain and other Mediterranean countries such as Italy would be included between the 30% and the 35% range. The upper end results come perhaps as no surprise, as relevant trends in that sense could be seen way before the beginning of the Epidemic. According to Vilhelmson and Thulin (2016), for instance, work at home had become routine for 20% of the total workforce employed in Sweden by the end of 2012, after an overall increase of 3.8% between that very year and 2005. Back to Dingel and Neiman (2020), the analysis revealed that United States shares of work at home jobs across all urban areas would be positively correlated with median income and share of household members holding a college degree, but usually negatively correlated with the home ownership rate and the share of white residents per household. In terms of occupational variation, the authors found out that managers, educators, it personnel, finance experts and law experts would naturally represent the majority share of the work at home workforce, as agricultural, construction and production workers are typically unable to carry out their tasks at home. As a consequence of this, when considering a rather complete panel of 86 different countries, the authors are able to uncover a solid positive correlation between PPP per capita GDP and share of jobs potentially doable at home.

Focusing on a study case for Spain, Anghel et al. (2020) find out that work at home grew by 2.4% between 2009 and 2019, estimating that 30% of employed manpower could work at home, at least occasionally. Aside from sectoral considerations, the Authors show that work at home is usually more often chosen by or permitted to workers between 35 and 65 years old of age, and such proportion is even higher when university level education is considered. López-Igual and Rodríguez-Modroño (2020) offer some additional insights on the determinants (or perhaps covariates) of teleworking practices across the EU25 group. Analyzing a sample of more than 20000 workers belonging to the latest European Working Conditions Survey, the authors confirm that mobile teleworkers are indeed mangers and professionals, but also discover that technicians and associates (non-full) professionals represent a non negligible share of the work at home workers, while clerks and support staff workers would make up one of the largest group of mainly stationary, home-based workers. Most importantly, and breaking with past trends, the authors find out that the majority of highly mobile teleworkers are still men, but such gender disproportion could not be found anymore in the case of standard work at home employees. Following-up with a case study on gender effects, Pigini and Staffolani (2019) show that, besides higher education and family composition, gender as well may play a role into being a key determinant conditioning the probability of work at home. In particular, having children, being in possession of a college title, and being female now all appear to increase the base likelihood of standard at home teleworking in the Italian study case, contributing to an expected wage premium ranging from 2.7% to 8%.

Some of the most relevant contributions to work at home studies come from natural experiments, which happen to have been able to detect, at least internally, a causal relationship between teleworking and productivity. Amongst the relevant literature cases, Bloom et al. (2015) conducted a natural experiment on a NASDAQ-listed travel agency based on China. Employees from the call

center division of the company where randomly assigned to stay in office or work at home during 3 quarters. Causal increases in performance (measured in terms of hours of on-line activity detected and number of call per shift) were measured to range between 9% (increase in working hours) and 4% (more calls per minute). In qualitative terms, the workers were found to be more satisfied, and as workers were left free to self-select themselves into the work from home program in the three quarters following the initial period the detected efficiency increase raised to double its initial figures to 22%. This additional positive increase, would of course suffer, in terms of causal interpretation, by the lack of random selection. On a similar route, Dutcher (2012) carried out an on-campus experiment at Florida State University. As participants where incentivized to join the test through small payments for each round of the experiments, they were told to chose between two kind of tasks, one more menial, the other more creative. Dutcher easily showed that, when a duller and a more interesting task are supposedly carried out at home, the latter's productivity increases while the former's decreases. Recently, Battiston et al. (2017) reversed productivity studies on work at home policies by considering the impact of face-to-face communication, opportunity costs considered. They analyze the effect on efficiency of face to face communication in the emergency 999 line operator lines in Manchester, where call center operators do receive emergency phone calls from the population and then passes the case to operation managers who proceed to allocate some adequate form of response (firefighting, law enforcement or nations health system operators) to the case. By exploiting the exogenous source of variation coming from the fact that the informatic system allocates calls descriptions to the operations manager randomly according to their availability and considering that some operation managers are physically present in the rooms where call center operators are while some are in another room of the office, this experiment managed to prove causally that productivity is relatively higher when teammates not only share the same room but are also conveniently placed one next to the other or in very close proximity, with an even stronger effect when, taken the priority of the task under consideration, it appears to be more urgent or complex than others.

Following the line described the aforementioned literature, our article contributes to the literature on teleworking as it tries to uncover the probability of teleworking in Spain at the provincial level, with a focus on the different sectors of the economy as well as any other relevant socio-demographic covariate which we have mentioned in the literature. The logical economical downside to the adoption of work at home policies, as literature states, might indeed come from shirking, deriving from loss of supervision, and culminating with a loss in productivity instead of a net gain. However, such a loss might be compensated by mixed temporary at work policies, as stated by Pabilonia and Vernon (2021).

We remind the reader that this paper does not asks whether or not work at home policies might have a positive effect on the outcome of the epidemic, but rather outline the current conditions of the workforce and the weight of the current descriptors correlating with work at home. As Tavares (2017) pointed out with a general review on the topic in unsuspecting times, "empirical evidence favours a positive association between telework and worker health. However, there are also negative impacts on health such as stress and depression. The overall conclusion is that telework is likely to yield more good than bad for individual health".

2 Data and Methods

2.1 Teleworking in the Spanish Labor Force Survey

For this analysis we use annual data from the Spanish Labor Force Survey (SLFS), from 2017 to 2020. This survey gather information for the labor market conditions of a representative sample of individuals living in Spanish private households. These annual registers provide almost 100,000 individual observations each year, remaining around 37,000 after filtering data. Furthermore, sample weights were considered in the analysis, resulting in more than 18 million individual observations for each year considered. Our filtering procedure was based on the following special module question: Did you work from home within the last 4 weeks?[1]

With the aim to study the use of telework, we only kept the observations that answered the previous question in one of the three possible responses: not a single day, occasionally or over half of the working days. Thus immediately, we were keeping only those individuals over 15 who worked or were employed in the survey reference week, and placed themselves in one of the aforementioned categories. Afterward, we transformed this variable, generating a binary response variable which takes value 1 if the individual worked from home at least occasionally within the last 4 weeks, and 0 otherwise. Then, we were ready to perform logit estimations and compute teleworking probabilities.

2.2 Logistic regressions and predicted probabilities

Considering the binary response for teleworking as our dependent variable we fit a logistic regression for every year in our data, thus from 2017 to 2020. Therefore, we estimated four cross-sectional regressions, one for each year. For these logistic regressions, the log-likelihood function to be maximized is shown in equation 1.

$$lnL_t = \sum_{i=1}^{N} y_{it} ln\left(G(X_{it}^{'}\beta_t)\right) + (1 - y_{it}) ln\left(1 - G(X_{it}^{'}\beta_t)\right) \tag{1}$$

Where N denotes the sample size considering any individual i in a given year t from 2017 to 2020; y_{it} is our binary dependent variable for teleworking; $G(.)$ represents a logistic functional form, thus $exp(X_{it}^{'}\beta_t)/(1 + exp(X_{it}^{'}\beta_t))$, where the β_t denotes the parameters to be optimized by numerical algorithms and X_{it} are the covariates for a given year and individual. As covariates we considered sex, age group using five-year bands, Spanish regions, a dummy for at least one child under 16 at home, occupation based on the Spanish National Classification of Occupations in one digit dis-aggregation, type of contract (either part or full-time), sector (either public or private), and professional situation (either self-employed or salaried worker). These covariates, based on literature suggestions, may allow us to characterize the individuals who work from home, analyze the main determinants for teleworking and make comparisons between different groups. Other covariates which may be relevant like education or sector of activity have been excluded due to collinearity issues since we are considering occupation in our model specification. In this sense, we suspected occupation of being the most relevant determinant of teleworking so we did not drop it from the analysis at any time.

Thus, the probability of teleworking for the individual i in year t given their covariates in that year is assumed to follow the logistic distribution given by equation 2.

[1]This special module was purchased by the University of Huelva with research project funds.

$$Pr(y_{it} = 1|X_{it}) = \frac{exp(X_{it}^{'}\beta_t)}{1 + exp(X_{it}^{'}\beta_t)} \tag{2}$$

At this point, we estimated the predicted probabilities of teleworking conditioning by different characteristics of the individuals, e.g. their gender. However, since we are not fixing values for all covariates we would obtain a combination of different predicted probabilities and not a single one. In order to solve this issue, one possible approach consist in setting the rest of covariates to a specific value (typically their means) and compute the predicted probability for a theoretical individual with those characteristics. Nevertheless, this method would only take into account the prediction for one relevant stratum of observations. In addition, the presence of factor covariates would yield to unrealistic individuals when taking their mean values. Therefore, this time we used an often preferred method which consist in estimating the predicted probabilities summed to a weighted average over the covariates distribution in our population, as shown in equation 3.

$$Pr(Y = 1|E = e)_t = \sum_z Pr(Y = 1|E = e, Z = z)_t Pr(Z = z)_t \tag{3}$$

Hence, for a year t, the probability of teleworking ($Y = 1$) given a certain condition ($E = e$), e.g. being a female, is computed as a sum of the probabilities of teleworking imposing that condition on all possible combinations of the rest of covariates ($Z = z$) in that year, e.g. every occupation, every region, every age group, etc. And finally, weighting every addend by the distribution of those other covariates ($Pr(Z = z)$) that year t, e.g. probability of having that occupation, in that certain region, being in that age group, etc. To sum up, this marginal standardization method consider all possible combinations of the rest of covariates which have not been fixed, predicting the probability of teleworking and averaging these probabilities conditioned by the distribution of the sample in a certain year.[2]

Using this technique, we estimated the predicted probability of teleworking in the four years (2017, 2018, 2019 and 2020) by gender, by gender and whether having a child under 16, by age group, by one-digit occupation, by region, by self or salaried worker, by public or private sector, and lastly, by full or part-time working day.

3 Results

3.1 A first glance at teleworking in Spain and Andalusia

From 2017 to 2019 the use of teleworking experienced a slight increase in Spain which may reveal a short-run trend before the pandemic. During this period, the percentage of the employed who teleworked at least occasionally increased 1 percentage point (shorten as p.p.), from 7.35% in 2017 to 8.38% in 2019. In this sense, the advances in the enterprise digitalization process and the increasing hyper-connectivity might have been influential factors for this slow but sustained trend in the increase of home-based work. However, the sanitary crisis and the subsequent imposition of social distancing measures increased dramatically this fraction of teleworkers, jumping up to 15.22% in 2020, almost doubling pre-pandemic digits. (see Table A1 and Figure A1) Furthermore, as a consequence of lockdown, a major part of these teleworkers did it over half of the working days, so not only more people were teleworking, but they were also doing it more intensively.

These patterns seems to be quite similar when differentiating by sex, except for year 2020. This

[2] A discussion about these methods to compute logit predicted probabilities can be found in Muller and MacLehose (2014).

year, we found that women experienced an even higher leap in the use of teleworking with regard to men. Despite teleworking had been more common among males in the 2017-2019 period (around 1 p.p. above), the pandemic would have inverted this fact. As a result, we observed that women teleworking reached 1.63 p.p. above men in 2020. (see Table A1 and Figure A2) On the other hand, this and other relevant socio-demographic and job-related factors will be explored in detail afterward using the probabilistic approach, which allow us to control for potential confounders.

Focusing our attention to Andalusian statistics about teleworking we found that the percentage of employed individuals who teleworked at least occasionally fluctuated around 8% (near the national mean) in the 2017-2019 period. This time, there is no clue of any increasing pattern for remote work before the pandemic. Additionally, the increase of teleworking experienced in 2020, despite being quite relevant and unprecedented, was not as large as it was at national level, reaching 11.69% in Andalusia for year 2020. (see Table A3 and Figure A3) Nonetheless, the aforementioned gender gap and its reversal in the last year still stand for Andalusia, exactly as it happened using the whole national sample. (see Table A3 and Figure A4)

3.2 Probabilities of teleworking

The calculation of probabilities of teleworking for each individual on the Spanish Labour Force Survey (SLFS) allows us to produce detailed demographic breakdowns, by taking the average probability of teleworking within each demographic group. To produce those probabilities at one digit occupation level on the SLFS[3], we use pooled 4 years data (2017 to 2020), ensuring a sample size that enables us to calculate a probability for each digit occupation code.

We, therefore, predict the probability of teleworking for individuals on the SLFS using observed characteristics such as gender, if the individual has children, occupation, type of employee (self-employed or salaried worker), sector of employment (private or public), type of working day (part-time or full-time), and region of residence.

Although we cannot find any causal relationship between teleworking and the outbreak of Corona because we are working with cross-sectional data, the results are quite clear. In particular, we can determine the actual probability of working remotely based on different individual characteristics, years before and during the Covid-19 pandemic.

For this reason, we find that they were no patterns across sociodemographic characteristics that can determine short-run trends, with the exception of the type of occupation. As we explore the probabilities of teleworking considering the characterization of each of the individuals in the sample, we divide this section into different groups of sociodemographic and job-related determinants.

3.2.1 Sociodemographic determinants

Unlike any other modern recession, the downturn triggered by the Covid-19 pandemic has created larger employment losses for women than for men (Alon et al., 2020). In this section, we analyze the relation between *shecession*[4] and teleworking or, in other words, we determine if there exists any relationship between gender and probabilities of telecommuting and which are the factors that could drive those differences.

We first focus on the estimation of the probabilities of teleworking among men and women and whether having children matters when we assess them. As we can observe in Table A6,

[3]Taken from the National Classification of Occupations.

[4]Term coined by C. Nicole Mason, president, and chief executive of the Institute for Women's Policy Research, in a nod to the 2008 recession that came to be known as the "mancession" because more men were affected.

having children is closely related to more probabilities of performing a remote job. Although telecommuting and other forms of flexible work have long been promoted as a means for enabling individuals to effectively manage their on and off-work time, there is little empirical evidence to suggest that telecommuting is a generally effective way to mitigate work-family conflict (Lyttelton et al., 2021). Nevertheless, in Spain, we cannot consider teleworking as a way of making more flexible individuals' working days as the difference between having, at least, one child under 16 years old and being a childless individual is only about 1 p.p. (percentage point). As having children is not highly related with telecommuting, we expect that other factors different as family issues contribute more in the decision. During the lockdown, this weak relationship between having family responsibilities and performing a remote job are almost the same, increasing from 1 p.p. to 2 p.p..

Exploring if there are gender differences in the probability of teleworking, whether they are parents or not, we find that women, taking into account demographic and labor characteristics of each woman in the sample, were less likely to perform a remote job from home before the pandemic took place, which is a cornerstone to understand why telecommuting in Spain is not a mechanism to combine work with family commitments. Thus, if the outbreak of Corona had not happened, the evolution of the rates of remote jobs performed by women would differ from the actual ones, keeping men at a higher level than women. We estimate that women during the lockdown were 10 p.p. more likely to telecommute when compared with women with the same characteristics before the outbreak of Corona. This became even more significant as the 2020 marginal difference between women and men, compared to the same difference during the three years before the pandemic, appears to be positively skewed in favor of women by a 2 p.p. margin (see Table A5). In other words, the lockdown drove women, whether they are mothers or not, to more likely adapt their jobs remotely than men workers, turning around the situation.

3.2.2 Job-related determinants

Based on a review of the literature presented in Section 1.2, we, therefore, define teleworking as a work practice that involves members of an organization substituting a portion of their typical work hours (ranging from a few hours per week to nearly full-time) to work away from a central workplace—typically principally from home—using technology to interact with others as needed to conduct work tasks. This definition of telecommuting is based heavily on several widely adopted conceptualizations (e.g.(Bailey and Kurland, 2002); (Gajendran and Harrison, 2007)). Meanwhile, the ongoing development of ICT and the growth of the knowledge economy with its autonomous, task-based work culture is swelling the ranks of the professional, better educated, more internet-savvy sectors of the population who are more likely to telecommute (Felstead and Henseke, 2017). In other words, the adoption of teleworking is negatively related to the level of face-to-face interactions with the public needed in a particular sector (Fana et al., 2020).

We apply the intuition behind the estimation of the probabilities of automation, approach proposed by Frey and Osborne. In spite of the obvious differences, we have not included tasks in the estimation and, therefore, we calculate the average estimated probability per one-digit occupation taking into account each of the factors we have mentioned before which contribute to those individuals' estimated probabilities such as gender, age, family situation, type of employee, work day schedule, sector, and region of residence. We can observe in Figure A6 that an exogenous shock as the outbreak of the Corona virus is an opportunity to adapt the working system to telecommuting but only for those with the potential of being performed remotely potentially digital occupations.

We refer to potentially digital to all those jobs in which their workers develop digital skills as

well as those in which human interactions can be replaced by the use of ICT resources. Workers with strong digital skills are arguably better-positioned to respond to the demands of remote working during the current crisis, as it has been analyzed right after the lockdown by the European Commission (Fana et al., 2020).

There were large differences in the prevalence of teleworking across occupations before the pandemic. If we observe in Figure A6 the three-year window before Covid-19, we can divide into three groups the occupations. In the first place, we have those occupations whose 20% of the workers had performed a remote job such as Management and Directors, and Scientific and Intellectual technicians. In the second place, 10% of Support professionals and Agriculture and Manufacturing skilled workers in Spain telecommuted, and if we focus on the bottom of the distribution of jobs performed at home, we find those occupations with higher-level social interactions or those low- and middle-skilled occupations in which teleworking remains a largely unrealistic option, making these workers more vulnerable during the lockdown.

Figure A7 shows which occupations were already more likely to be *teleworkable* before the outbreak of Covid-19 and which ones had a probability not marginally different from zero. The lockdown exacerbated the likelihood of performing a job remotely for those occupations with characteristics that enabled a fast adaptation of the work system and a prompt transformation of face-to-face into virtual services necessary to continue performing them. Nevertheless, it is important to remark that occupations such as technicians, support professionals, and others related to accounting, administrative, and other office employees experimented an increase in their likelihood to telecommute close to a 20 p.p., which is relatively the same magnitude compared to those we have mentioned before (moved from 20% to near 40%)[5].

Henceforth, we determine that the lockdown caused by the outbreak of the pandemic revealed three types of *teleworkable* occupations in Spain: occupations in which the use of ICT resources can offer almost the same job performance and quality of services demanded; occupations in which telecommuting can be implemented to make jobs more flexible, and occupations in which the productive and organizational structure prevents their online performance.

Regarding the type of employee, self-employed or salaried worker, our results are consistent with those found in the literature. Evidence suggests that for many own-account workers their home is often their place of work. However, the definition of own-account teleworkers is wider and includes not only those "working at home" without ICT, such as small artisans and farmers, but also those "working from home" using ICT resources, such as designers or software developers (Sostero et al., 2020).

As we can observe in Table A10, self-employed individuals were already more likely than salaried workers to telecommute before the outbreak of Covid-19, in particular, they were, on average, 17 p.p. more likely to perform a remote job than employees. However, even when more than 80% of the working population in Spain are salaried workers, they are 18 p.p. less likely to perform their jobs remotely during the lockdown compared to own-account workers. This result reveals that dependent workers can not adapt or make their jobs more flexible as self-employed, who in principle have much greater discretion over how and where their work is carried out, and this can be more related with workers' autonomy than with technical teleworkability.

Beyond the technical feasibility, differences in access to telework across occupations also reflected varying degrees of workers' autonomy, which in turn depend on employers' trust. Many employers have been reluctant to give up direct supervisory control, or argue that face time is a critical feature of the productive process (Allen et al., 2015). Nevertheless, the expansion of

[5]More detailed information can be found in Table A9.

telecommuting across salaried workers has also been linked to a general expansion of work hours and low wage returns to working at home beyond the standard work week (Glass and Noonan, 2016).

Conversely, part-time jobs provide an opportunity for flexible hours of work and for combining work with family commitments. Thus, we could expect that those part-time employees are more likely to adapt their jobs and perform them from home as they have already a more flexible working day compared to those working under full time schedules. However, as we can observe in Table A12, in Spain a full-time worker is, on average, 4 p.p. more likely than a part-time worker to perform their work from home, estimated for the three years period before the Covid-19. This differences are intensified by the outbreak of Corona, where the lockdown is related to an increment of almost 7 p.p. in both type of work days and to a wider gap between full-time and part-time workers during the lockdown.

It was also worth mentioning that the intuition behind telecommuting is associated with the increase of work flexibility although, the evidence suggests that part-time workers would be less likely to be given the opportunity of telecommuting by their employers, which could be defined the *part-time paradox*. In Spain, women, low-paid, and multiple job holders are the vast majority of part-time workers which means that they are working under a more flexible schedule but without benefit neither from it nor from an opportunity of telecommuting to buffer the lockdown and its containment and mobility measures.

If we analyze deeper results differentiating the individuals' estimated probability by the type of work day and gender, we find that during the lockdown women with full-time jobs were more than 4 p.p. more likely to be performing a remote job than their counterparts males. At the same time, women holding a part-time job were less likely to adapt their jobs to telecommuting than men, which can be explained by the type of occupations where they are usually over represented in part-time jobs, which are the same as those occupations with lower probabilities of teleworking.

Among men workers, it is important to remark that the estimated probability of telecommuting is almost the same (lower than 2 p.p.) between those who work full-time compering with those who do it part-time. However, when we estimate the same probabilities for women, holding a part-time job penalizes them being the likeliness of performing a remote job halved (see Table A13). Thus, we can determine that there is no relationship between the type of employee and being women or men with the probability of teleworking but it has to be related with the type of work day among different occupations.

Finally, homeworking appears to have mitigated negative employment effects not only at an individual level but also at a national level (Sostero et al., 2020). In the case of Spain, the SLFS data enables us to evaluate in which regions teleworking was more prevalent before and after the irruption of the Covid-19. Nevertheless, there was no such difference among regions before the pandemic took place and the levels of telecommuting and individuals' probabilities to telework across territories does not distance so far between them. Thus, we find that, before Covid-19, performing a remote job was not related to a specific group of Spanish regions.

It is important to underline that, according to the existing polarization that characterizes the Spanish labor market, non preexisting differences among regions lead to an increase in the probabilities of telecommuting that are explained only by their relationship with particular characteristics of the productive system in each of them.

During and after the lockdown, when teleworking was used as a labour market buffer, differences arose and workers in Madrid and Catalonia were more likely to perform a remote job than they were before the pandemic, and this was not the case for the other regions. This dissimilarity can

not be attributed to the economic performance of those territories[6].

The ranking of regions where workers are more likely to telecommute demonstrates, surprisingly, no gap between those better positioned in economic performance (those with lower levels of unemployment such as Basque Country, Navarre, Madrid, and Catalonia, among others) and those in the bottom (such as Canary Islands, Andalusia, and Extremadura).

Regarding the estimated probabilities of telecommuting among the 17 Spanish regions, we find an homogeneous result in performing a remote job all over the territory, presenting a regional convergence during the three year window before the pandemic, as we show in Table A8. Nevertheless, the outbreak of Corona revealed that those regions with higher economic performance are those reporting to be significantly more likely to adapt jobs remotely. In particular, during the lockdown, workers in Madrid and Catalonia were, on average, twice as likely to telework than other workers located in any other Spanish region.

4 Conclusions

The massive expansion of telework during the COVID-19 pandemic can be considered a natural experiment in countries' labor markets around the world. Restrictions on mobility and physical distancing policies led to the shuttering of many workplaces. Although containment measures were only designed and established to contain the pandemic, they also had a negative impact in the worldwide economy. The lockdown force industries, companies, and workers to restructure work organizations to fight against the upcoming unprecedented economic crisis.

In this study, we determine that the technical feasibility pertaining to each occupation is the factor affecting more the probability of teleworking. We find that telecommuting can be used as a tool to make jobs more flexible. Accordingly, teleworking can be a candidate to substitute gender strategies to conciliate family and work responsibilities that many families adopt following childbirth (Pascal, 2011). Nevertheless, prior literature suggests that telecommuting may exacerbate gender inequalities between parents by increasing mothers' exposure to domestic demands and blurring the work-life boundary. Based on conceptual and empirical evidence, we expect telecommuting to increase mothers' housework and childcare and reduce their leisure relative to fathers' (Lyttelton et al., 2020).

Conversely, and one of the most important findings, we classify occupations in Spain by their degree of *teleworkability*, creating three groups. First, one group of occupations that are very likely to perform remotely because they leverage the potential of its access and use of ICT resources in its working process. A second group which is unaffected by an exogenous shock as the worldwide lockdown because of its high level of human interactions. And, finally, a third group composed by all those occupations where the supply of activities or services conducted at workplaces can be replaced conducting them from workers' homes. As the lockdown and its containment measures force companies and workers to adapt work organizations to the new and uncertain situation, in this last category we find the most potential of working remotely as a tool to make jobs more flexible, since they were adapted once the lockdown took place which would certainly not have been the case if the exogenous *nudge* of Covid 19 never happened.

To sum up, as the implementation of telecommuting can be also a double-edged sword, its enforcement has to be assessed as any other labor market policy.

[6]Madrid and Catalonia display one of the highest GDP per capita values among regions in Spain.

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Appendix

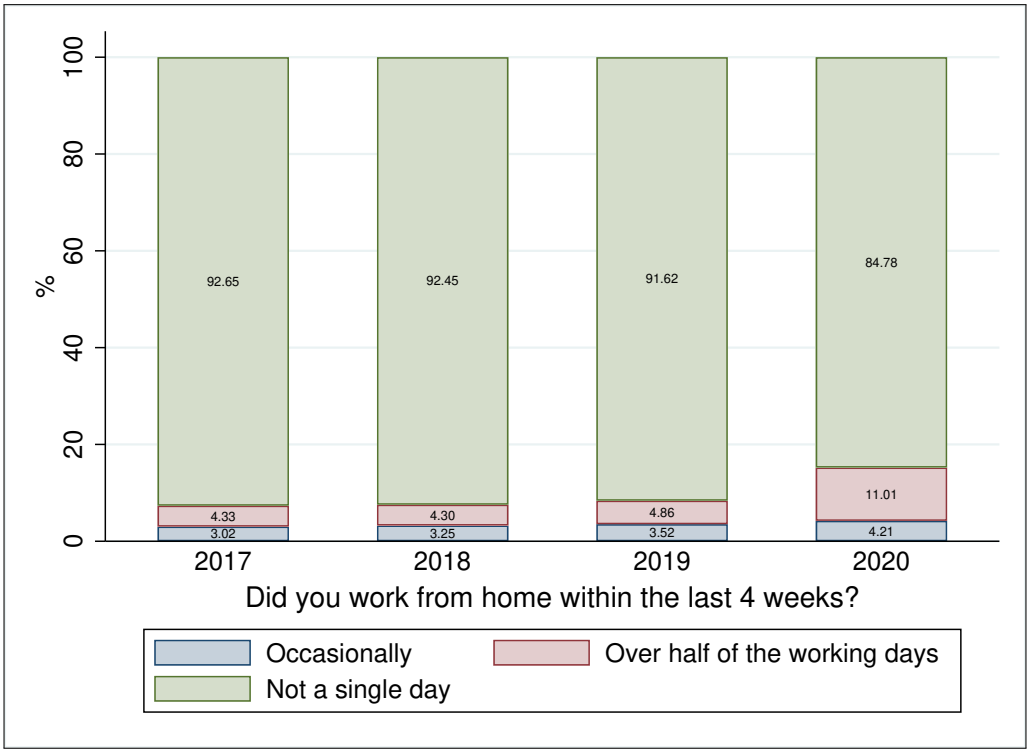

Figure A1: Teleworking intensity in Spain. Data source: Spanish LFS.

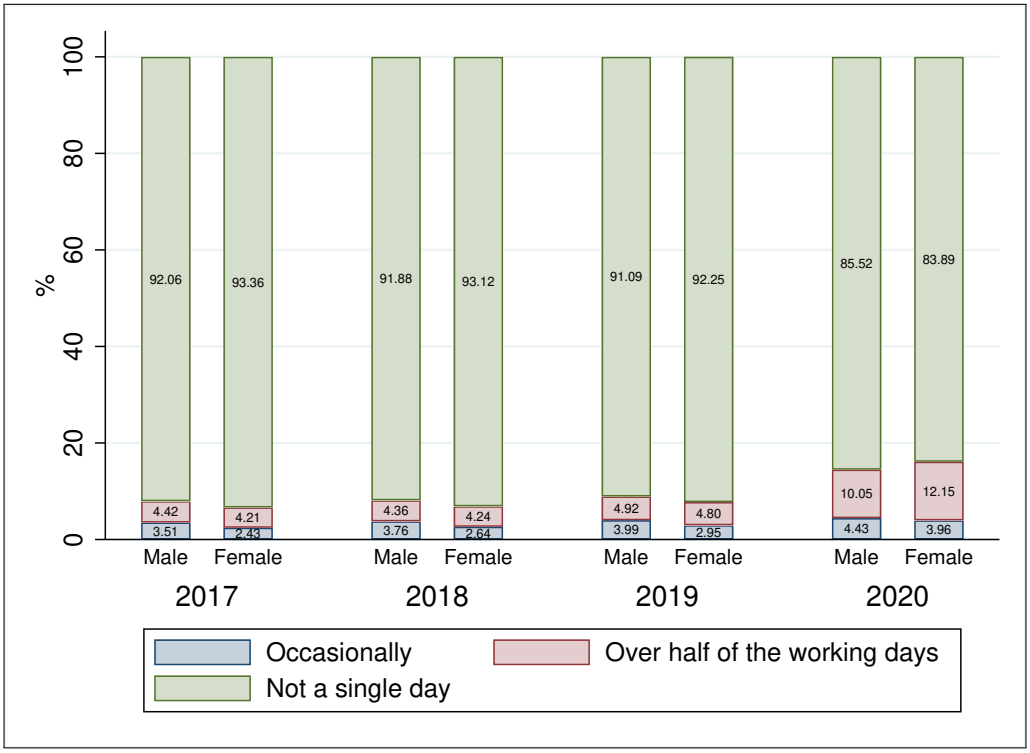

Figure A2: Teleworking intensity in Spain by sex. Data source: Spanish LFS.

Table A1: Teleworking intensity in Spain by sex (%)

		2017	
	Male	Female	Total
Not a single day	92.06	93.36	92.65
Occasionally	3.51	2.43	3.02
Over half of the working days	4.42	4.21	4.33
Total	100.00	100.00	100.00
		2018	
	Male	Female	Total
Not a single day	91.88	93.12	92.45
Occasionally	3.76	2.64	3.25
Over half of the working days	4.36	4.24	4.30
Total	100.00	100.00	100.00
		2019	
	Male	Female	Total
Not a single day	91.09	92.25	91.62
Occasionally	3.99	2.95	3.52
Over half of the working days	4.92	4.80	4.86
Total	100.00	100.00	100.00
		2020	
	Male	Female	Total
Not a single day	85.52	83.89	84.78
Occasionally	4.43	3.96	4.21
Over half of the working days	10.05	12.15	11.01
Total	100.00	100.00	100.00

Source: Spanish LFS.

Table A2: Statistics based on Table A1

	2017	**2018**	**2019**	**2020**
Pearson chi2	1.9e+04	1.9e+04	1.6e+04	2.3e+04
Pr	0.000	0.000	0.000	0.000
Gamma	-0.0909	-0.0844	-0.0712	0.0661
ASE	0.001	0.001	0.001	0.001
Kendall's tau-b	-0.0237	-0.0223	-0.0198	0.0242
ASE	0.000	0.000	0.000	0.000

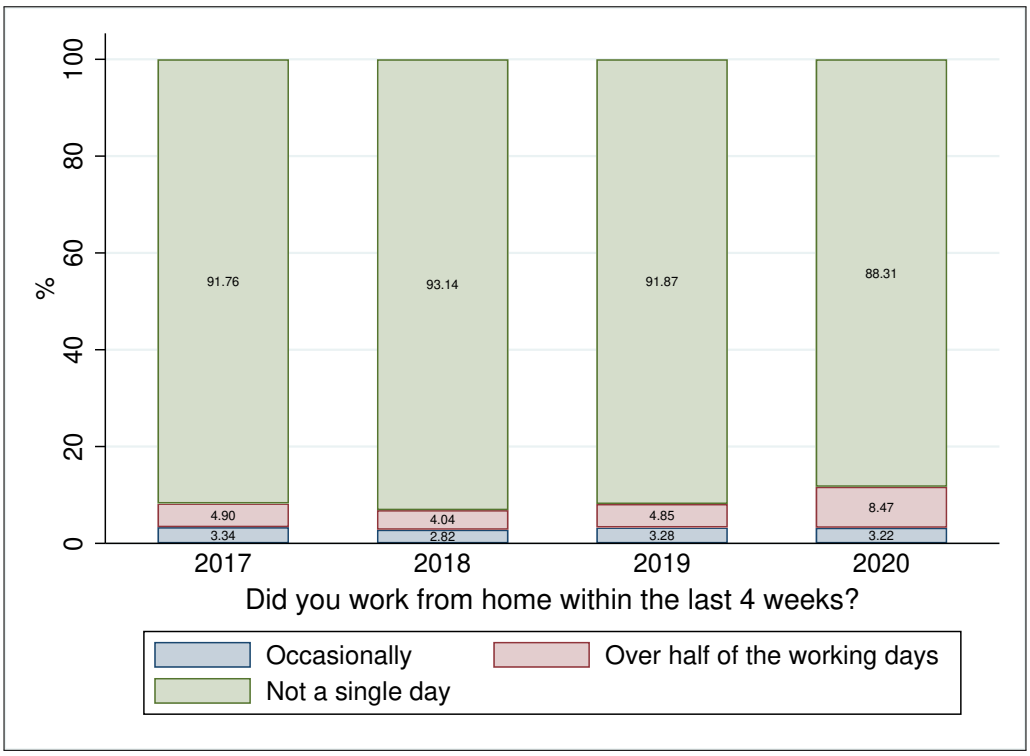

Figure A3: Teleworking intensity in Andalusia. Data source: Spanish LFS.

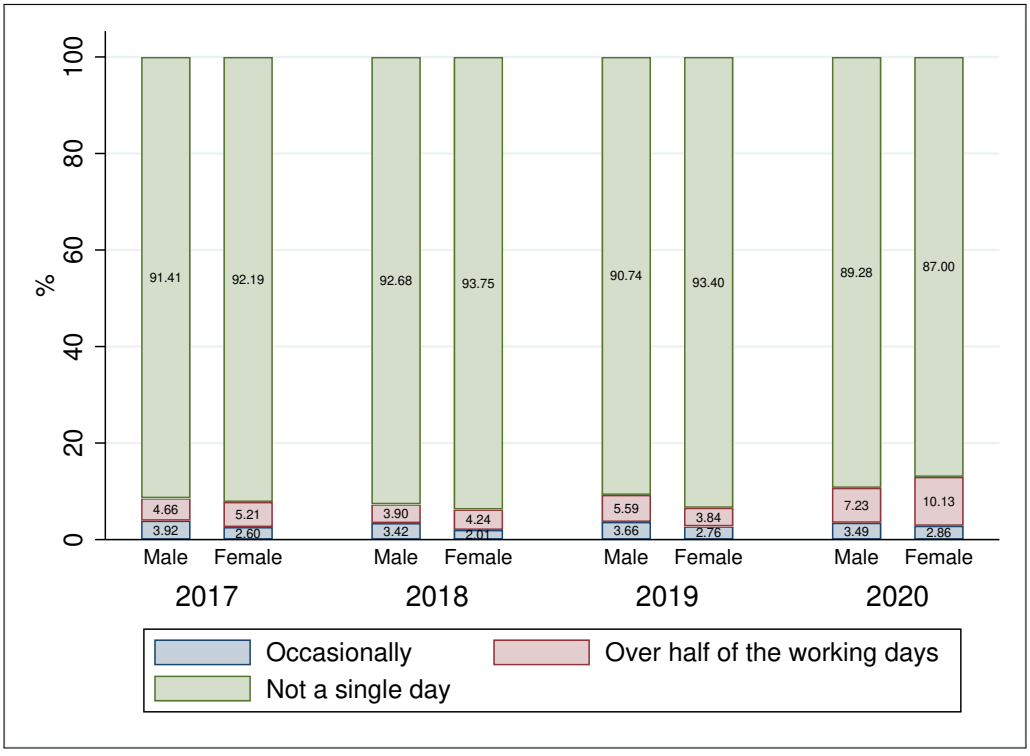

Figure A4: Teleworking intensity in Andalusia by sex. Data source: Spanish LFS.

Table A3: Teleworking intensity in Andalusia by sex (%)

		2017	
	Male	Female	Total
Not a single day	91.41	92.19	91.76
Occasionally	3.92	2.60	3.34
Over half of the working days	4.66	5.21	4.90
Total	100.00	100.00	100.00
		2018	
	Male	Female	Total
Not a single day	92.68	93.75	93.14
Occasionally	3.42	2.01	2.82
Over half of the working days	3.90	4.24	4.04
Total	100.00	100.00	100.00
		2019	
	Male	Female	Total
Not a single day	90.74	93.40	91.87
Occasionally	3.66	2.76	3.28
Over half of the working days	5.59	3.84	4.85
Total	100.00	100.00	100.00
		2020	
	Male	Female	Total
Not a single day	89.28	87.00	88.31
Occasionally	3.49	2.86	3.22
Over half of the working days	7.23	10.13	8.47
Total	100.00	100.00	100.00

Source: Spanish LFS.

Table A4: Statistics based on Table A3

	2017	**2018**	**2019**	**2020**
Pearson chi2	4.3e+03	5.5e+03	7.3e+03	8.5e+03
Pr	0.000	0.000	0.000	0.000
Gamma	-0.0453	-0.0785	-0.1790	0.1127
ASE	0.002	0.002	0.002	0.002
Kendall's tau-b	-0.0124	-0.0196	-0.0478	0.0368
ASE	0.001	0.001	0.001	0.001

Table A5: Predicted probabilities of teleworking by gender.

	2017	2018	2019	2020
Male	0.0793***	0.0811***	0.0891***	0.1446***
	[0.0791,0.0794]	[0.0809,0.0812]	[0.0890,0.0893]	[0.1445,0.1448]
Female	0.0664***	0.0686***	0.0775***	0.1611***
	[0.0663,0.0666]	[0.0685,0.0688]	[0.0773,0.0776]	[0.1609,0.1613]
Observations	18637780	19134208	19572089	18905557

95% confidence intervals in brackets

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Table A6: Predicted probabilities of teleworking by gender whether they have children or not.

	2017	2018	2019	2020
Childless men	0.0752***	0.0746***	0.0844***	0.1397***
	[0.0750,0.0753]	[0.0745,0.0748]	[0.0842,0.0846]	[0.1395,0.1399]
Men with children	0.0871***	0.0936***	0.0990***	0.1549***
	[0.0869,0.0873]	[0.0934,0.0938]	[0.0987,0.0992]	[0.1547,0.1552]
Childless women	0.0628***	0.0619***	0.0738***	0.1511***
	[0.0627,0.0630]	[0.0617,0.0621]	[0.0736,0.0740]	[0.1509,0.1514]
Women with children	0.0743***	0.0835***	0.0861***	0.1844***
	[0.0741,0.0745]	[0.0833,0.0837]	[0.0858,0.0863]	[0.1840,0.1847]
Observations	18637780	19134208	19572089	18905557

Note. 95% confidence intervals in brackets

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Table A7: Predicted probabilities of teleworking by five-year age groups.

	2017	2018	2019	2020
From 16 to 20 years old	0.0046***	0.0123***	0.0116***	0.0323***
	[0.0043,0.0048]	[0.0118,0.0127]	[0.0112,0.0120]	[0.0316,0.0330]
From 21 to 25 years old	0.0308***	0.0227***	0.0322***	0.0930***
	[0.0304,0.0311]	[0.0224,0.0230]	[0.0319,0.0325]	[0.0924,0.0935]
From 26 to 30 years old	0.0536***	0.0460***	0.0569***	0.1535***
	[0.0533,0.0539]	[0.0457,0.0463]	[0.0566,0.0572]	[0.1530,0.1540]
From 31 to 35 years old	0.0575***	0.0685***	0.0717***	0.1584***
	[0.0572,0.0578]	[0.0682,0.0688]	[0.0714,0.0720]	[0.1580,0.1589]
From 36 to 40 years old	0.0767***	0.0798***	0.0865***	0.1599***
	[0.0764,0.0769]	[0.0795,0.0801]	[0.0862,0.0868]	[0.1595,0.1603]
From 41 to 45 years old	0.0881***	0.0918***	0.0995***	0.1636***
	[0.0878,0.0884]	[0.0915,0.0921]	[0.0992,0.0998]	[0.1632,0.1639]
From 46 to 50 years old	0.0888***	0.0872***	0.0956***	0.1562***
	[0.0885,0.0891]	[0.0869,0.0875]	[0.0953,0.0959]	[0.1558,0.1566]
From 51 to 55 years old	0.0780***	0.0814***	0.0880***	0.1588***
	[0.0777,0.0783]	[0.0810,0.0817]	[0.0877,0.0883]	[0.1584,0.1592]
From 56 to 60 years old	0.0805***	0.0795***	0.0993***	0.1464***
	[0.0801,0.0809]	[0.0791,0.0798]	[0.0989,0.0997]	[0.1459,0.1468]
From 61 to 65 years old	0.0705***	0.0804***	0.0860***	0.1217***
	[0.0699,0.0710]	[0.0798,0.0809]	[0.0855,0.0866]	[0.1211,0.1223]
More than 65 years old	0.1885***	0.1936***	0.1734***	0.3023***
	[0.1863,0.1907]	[0.1915,0.1957]	[0.1716,0.1752]	[0.3001,0.3045]
Observations	18637780	19134208	19572089	18905557

95% confidence intervals in brackets

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Table A8: Predicted probabilities of teleworking by Spanish regions.

	2017	2018	2019	2020
Andalucía	0.0824***	0.0685***	0.0811***	0.1169***
	[0.0821,0.0827]	[0.0682,0.0687]	[0.0809,0.0814]	[0.1166,0.1172]
Aragón	0.0769***	0.0781***	0.0986***	0.1276***
	[0.0762,0.0775]	[0.0775,0.0788]	[0.0979,0.0993]	[0.1269,0.1284]
Asturias	0.0749***	0.0698***	0.1104***	0.1669***
	[0.0742,0.0756]	[0.0690,0.0705]	[0.1095,0.1113]	[0.1658,0.1680]
Baleares	0.0502***	0.0653***	0.1102***	0.1421***
	[0.0497,0.0508]	[0.0647,0.0659]	[0.1096,0.1109]	[0.1413,0.1430]
Canarias	0.0648***	0.0596***	0.0630***	0.0936***
	[0.0643,0.0652]	[0.0592,0.0601]	[0.0625,0.0634]	[0.0931,0.0942]
Cantabria	0.0718***	0.0745***	0.0715***	0.0842***
	[0.0709,0.0728]	[0.0735,0.0755]	[0.0706,0.0724]	[0.0831,0.0853]
Castilla y León	0.0765***	0.0718***	0.0861***	0.1137***
	[0.0760,0.0770]	[0.0714,0.0723]	[0.0856,0.0866]	[0.1131,0.1143]
Catilla-La Mancha	0.0696***	0.0690***	0.0753***	0.1092***
	[0.0691,0.0701]	[0.0685,0.0695]	[0.0748,0.0758]	[0.1086,0.1098]
Cataluña	0.0513***	0.0724***	0.0865***	0.1799***
	[0.0511,0.0515]	[0.0721,0.0726]	[0.0862,0.0867]	[0.1796,0.1803]
C. Valenciana	0.0820***	0.0858***	0.0862***	0.1310***
	[0.0816,0.0823]	[0.0855,0.0862]	[0.0858,0.0865]	[0.1306,0.1314]
Extremadura	0.0706***	0.0916***	0.0804***	0.1282***
	[0.0699,0.0714]	[0.0908,0.0924]	[0.0796,0.0812]	[0.1273,0.1292]
Galicia	0.0690***	0.0900***	0.0893***	0.1398***
	[0.0685,0.0694]	[0.0895,0.0905]	[0.0888,0.0898]	[0.1392,0.1404]
C. Madrid	0.0978***	0.0845***	0.0836***	0.2520***
	[0.0975,0.0981]	[0.0842,0.0848]	[0.0833,0.0839]	[0.2516,0.2524]
R. Murcia	0.0663***	0.0748***	0.0752***	0.1151***
	[0.0658,0.0669]	[0.0742,0.0755]	[0.0746,0.0759]	[0.1144,0.1159]
C.F. Navarra	0.0547***	0.0694***	0.0664***	0.1155***
	[0.0539,0.0556]	[0.0685,0.0702]	[0.0655,0.0672]	[0.1144,0.1166]
País Vasco	0.0644***	0.0665***	0.0786***	0.1128***
	[0.0640,0.0649]	[0.0661,0.0670]	[0.0781,0.0791]	[0.1122,0.1134]
La Rioja	0.0696***	0.0806***	0.0612***	0.1325***
	[0.0683,0.0709]	[0.0793,0.0820]	[0.0600,0.0623]	[0.1309,0.1342]
Observations	18637780	19134208	19572089	18905557

95% confidence intervals in brackets

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Table A9: Predicted probabilities of teleworking by one-digit occupation.

	2017	2018	2019	2020
Armed forces occupations	0.0108***	0.0058***	0.0182***	0.0542***
	[0.0101,0.0115]	[0.0053,0.0063]	[0.0174,0.0190]	[0.0529,0.0556]
Directors and managers	0.2145***	0.2037***	0.2484***	0.3588***
	[0.2136,0.2154]	[0.2028,0.2045]	[0.2474,0.2493]	[0.3578,0.3599]
Scientific and intellectual technicians and professionals	0.1907***	0.1897***	0.2208***	0.3692***
	[0.1903,0.1911]	[0.1893,0.1901]	[0.2204,0.2212]	[0.3687,0.3696]
Technicians, support professionals	0.1028***	0.1045***	0.1294***	0.2814***
	[0.1024,0.1032]	[0.1041,0.1049]	[0.1290,0.1298]	[0.2808,0.2819]
Accounting, administrative and other office employees	0.0310***	0.0246***	0.0312***	0.1767***
	[0.0308,0.0312]	[0.0244,0.0248]	[0.0310,0.0314]	[0.1762,0.1772]
Workers in catering, personal, and protection services and trade salespersons	0.0283***	0.0327***	0.0305***	0.0332***
	[0.0281,0.0284]	[0.0326,0.0329]	[0.0304,0.0307]	[0.0330,0.0334]
Skilled agricultural, livestock, forestry and fishery workers	0.1004***	0.1495***	0.1183***	0.0878***
	[0.0996,0.1013]	[0.1485,0.1505]	[0.1174,0.1192]	[0.0869,0.0886]
Skilled manufacturing industry and construction craftspersons and workers	0.0458***	0.0536***	0.0543***	0.0506***
	[0.0455,0.0460]	[0.0533,0.0538]	[0.0540,0.0545]	[0.0504,0.0509]
Plant and machine operators, and assemblers	0.0232***	0.0169***	0.0136***	0.0090***
	[0.0230,0.0234]	[0.0167,0.0171]	[0.0134,0.0138]	[0.0088,0.0091]
Elementary occupations	0.0063***	0.0113***	0.0072***	0.0086***
	[0.0062,0.0064]	[0.0111,0.0114]	[0.0071,0.0073]	[0.0085,0.0087]
Observations	18637780	19134208	19572089	18905557

95% confidence intervals in brackets

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Table A10: Predicted probabilities of teleworking for either self-employed or salaried workers.

	2017	2018	2019	2020
Salaried worker	0.0354***	0.0368***	0.0431***	0.1238***
	[0.0353,0.0355]	[0.0367,0.0369]	[0.0430,0.0432]	[0.1237,0.1240]
Self-employed	0.2688***	0.2803***	0.3060***	0.3010***
	[0.2683,0.2693]	[0.2799,0.2808]	[0.3055,0.3065]	[0.3006,0.3015]
Observations	18637780	19134208	19572089	18905557

95% confidence intervals in brackets

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Table A11: Predicted probabilities of teleworking for either public or private sector.

	2017	2018	2019	2020
Private sector	0.0708***	0.0735***	0.0795***	0.1410***
	[0.0706,0.0709]	[0.0734,0.0736]	[0.0794,0.0796]	[0.1408,0.1411]
Public sector	0.0875***	0.0853***	0.1059***	0.2053***
	[0.0872,0.0878]	[0.0850,0.0856]	[0.1056,0.1062]	[0.2049,0.2057]
Observations	18637780	19134208	19572089	18905557

95% confidence intervals in brackets

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Table A12: Predicted probabilities of teleworking for either full or part-time.

	2017	2018	2019	2020
Full-time	0.0793***	0.0814***	0.0900***	0.1605***
	[0.0792,0.0794]	[0.0813,0.0816]	[0.0899,0.0901]	[0.1603,0.1606]
Part-time	0.0413***	0.0416***	0.0487***	0.1021***
	[0.0411,0.0415]	[0.0414,0.0418]	[0.0485,0.0490]	[0.1018,0.1024]
Observations	18637780	19134208	19572089	18905557

95% confidence intervals in brackets

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Table A13: Predicted probabilities of teleworking by gender and type of work day.

	2017	2018	2019	2020
Full-time & Male	0.0812***	0.0832***	0.0908***	0.1464***
	[0.0810,0.0813]	[0.0831,0.0834]	[0.0907,0.0910]	[0.1462,0.1466]
Full-time & Female	0.0767***	0.0788***	0.0887***	0.1807***
	[0.0765,0.0768]	[0.0786,0.0790]	[0.0885,0.0889]	[0.1805,0.1810]
Part-time & Male	0.0579***	0.0520***	0.0667***	0.1204***
	[0.0576,0.0582]	[0.0517,0.0523]	[0.0663,0.0670]	[0.1200,0.1208]
Part-time & Female	0.0347***	0.0382***	0.0424***	0.0956***
	[0.0345,0.0349]	[0.0380,0.0384]	[0.0422,0.0426]	[0.0953,0.0959]
Observations	18637780	19134208	19572089	18905557

95% confidence intervals in brackets

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

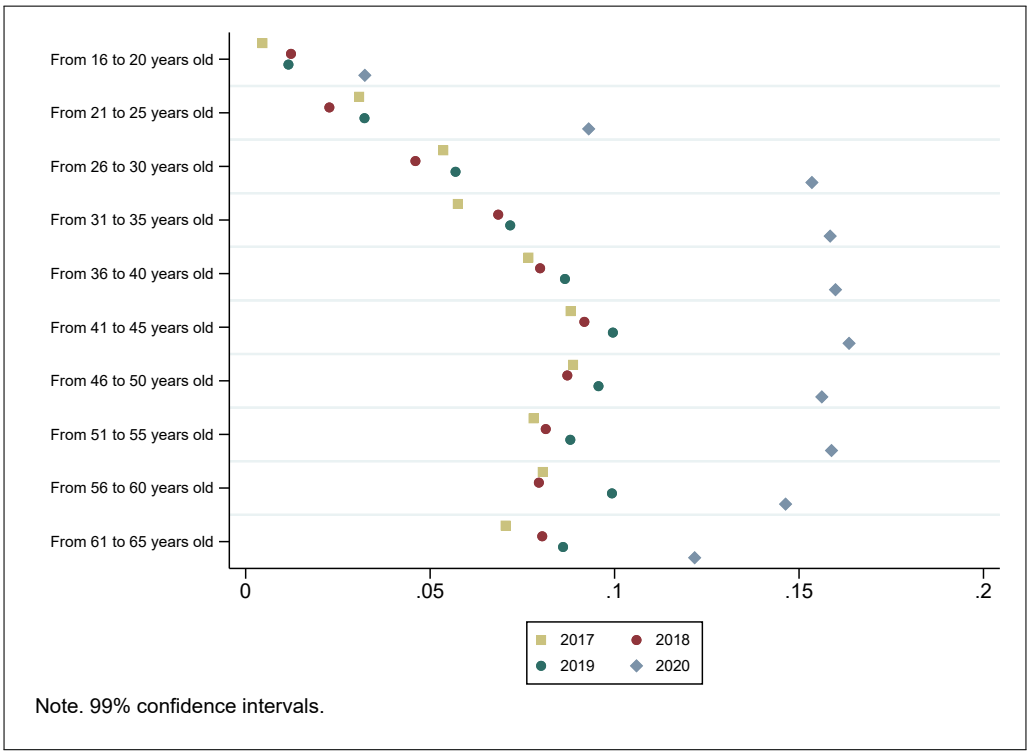

Figure A5: Teleworking estimated probabilities by age groups. Data source: SLFS.

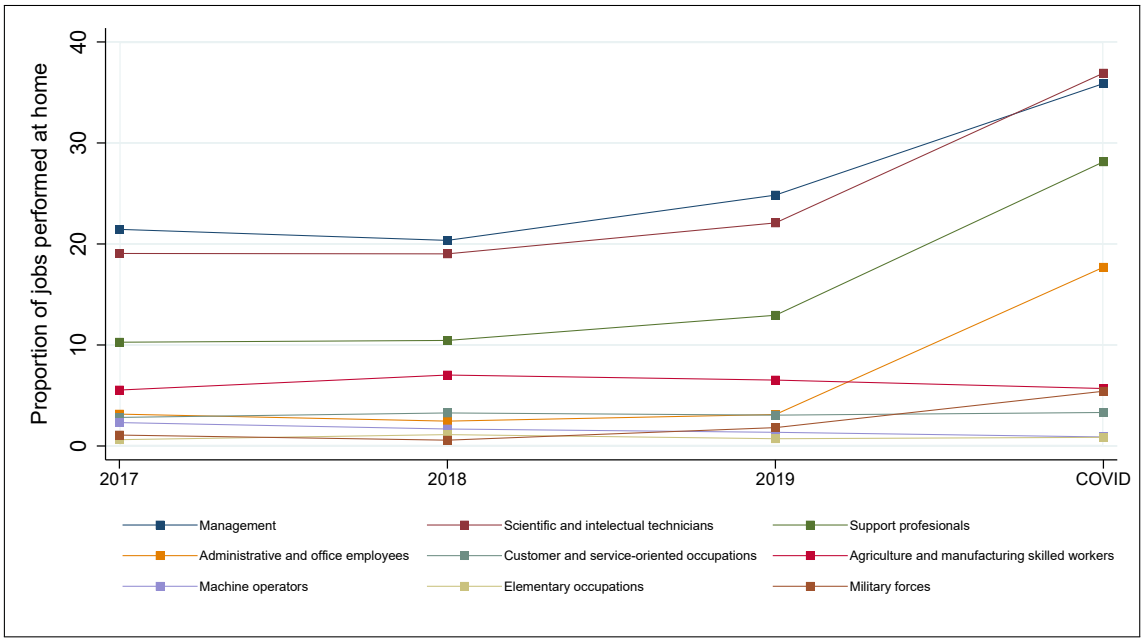

Figure A6: Proportion of individuals who perform a remote job classified by 1-digit occupations. Data source: SLFS.

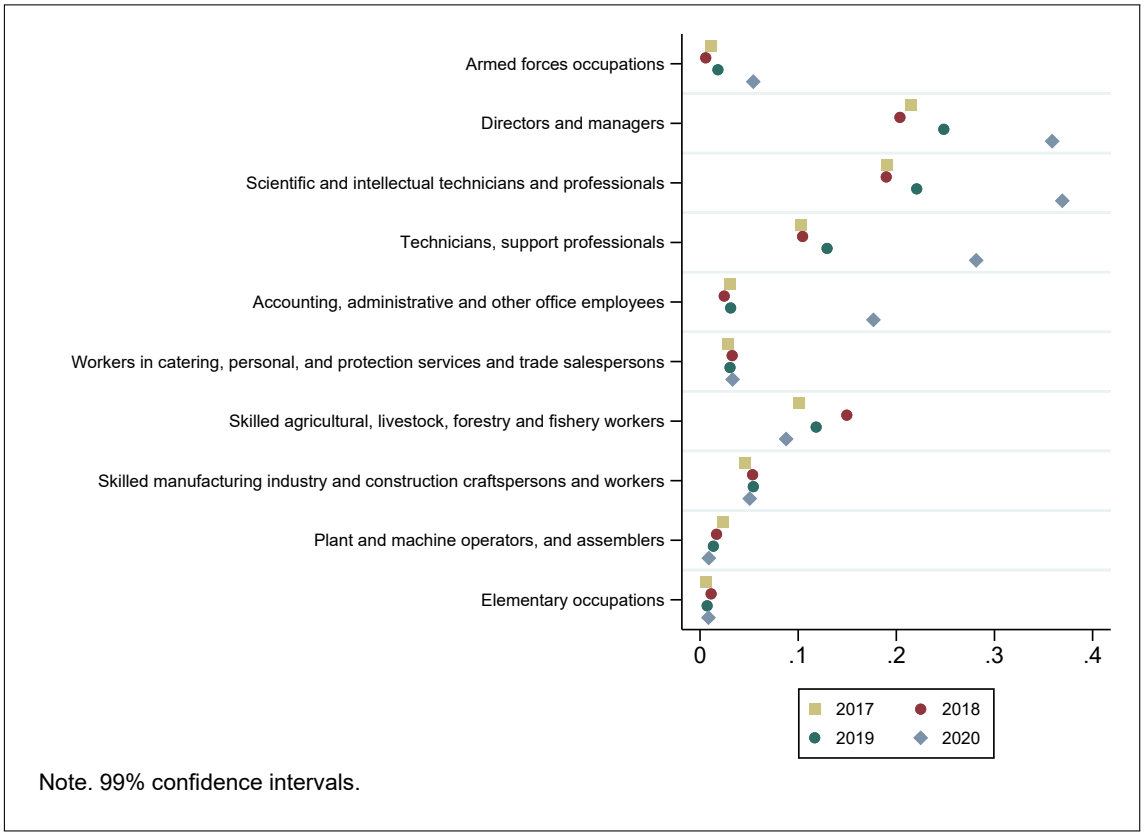

Figure A7: Predicted probabilities for teleworking across occupations. Data source: SLFS.