



Telework by region and the impact of COVID-19 pandemic: An occupational analysis

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Contents

Executive summary	2
1 Introduction	4
2 Literature review	5
3 Data and Methodology	8
4 The geography of telework in Europe since COVID-19: countries, regions, and degrees of urbanisation.....	10
4.1 Telework across EU Member States.....	11
4.2 Telework across EU NUTS regions.....	13
4.3 Telework by degree of urbanisation.....	15
4.4 Local internet connectivity.....	16
4.5 The regional variation of telework and potential teleworkability perspective	17
5 Econometric analysis of the determinants of telework.....	19
6 Discussion and conclusions.....	22
References.....	25
List of figures.....	27
List of tables	28
Appendix	29
1. Employees and self-employed.....	29
2. Place of work and place of residence	30

Telework by region and the impact of COVID-19 pandemic

An occupational analysis

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Abstract

Following the sudden expansion of telework across the EU during the COVID-19 pandemic, this study reveals a widespread increase in the prevalence of work from home across EU countries, regions, and territorial typologies. While telework rates have slightly receded from their peak at the height of COVID-19 restrictions, they remain markedly higher than pre-pandemic levels nearly everywhere in the EU, reflecting a lasting shift in work practices. Despite this common trend, stark disparities persist, especially between urban and rural areas, between capital regions and the rest, but also across countries. Regional analysis of the EU Labour Force Survey underscores the critical role of regional occupational structures in explaining differences in the local prevalence of telework. The findings show that technical teleworkability, as determined by occupational tasks, has become an even more significant predictor of the regional prevalence of telework after the pandemic. The study also challenges some common assumptions about rural internet connectivity, which has improved remarkably since before the pandemic, and which may now matter relatively less than regional occupational structure as a driver of telework. Our research also suggests that both the extent and frequency of telework matter for regional development, highlighting the nuanced policy trade-offs to promoting telework for sustainability and regional equity in a post-pandemic landscape.

Keywords: Telework, occupations, division of labour, regional employment.

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Executive summary

The recent surge in telework, accelerated by the COVID-19 pandemic, has profound implications for the European Union's socio-economic landscape, particularly in terms of the upward convergence in living and working conditions, as well as regional development and sustainability. This paper explores the evolution of telework across EU regions, focusing on the period from 2018 to 2022, to understand the distribution and determinants of telework adoption at the regional level, and its implications for future policy and practice.

Policy context

Telework refers to work that would otherwise be performed in the employer's premises that is done remotely, mostly from home, using connected digital devices. It has been posited as a transformative force for achieving a range of societal and potential environmental benefits, including reduced commuting and the emissions associated with it, as well as the potential to balance geographic population distribution, thus alleviating urban congestion and revitalizing rural areas. The COVID-19 pandemic, which temporarily required telework to all who could do it, has brought these issues to the forefront: it showed that many more workers could work remotely than was previously the case. This challenged pre-existing organizational norms and routines and showed the potential of telework and its role in the future of work.

Since the ability to telework is also generally seen as an improvement in working and living conditions, geographical disparities in the rate of telework for the same occupations should be avoided, to ensure the upward convergence in living and working conditions across the European Union.

Key conclusions

This analysis of the EU Labour Force Survey 2019–2022 reveals a significant increase in the prevalence of telework (working from home) across nearly all EU regions, compared to pre-pandemic levels. EU regions with historically lower telework rates have seen some of the proportionally larger increases in the prevalence of telework, but substantial regional disparities persist across Member States, NUTS regions, and territorial typologies (cities, towns and suburbs, rural areas). The highest telework rates are concentrated in Northern European capitals and the lowest in rural regions of South-Eastern countries.

The geographical differences in the adoption of telework partly reflect persistent structural differences in the occupation and industry specialisation of EU regions. The analysis underscores the critical role of regional occupational structures in explaining these differences, with our findings indicating that the potential for telework, driven by occupational characteristics, has become a more significant predictor of telework prevalence post-pandemic.

Telework is more common among city residents than in towns, suburbs, and rural areas, primarily because the types of jobs that allow telework are more common in cities, and that most people teleworking do so only some of the time. As EU regions specialise in different economic activities and occupations, large regional differences in telework may persist, or increase even further. A continuing expansion of telework may in fact increase the difference in economic activities between cities (particularly capitals) and rural areas in Europe. Although telework may potentially allow urban workers to relocate to rural areas, there is no evidence that this is happening on a meaningful scale.

Main findings

- **Continued impact of the pandemic on work practices:** the share of employed people teleworking at least some of the time across the EU in 2022, after the retreat of public-health measures, was 22.6%. This was slightly below the pandemic peak of 24.2% in 2021, but well above the pre-COVID level of 14% in 2019. The enduring shift in work practices points to broader acceptance and integration of telework into work culture.
- **Geographic disparities at all levels in the adoption of telework:** throughout the period 2018–2022, the share of employees teleworking has been higher in Northern European countries compared Southern and Eastern ones. Similarly, capital regions had higher prevalence of telework than other regions in the same country. On average, telework is more common in cities (17.3% in 2022) than towns or suburbs (12.9%), and rural areas (12.7%). Between 2019 and 2022, the telework levels have increased everywhere, but even faster in cities, compared to towns, suburbs or rural areas.

- **Regional occupational structure as a key determinant:** The study shows that regional occupational structures are the primary determinants of the rate of telework the regional level. The regional teleworkability index, based on the technical feasibility of telework by occupation and regional occupational structure, is an increasingly strong predictor of regional telework rates over the years, explaining most of the difference between EU regions. This finding underscores the importance of job characteristics in enabling or constraining telework.
- **The role of regional internet connectivity:** Internet connectivity is the key enabling technology of telework. Inferior service in some rural areas may hamper the potential of remote work. However, connection speeds have improved remarkably across the board over the pandemic period, in part stemming from EU targets and investments, which accelerated during the pandemic. Although urban areas on average still enjoy higher internet speeds than towns and suburbs or rural areas, by 2022 the average internet speed in rural areas (around 100 Mbps) was higher than what was available in urban areas in 2019 (around 65 Mbps). Rural internet speeds in the EU are now likely enough to support telework, though some national differences remain. Partly as a result, higher internet speeds are no longer significant predictors of higher levels of regional rates of telework.
- **Narrowing the gap between employees and the self-employed:** Telework has consistently been more common among the self-employed than among dependent employees, even for the same occupation, which reflects organizational and contractual barriers to telework. The gap between the two has narrowed over the pandemic period (from around 24 ppts in 2019 to around 18 ppts in 2022), which may signal a growing recognition of the benefits of telework for both employers and employees.

Related and future JRC and Eurofound work

This paper's findings contribute to a growing body of research on telework and its implications for regional development, sustainability, and the future of work. The Joint Research Centre (JRC) and Eurofound are both actively engaged in related research streams, including studies on the digital transformation of work, the impact of telework on urban and rural development, and the intersection of telework with broader socio-economic trends such as digitization and the green transition.

1 Introduction

In the European Union of today, a large share of economic activity is in the service sector, and much of it takes place in the digital domain. The pervasiveness of digital devices and networks in all kinds of economic activity means that, in principle, a large share of EU labour could be provided remotely, through so-called telework. The potential dissociation of the place of work and place of residence has several possible societal benefits, in terms of environmental sustainability and regional development. An increase in telework has been touted as potentially reducing overall energy consumption (and the associated emissions), by reducing the amount of commuting, although it has also been shown that rebound effects may decrease the gains from reduced work travel (Bisello and Profous, 2022). Many also hope that telework can contribute to a more balanced geographic distribution of the population, potentially reducing the congestion in urban areas and revitalising rural communities. For these reasons, there is a growing interest in European policy in the observed levels of telework across different European regions, the factors behind observed differences and the possibilities of expanding it where it is lowest.

This interest was further intensified by the sudden and generalised increase in work from home across Europe during the COVID-19 crisis. The measures put in place during the pandemic were a major milestone in the evolution of telework in Europe and other developed economies. Given the growing technical feasibility for the expansion of telework in the digital age, in fact, it is surprising that telework had not caught on before the pandemic. Across most of the EU, it was a marginal form of work, mostly used in some niche jobs which had long been working mostly from home (well before the digital revolution), or alternatively as a non-pecuniary benefit of some privileged occupations (mostly managers and professionals). The contrast between the potential and the reality of telework before COVID-19 suggests that a significant constraint for telework was not technical feasibility, but organisational routines, or corporate culture, which traditionally relies on in-person presence for performance monitoring. Only the extraordinary context of a global pandemic, with the need of reducing social interaction to the minimum possible, broke these cultural resistances so that technical feasibility became for a time the primary determinant of telework. Under the most restrictive confinement measures taken during the COVID-19 crisis, the majority of those who could telework did so. According to an early estimate, which considered the task content of the different occupations, around one-third of dependent employment in the EU is teleworkable (Sostero et al. 2020). At the peak of the COVID pandemic, around one fourth of the workforce in the EU27 was working from home at least some of the time. As the crisis ended, the prevalence of telework remained at high levels, despite a drop at the intensive margin, indicating that for many types of jobs, telework had always been feasible. In this period, new methods of monitoring and control of remote work emerged that made employers less reluctant to adopt this form of work, while workers acquired new skills and habits for working and collaborating remotely (Brynjolfsson et al. 2020; Fana et al 2020). In other words, after the COVID pandemic telework finally took off as a common form of work around Europe, even if its full potential has likely not materialised yet.

Because telework has significant potential implications for regional development and sustainability, it is important to assess how its recent surge has been distributed across European regions. Have the levels of telework across regions become more similar after the COVID-19 crisis? Or did the COVID-induced increases in telework concentrate in some specific regions, exacerbating previous differences? Did the factors explaining the differences in the rates of prevalence of telework across regions change also because of COVID-19? How do individual characteristics affect the propensity to work from home, and did they change during the pandemic?

This paper addresses these questions by using data on the evolution of telework across European Union regions from 2018 until 2022, that is before, during, and after the COVID-19 crisis. It reviews the existing literature on the recent evolution of telework in the European Union, with a focus on its geographic distribution. Then, it briefly discusses the data and methods applied in this paper. The fourth section presents descriptive data on the geography of telework in Europe since COVID-19 and evidence on local internet connectivity, while the fifth section discusses specifically the

importance of the occupational structure in explaining the observed differences in the take-up of telework across regions. The sixth section estimates econometrically the relative importance of technical feasibility and other factors in explaining the observed differences in telework. The final section discusses findings and policy implications, and points to further avenues for potential research.

2 Literature review

The COVID-19 pandemic triggered a large and sudden shift in the location of work around the world.

This phenomenon has taken different names: “remote work”, “telework”, or “work from home”. The International Labour Organization (ILO 2020) describes remote work as “situations where the work is fully or partly carried out on an alternative worksite other than the default place of work”. Telework is a subcategory of the broader concept of remote work, which includes the use of personal electronic devices. Although telework and remote work can potentially be carried out in different locations, including co-working spaces, satellite offices, or cafés, the most common option is from one’s home. This paper is concerned with the prevalence and distribution of telework in the European Union, where the most common source of data comes from surveys that ask whether respondents work from their home. In practice, “work from home” largely overlaps with the concept of telework – which concerns work that would otherwise be carried out in business premises – but also includes certain categories that have traditionally been carrying out economic activities at their place of residence, including farmers, teachers preparing lessons or grading homework, and some craftspeople. Consistently with much of the literature, this paper uses and “telework” and “work from home” interchangeably.

Evidence from the Global Survey of Working Arrangements (G-SWA) conducted in 27 countries suggests that the high level of telework will likely persist beyond the pandemic, with employees’ preferences even exceeding employers’ plans to continue offering such working arrangement (Aksoy et al. 2022). In the EU-27, before the COVID-19 pandemic, the share of all workers who worked from home at least some of their time was around 14%. Over the period 2019–2021, the rate of working from home increased by 10 ppts, mainly due to an increase of those in regular telework (Adascalitei et al., 2022). The most recent data published by Eurostat shows that in 2022 this figure stabilized at around 22%, with a decline in the rate of regular telework since the previous year (from 13.4 to 10.2%) and a slight increase in the rate of those working from home occasionally (from 10.6 to 12.2%)¹

Dependent employees, more than the self-employed, are those who experienced the largest increase in teleworking because of the COVID-19 outbreak, with working from home officially mandated or encouraged for workers who were able to do so. A significant share of self-employed, over a third (35%), were also working from home before the COVID-19 crisis, and many of them on a regular basis (Sostero et al., 2020). A much smaller share of dependent employees worked from home in 2019 (11%). This figure doubled to around 22% in just over two years and remained at 20% in 2022, after the last COVID-19 confinement measures were lifted across the EU. The increase in the rate of the self-employed working from home was much more modest (2 ppts between 2019 and 2021) (Adascalitei et al., 2022) and stood at around 38% in 2022.

Despite the increase in the share of employees working from home, this appears to have remained below its potential in 2020, as measured by a technical teleworkability index (Sostero et al., forthcoming). Indeed, around 36% of dependent employment in the EU was found to be in occupations that are fully “teleworkable” from a purely technical perspective, based on the task requirements of the job. Comparing these “potential” estimates of telework with figures on the

¹ https://ec.europa.eu/eurostat/databrowser/view/LFSA_EHOMP__custom_7026137/default/table?lang=en

actual rate of work from home, the study shows that, before the COVID-19 crisis, the gap between the two was larger for lower-level white-collar occupations. This suggests the persistence of some non-technical barriers that prevented the diffusion of telework before the outbreak and its subsequent adoption to its full potential, including for instance a culture of direct supervision (Clear and Dickson, 2005; Dimitrova, 2003; Felstead et al., 2003). The problem of managerial control in the case of telework has been widely debated (for a review of relevant literature on the forms of control applied to telework, see Fana et al, 2022).

In terms of geographical distribution, while the share of employees working from home rose in all countries between 2019 and 2021, important variations emerge both in terms of pre-COVID prevalence and its subsequent expansion. In the Benelux and Nordic member states as well as Ireland, between one in three and a half of employees reported working from home at least some of the time in 2021, the high-water mark of telework in the EU. This compared with 6 and 7% in Bulgaria and Romania, respectively, which still represented a five-fold expansion on pre-COVID levels (Adascalitei et al., 2022). Sostero et. al. (2020) show that the gap between actual and potential rates of telework is higher for those countries with limited previous experience with teleworking. Cross-country variations in the development of IT/broadband infrastructure may partly explain such patterns. The observed rates of teleworking tend to correlate strongly with ICT readiness at national level (Sostero et. al, 2020).

Significant differences in the spatial distribution of telework are also found within countries. Eurostat's (2021) yearly analysis of regional employment trends shows that between 2019 and 2020 the share of employed individuals usually working from home grew at its fastest pace in capital regions, while urban regions accounted for most of the remaining regions that recorded a rapid increase in homeworking. When looking at the prevalence of telework by degree of urbanisation, before the pandemic working from home was much more likely in densely populated metropolitan areas than in suburbs and rural areas, as reported in Sostero et al (2020). The findings are also in line with Özgüzel et al. (2023), who similarly analyse the regional difference in remote work in the EU until 2021, but correlate it with rates on excess mortality, and rely on measures of potential telework from Dingel and Neiman (2020), which are based on occupation measurements from the United States.

The higher rates of telework in urban areas that occurred during the COVID-19 pandemic are consistent with findings on the geography of remote work potential. Estimates from Sostero et al. (2020) based on pre-Covid labour force survey data indicate that 'teleworkable' employment tends to be more common in cities (44%) compared to towns or suburbs (35%), or rural areas (29%). This reflects differences in the employment structure as more densely populated, metropolitan areas are richer in the knowledge-based, white-collar services jobs that lend themselves to remote working. Rural areas, by contrast, tend to have a higher share of jobs that cannot be performed remotely, as they involve more physical task content, such as those in agriculture. As shown in Bisello and Profous (2020) the employment share of jobs which are 100% technically teleworkable and have relatively low social interaction is much higher in cities than rural areas, ranging from over 30% for secretaries, to up to almost 70% in the case of legal professionals.

In line with the evidence for Europe, a recent study for the United States also shows that big cities experienced much larger rates of remote work compared to smaller cities, as they specialise in high-skill service jobs, and in line with their findings on the geography of remote work potential (Althoff et al., 2021). Using U.S. data on commuting zones and teleworking potential, the analysis documents a positive relationship between a city's population density and the share of jobs that can be done remotely. In America's densest cities, around 45% of local jobs have the potential to be done remotely.

Another study covering a larger set of OECD countries confirms that the share of jobs amenable to remote working in 2018 was higher in more densely populated areas also in other countries outside Europe and it shows a positive relationship between regions' levels of potential remote working and

the share of workers with tertiary education, albeit with some cross-country differences in the strength of the correlation, which reflects the industrial composition of the regional economies (OECD, 2020).

Consistently with these findings, research in the US shows that job postings that allow for remote work are more likely to be from urban employers. Indeed, since 2019 job postings mentioning telework have grown 102% in urban areas compared to only 14% in rural communities (Nitschke et al., 2022). A study for Germany using more than 35 million online job advertisements from 2014 to 2021 also shows that telework options are offered more frequently in metropolitan areas and in Western Germany (Alipour et al., 2021). However, it also finds that remote work is increasingly reaching rural areas, and that growth in telework opportunities in job ads occurred more strongly in smaller towns and rural regions with higher untapped potential for flexible work arrangements. While in 2020 job ads from urban areas were about 1.8 times more likely to offer telework than job ads from rural areas, the urban-rural gap in access to telework dropped to about 30 percent compared to 2019.

National-level evidence for Italy also shows that provinces with higher population density have higher values of both potential and actual telework (Croce and Scicchitano, 2022). For Ireland, 'the Regional Co-Working Analysis' identifies the actual number of private sector workers that can work remotely on a national and regional basis, as of Q2 2020 (Regional Assemblies of Ireland, 2020). The estimate, which is based on the definition of 'teleworkable' sectors (as opposed to occupations) developed by Fana et al. (2020), shows that the potential number of private sector workers that can work remotely was notably high in local authorities with high populations, with the highest figure in the capital city, Dublin.

For Spain, Anghel et al. (2020) calculate the rate of telework by regions and estimate the share of teleworkable jobs, using the methodology developed by Dingel and Neiman (2020) for the U.S. The analysis shows that the highly populated regions of Cataluña, Comunidad de Madrid o Andalucía recorded the highest share of teleworkers in 2019. Comunidad de Madrid and Cataluña, together with País Vasco, were also those for which the potential to increase the share of remote workers was the highest.

Research for Germany calculate the telework potentials for regions, occupational and industry groups using country-specific data on the task content of jobs from the BIBB-BAuA Employment Survey 2018, and administrative data from the Federal Employment Agency (Alipour et al., 2020). The findings show a strong correlation of 0.88 between working from home capacity and population density across counties, with a clear geographical divide between East and West Germany and between densely populated, urban counties and rural counties with lower population density. By construction, the regional variation in telework capacity is determined by the occupational composition in each county.

This paper contributes to the above literature on the rates and potential of remote work from a geographical perspective. First, the analysis complements existing studies by providing a detailed and updated overview of the prevalence of telework across different regions and degrees of urbanisation in Europe, and its evolution over time. We expect that while the COVID-19 crisis induced an increase in telework and marked changes in its frequency, this was not even across all regions, with important variations by type of regions within countries (e.g., urban/capital regions vs rural areas), but also significant cross-country differences in such trends. Secondly, the present study develops and tests the implications of the concept and measure of technical teleworkability from Sostero et al. (2020, 2023). That research showed that the rate of telework among many occupations was below what was technically possible before the COVID crisis, and argued that the constraints were likely to be institutional and cultural. This was apparent from several structural differences in telework before COVID: the self-employed, who generally benefit from more autonomy, tended to telework more frequently than employees in the same occupation. Likewise, different countries had different rates of telework for the same occupation, reflecting differences in systems of industrial relations. The paper then showed that the COVID crisis lifted many of the

organisational and cultural barriers to telework, such that – at least during public health measures – the only binding constraint to telework was technical: the extent to which a given job requires the physical interaction with machines, tools, or people.

This paper argues that the regional rate of telework is primarily determined by the regional occupational structure — the number of people employed in different occupations — to a greater extent than other regional characteristics, including the quality of internet connection. By combining the technical teleworkability index of each occupation with the regional share of employment of the same occupations provides a simple index of regional teleworkability potential, which should correlate with the share of the population that actually works from home. We verify this by means of an econometric analysis, investigating the role of different regional factors, including digital connectivity, in explaining variation in the rates of telework.

3 Data and Methodology

This study aims to document and explain the differences across EU regions in the rates of work from home, and how these have changed over time, around the COVID-19 crisis. Of particular interest is the role of geography: to what extent variation in rates of telework reflect differences across countries, regions within countries, or between cities and rural areas can be explained by their geographic characteristics, or by their different occupational structure?

To answer this question, we rely on the European Labour Force Survey (EU-LFS), which is conducted annually, and provides a representative sample of the working-age population. In our analysis, we consider the period 2018-2022 and the population of interest includes people aged 15 and over, who are either employees or self-employed, excluding family workers. The main variable of interest measures how often the respondent reports working from home, with the possible answers “never”, “sometimes” or “usually”.² From this variable, we derive a binary indicator equal to one when the respondent reports working from home at least some of the time (“sometimes” or “usually”), and zero when they do not (“never”), but also report some figures that distinguish between these different frequencies of telework. Missing responses to this question are excluded from this analysis, and generally concern between 0–5% of respondents in all countries.

In 2022, the most recent year for which data is available, the relevant sample of the EU-LFS included over 1.2 million respondents across the 27 EU Member States, representing a total population of interest of around 200 million employed workers. However, as COVID-19 and related public-health measure disrupted nearly every human activity, they also affected the collection of official statistics, and the EU-LFS, which is preferably conducted face-to-face, was no exception. Moreover, the pandemic period happened to coincide with changes to the Integrated European Social Statistics regulations in 2021³, which regulate the collection of social surveys, including the LFS. This may have resulted in the reduction in sample sizes in some countries. Overall, the numbers of respondents fell in 2020, compared to the previous years: most countries saw a 1%-15% drop, but France reduced its LFS sample by of 76% (from 192,244 respondents in 2019, the third-largest sample in the EU at the time, to 46,064 in 2020), and Germany by 75% (from 267,335 in 2019, the largest EU sample, to 67,613 in 2020). Other countries with a notable drop in respondents 2020 include Luxembourg (-39%), Portugal (-20%) and Ireland (-16%). By contrast, five Member States managed to increase the number of respondents in 2020 compared to the previous year, most notably Sweden (+14%) and Poland (+12%). The negative effect of COVID-19 on the collection of statistics continued after 2020: as of 2022, despite the retreat of public health measures, the number of LFS respondents was lower than it was before COVID-19 in 21 out of 27

² Table LFSA_EHOMP, see <https://ec.europa.eu/eurostat/databrowser/bookmark/50019178-d816-4224-a794-b1e7adcd18f8?lang=en>

³ Regulation (EU) 2019/1700 of the European Parliament and of the Council <https://eur-lex.europa.eu/eli/reg/2019/1700/oj>

countries. The number of respondents was still at least 30% lower in 2022 with respect to 2019 in Greece and France (-86%), Ireland (-85%), Portugal (-78%), Germany (-63%), Malta (-46%), and Luxembourg (-39%). By contrast, the LFS sample grew in the same period in The Netherlands (+174%), Croatia (+19%), Poland, Hungary and Slovenia (around +12%) and Latvia (+6%). On aggregate across the EU, the total number of respondents of the EU-LFS was highest in 2018 (1.74 million), declined slightly in 2019 (1.67 million), and fell to 1.27 million in 2019 (a 24% drop), reached a minimum of 1.18 million in 2021, before recovering slightly in 2022, to 1.2 million.

The reduction in sample size in most EU countries is certainly concerning, as it implies that estimates from 2020 onwards are based on a smaller number of observations, and may thus be less precise. Moreover, there may be some sample selection bias with respect to our main variable of interest (working from home): respondents that work from home may have been easier to reach, and thus more likely to participate to the EU-LFS survey during COVID-19, relative to those who worked at employer's premises even during confinement measures. In general, the EU-LFS sampling strategy is intended to accurately represent the working population of interest in the EU, and observations are weighted, based on the individual respondent's characteristics, to ensure that the overall sample is representative of the relevant population.⁴

Concerns about sample size notwithstanding, among the reference population of the EU-LFS, in 2022 an estimated 45.3 million (or around 22.6%) worked from home at least some of the time. As the next section documents, the rate of working from home varies substantially across EU countries and regions. It increased substantially in the wake of the COVID-19 pandemic and the related shift to mass telework, and declined only slightly in 2022, after the last confinement measures were lifted.

The EU-LFS cannot be used to track changes over time in individual patterns of work from home, because it is structured as an anonymous cross-sectional survey, not intended for longitudinal analysis. Nevertheless, some aggregate trends emerge at the territorial, regional and national level. We analyse differences in work from home on a geographical basis, along various dimensions: besides the national level, we consider the NUTS region of the respondent's residence.⁵ These regional geographical units are reported at NUTS-2 level in all countries that have such subdivisions, except for Germany and Austria (which report the place of residence at the more aggregate NUTS-1 level) and the Netherlands (which reports all observation at the national NUTS-0 level). Cyprus, Estonia, Latvia, Luxembourg, and Malta consist of a single NUTS-2 region. We classify NUTS regions into five different groups: "capital region", "mainly urban", "intermediate", "mainly rural", or "whole country". This designation is loosely derived from a more granular classification of territorial typology developed by Eurostat at the NUTS-3 level, based primarily on average regional population density, which we aggregate to the reporting level of the EU-LFS microdata (see Eurofound and JRC, 2019).

Additionally, we consider the *degree of urbanisation* of the respondent's residence, as being either a "city", a "town or suburb", or a "rural area", based on a fine-grained geographical grid of population size and density.⁶ These categories are applied to the addresses of LFS respondents, which are otherwise not reported in the microdata. This additional classification thus allows to compare similar territories within and across different NUTS regions and countries: for example, a given NUTS-2 region may be "mainly urban" as a whole, but some of its residents may nevertheless live

⁴ Additionally, starting in 2021 such sampling weights were not provided for a large share of responses in The Netherlands (55% of observations lacked a sampling weight in 2021) and Luxembourg (54% in 2021 and 60% in 2022). In a few other countries, the rate of non-weighted observations was also high, but constant before and during COVID-19: 45-48% in Finland, 13-14% in Denmark and 2.5-6% in Sweden. Observations lacking sampling weights are excluded from our analysis, as intended. In the analysis that follows, we highlight whenever a particular statistic appears unreliable because of a particularly small number of underlying observations.

⁵ <https://ec.europa.eu/eurostat/web/nuts/background>

⁶ <https://ec.europa.eu/eurostat/web/nuts/local-administrative-units>

in rural areas.

In summary, the geographical information provided in the EU-LFS distinguishes at most between different degrees of urbanisation (cities, towns and suburbs, rural areas) within NUTS-2 regions. However, it does not identify specific local administrative units, which prevents us from associating respondents to specific “commuting zones” or “travel-to-work-areas”.⁷

To better understand the determinants of the variation in rates of work from home, we rely on the occupational *technical teleworkability index* developed in Sostero et al. (2020, 2023). This composite index is based on the occupational task contents – what people do at work – measured through surveys (administered before COVID-19), and provides an estimate of whether any given occupation can work remotely in the digital era.⁸ The *technical teleworkability index* summarises whether any given occupation faces physical constraints in working remotely, by requiring physical manipulation of objects, people, or machinery, which cannot be done remotely with available digital technologies. This index is intended to be the primary predictor of whether a given occupation can telework or not, ranging between 0 (occupation is not “teleworkable”, because it involves physical constraints) to 1 (occupation fully “teleworkable”). In this paper, we analyse whether technical teleworkability helps explain work from home, both in terms of differences across EU regions and at the individual respondent level, and whether its explanatory power has changed over time.

Since internet connectivity is the key enabling technology of telework, this study also examines internet speeds across EU regions and territorial typologies as a determinant of telework rates. The data, derived from Ookla *Speedtest Intelligence*[®], measures real-world connectivity speed, as tested by consumers, in either cities, towns and suburbs and rural areas of EU NUTS-2 regions.⁹

The next section documents how rates of working from home have changed across EU regions, degrees of urbanisation, and countries since COVID-19, whereas section 5 shows the changing relation between what teleworkability indices predict and the actual share of work from home. Section 6 presents an econometric framework to understand the regional differences and changes over time of the share of people working from home.

4 The geography of telework in Europe since COVID-19: countries, regions, and degrees of urbanisation

This section uses micro-data from the EU Labour Force Survey to document changes across countries, regions, and degrees of urbanisation in the rate of telework before, during and in the wake of the COVID-19 crisis.

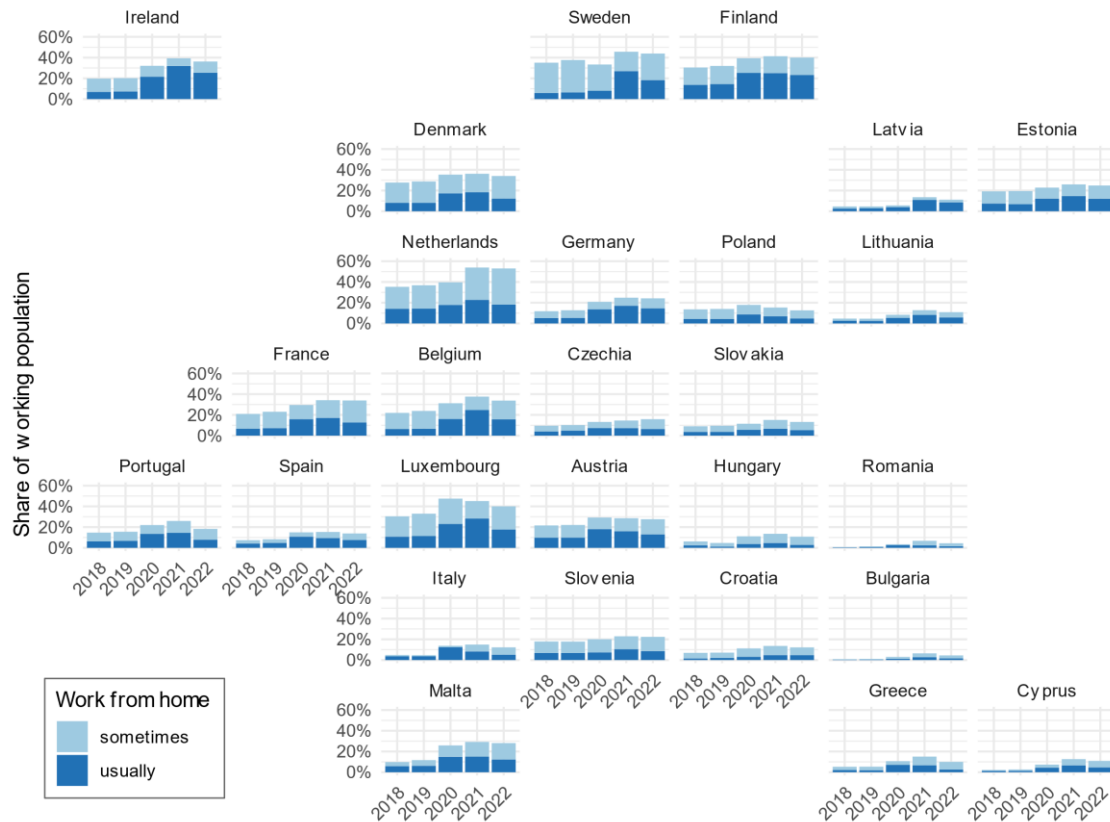
⁷ For instance, respondents of ES6 (Andalusia, in Spain) living in urban areas may potentially be residents of Seville, Málaga, Granada, Córdoba, or any other city in that NUTS region.

⁸ These indices are originally computed at ISCO 2008 3-digit level, which is also reported in the EU-LFS for most countries, excluding Bulgaria, Slovenia and Malta which report occupation at a more aggregate level, and are thus excluded from the econometric analysis in Section 6.

⁹ We are grateful to by Patrizia Sulis, of the European Commission Joint Research Centre, for elaborating and sharing the data with us.

4.1 Telework across EU Member States

Figure 1: Frequency of work from home, by country and year



Source: EU-LFS data, own analysis

The share of employed people teleworking — that is, those working from home ‘sometimes’ or ‘usually’ — before COVID-19 was around 14% on average across the EU, and mostly stable between 2018 and 2019 (see

Figure 1). With the introduction of COVID-19 confinement measures 2020, it increased markedly in every country (20.8% on average across the EU) and increased even further in 2021 in many countries (24.2% on average). In 2022, after confinement measures were lifted, telework rates decreased slightly everywhere, while remaining well above pre-COVID levels (22.6% on average).

Despite this common trend, the magnitude of changes in the rates of telework varied across Member States, and in some cases so did their timing. Sweden is notable in being the only country where the rate of telework ostensibly dropped between 2019 and 2020, by around 4 percentage points, though Eurostat marks the figure for Sweden in 2020 as being of low reliability.¹⁰ Luxembourg and Malta recorded the largest absolute increase between 2019 and 2020, over 14 percentage points. They were followed by another small country, Ireland, where the share of people teleworking increased from 20% to 32%, with a threefold increase in the share of employed people doing so usually (from 7% to 22%). While Luxembourg had very high rate of telework already pre-Covid (33% in 2019), this was less the case for Ireland (20%) and Malta (12%). Italy, Belgium, Germany, Finland, and Austria also recorded a noticeable increase in prevalence of working from home (above 7 pp). At the other end of the spectrum, the smallest absolute changes – below or

¹⁰ https://ec.europa.eu/eurostat/databrowser/view/lfsa_ehomp/default/table?lang=en

around 2 pp increase – were recorded in Latvia, Romania, Bulgaria, Slovakia, and Slovenia. Bulgaria and Romania had particularly low levels of telework already in 2019 (just above 1%).

In terms of frequency of work from home, in several countries the rise in telework between 2019 and 2021 came predominantly from those doing so ‘usually’ rather than ‘sometimes’ (as show by the different shades in

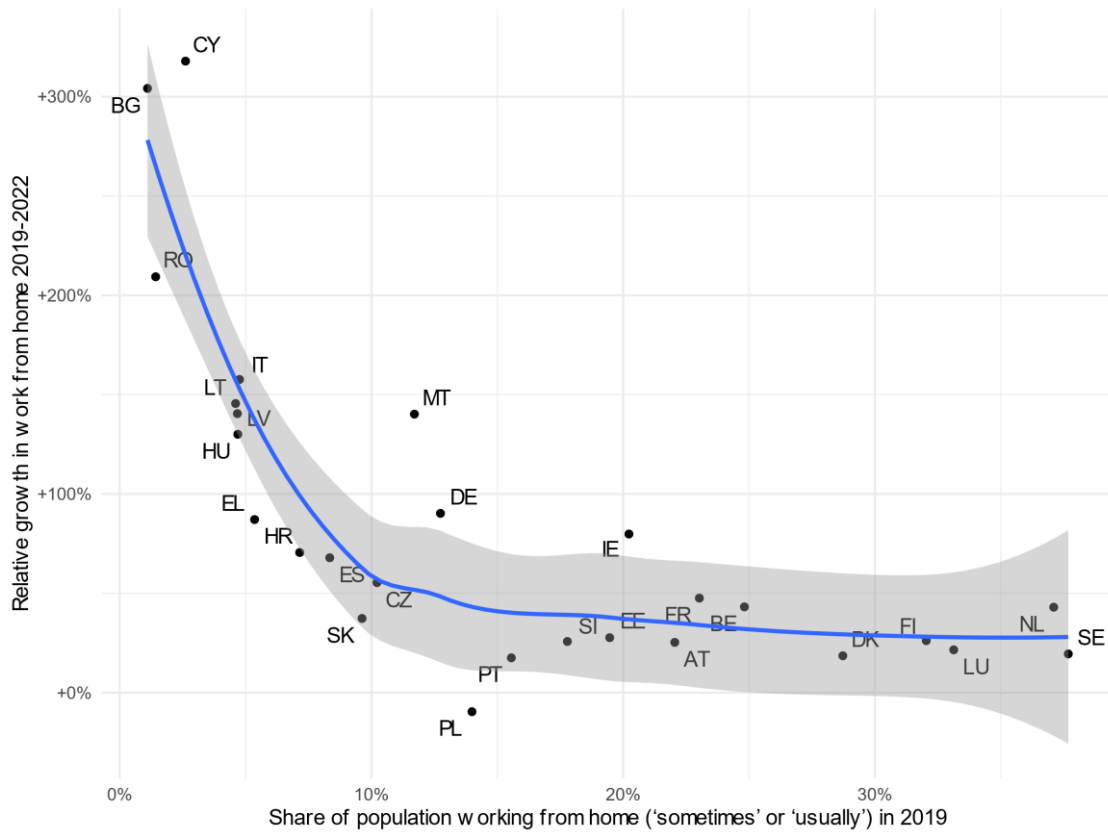
Figure 1). This was particularly the case in Ireland, Sweden, Belgium, and Luxembourg with an increase in regular telework higher than 20 percentage points in the first two countries, and between 17 and 19 in the others. However, in many Eastern and Mediterranean Member States the increase was more balanced, or even slightly in favour of occasional telework (e.g., in Hungary, Croatia, Italy, Bulgaria and Romania).

Between 2020 and 2021, with COVID-19 confinement measures still in place, and being tightened in some countries, the increases in the prevalence of telework progressively consolidated or remained stable, albeit to a very different extent. Only in three countries the rates of working from home slightly decreased, notably in Poland (-2.5 pp), Luxembourg (-2.4 pp) and Austria (-0.6 pp). By contrast, in the Netherlands and Sweden, there was a considerable increase in the uptake of working from home (+14 and 13 pp respectively). In 2021, these two countries ranked the highest in terms of prevalence of telework (54% and 47%), followed by Luxembourg (45%), Finland (41%), Ireland and Belgium (40%), Denmark (36%) and France (34%). In all other countries the respective shares were below 30%, with most Eastern European, Baltic and Mediterranean countries standing around or below 15%. Romania and Bulgaria continued to record the lowest rate, around 7%, albeit this represents a five-fold expansion on pre-COVID levels, given low starting levels.

In 2022, nearly all the public-health measures were lifted across all Member States, but the rate of telework reduced only slightly (between 1 and 3 pp in most countries), remaining well above the pre-COVID levels of 2019. In absolute terms, the share of people working from home decreased the most in Portugal (from around 26% in 2021 to 18.3% in 2022, over 7pp), Luxembourg (45.4% to 40.3%), Greece (15.1% to 10%) and Belgium (39.9% to 35.5%). Czechia was the only exception to the general downward trend, as teleworking rates there increased from 14.6% to 15.9%.

Across the European Union, the reduction in the overall share of people teleworking between 2021 and 2022 was mostly due to a reduction in the share of those working from home ‘usually’, by around 3.6pp on average, with larger drops in Luxembourg and Belgium (around -10pp), Sweden (-9pp), Portugal, Ireland, and Denmark (around -6pp each). This drop in regular telework was partly compensated by an increase in the share of those reporting to work from home ‘sometimes’ (around 1.4pp on average), especially in the same countries that saw the sharpest drop in regular telework. Although the lack of longitudinal identifiers in the EU-LFS prevents us from tracking the changes in individual responses over the years, it’s possible that the trend in 2022 reflects individual transitions from regular to occasional telework, for a small but appreciable segment of the workforce.

Figure 2: Relative growth in work from home from 2019 levels, EU-27 Member States



Source: EU-LFS data, own analysis

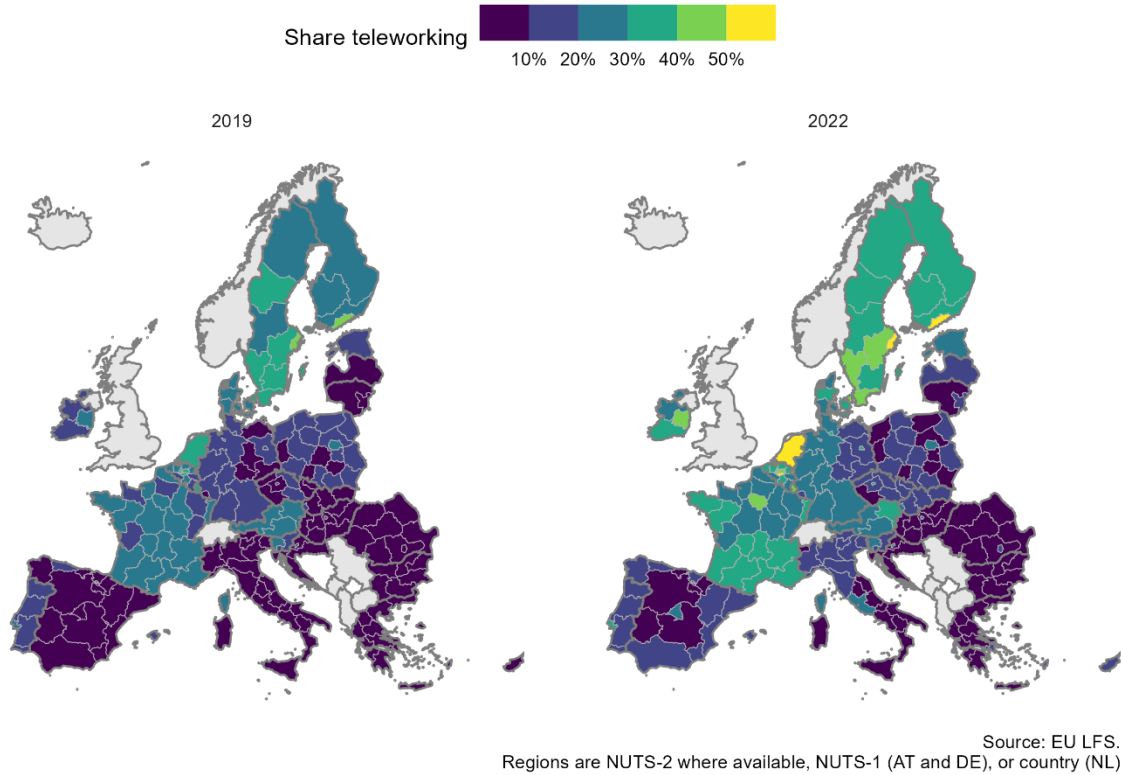
Overall, the countries with the lowest starting prevalence of telework are those where it grew proportionally the most. This is clearly visible in Figure 2 above, which shows a negative relationship between teleworking rates in 2019, before COVID-19 (horizontal axis) and relative growth between 2019 and 2022 (vertical axis). The line of best fit, based on localised regressions, shows that countries a pre-COVID rates of telework below 10% experienced the largest proportional growth in the following years, between 50 and 300%. Countries where telework was already relatively more common (over 10% in 2019) also experienced growth, of around 40-50% on average, which while proportionally smaller, translates to a large absolute increase in the total number of people teleworking.

4.2 Telework across EU NUTS regions

Besides the differences across EU Member States, there was considerable heterogeneity in the prevalence of telework across European regions, as shown by Figure 3, based on region of residence of the EU-LFS respondents. Before Covid-19, Stockholm and Helsinki were the only NUTS-2 regions with telework rates higher than 40%, standing out also compared to other areas of the country (particularly in Finland, as several other southern and central regions in Sweden – including mainly rural and intermediate – also recorded high rates of telework, around or above 30%). In Denmark instead, the interregional variability was much less pronounced, with consistently high rates of telework in all regions, albeit higher in Copenhagen. In Belgium, the share of people working from home in 2019 was highest in the commuting regions surrounding Brussels, that is Flemish Brabant and Walloon Brabant. In most of Eastern European, Baltic, and Mediterranean countries with very low pre-Covid rates of telework instead, the rates were not very different in the capitals or surrounding regions. In Romania and Bulgaria for instance, Bucharest and Sofia region ranked third and second within their countries, with only 1.5% and 1.4% of people working from home in 2019, respectively.

The COVID crisis resulted in a significant rise in teleworking rates in most regions: at the peak of telework 2021, 195 out of 202 NUTS-2 regions (96%) had higher rates of telework than they did in 2019. By 2022, with the retreat of public health measures, this was still the case for 181 NUTS-2 regions (89%), with most of the exceptions concentrated in Poland and Portugal.

Figure 3: Regional share of the working population working from home at least some of the time



Source: EU-LFS data, own analysis

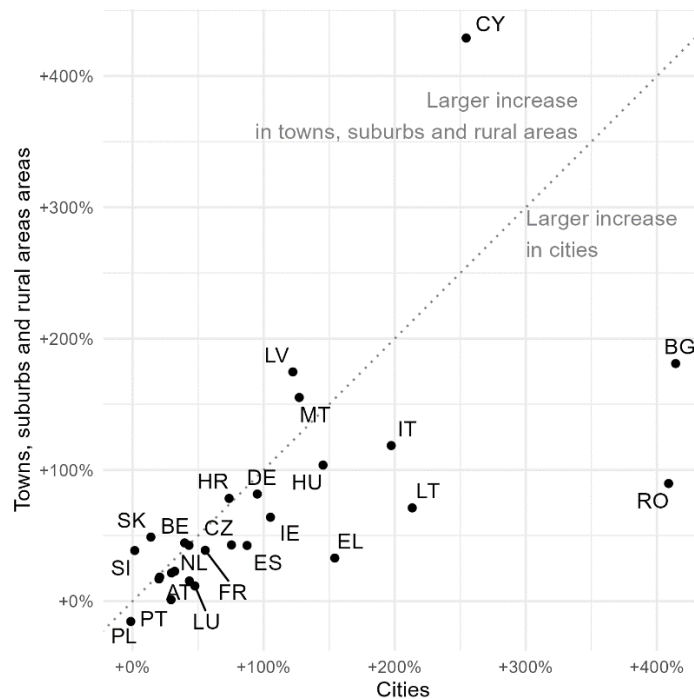
Within countries themselves, the range between the regions with the highest and lowest of rates of work from home in 2019 was particularly high in Belgium, Poland, Slovenia (above 20 percentage point difference), Finland, Slovakia, France (above 14 ppts). Although further analysis suggests a small correlation between the number of NUTS regions in a country and the range of variation, some large countries like Spain, Italy, and Romania showed very little heterogeneity at the regional level, and a few countries consist of a single NUTS region. Across the EU, while telework rates have risen across the great majority of regions since 2019, this increase has been uneven not just across countries, but also across different regions in the same country. The EU-average range between the regions with the highest and lowest rate of telework increased from around 10 pp in 2019, to around 16 pp in 2020.¹¹ In 2021, when the average rate of telework was the highest, so was the range between the highest and lowest region, at 19 percentage points, before narrowing somewhat in 2022 (17.3 ppts). Between 2019 and 2022, seven out of the ten NUTS regions that increased their rates of telework the most (by 15-22 ppts) surrounded national capitals. In summary, within countries, EU regions were more unequal in terms of their rate of telework in 2022 than they were in 2019, with capital regions tending to have the highest rates within countries.

¹¹ This excludes EU Member States that consists of a single NUTS-2 region (namely Cyprus, Estonia, Luxembourg, and Malta) as well as the Netherlands, which reported EU-LFS microdata at the national level only.

4.3 Telework by degree of urbanisation

The higher rates of telework in capital regions are part of a broader trend: even within NUTS regions there has been a more general de-coupling of cities compared to towns and suburbs, or rural areas. In 2019, telework was more prevalent in cities, with an average of around 17.3% of workers working from home across the EU, compared to 12.9% in towns and suburbs and 12.7 % in rural areas. Since then, the rate of telework has grown everywhere, but gap between cities and the rest has grown even wider: by 2022, the rate was 28.3% in cities, 19.4% in towns and suburbs, and 17.5% in rural areas. Figure 4 shows the proportional increase in rates of telework among the employed population in cities and other areas. Rates of telework have grown in nearly every country between 2019 and 2022, but to a greater extent in cities (below the diagonal) than in towns, suburbs or rural areas (above the diagonal). Countries with relatively low rates of teleworking before the pandemic (see Figure 4), such as Bulgaria, Romania, Cyprus, Lithuania or Italy saw larger proportional increases in rates of remote working, but these were particularly skewed towards cities. By contrast, countries with relatively higher rates of telework in 2019 — such as Belgium, the Netherlands, Finland, or Denmark — saw a more modest proportional increase, but more even between cities and other areas. Poland is a notable exception, as the share of population teleworking similarly declined across different degrees of urbanisation.

Figure 4: Relative changes in work from home 2019–2022



Source: EU-LFS data, own analysis

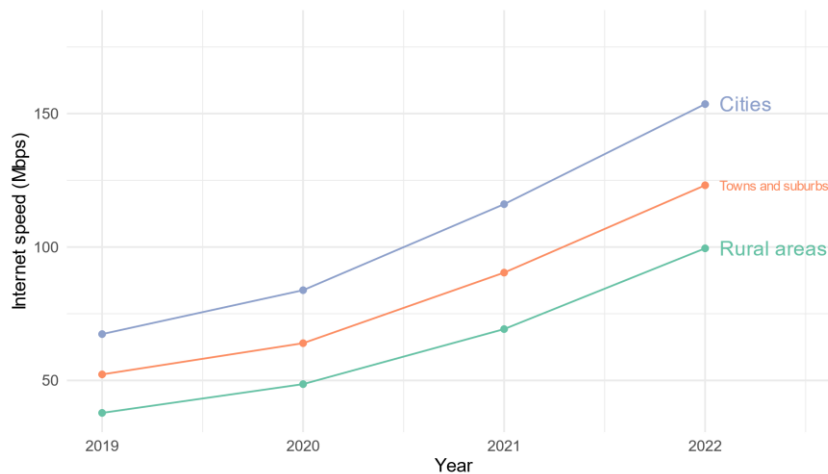
Cities also saw the largest increases in the rate of regular telework: between 2019 and 2022, the share of workers reporting working from home “usually” grew by 7 percentage points in cities, compared to only 3.9 ppts in towns and suburbs, and 2.2 ppts in rural areas. In summary, the pandemic shifted the balance of telework in favour of cities compared to other areas: it increased the share of urbanites teleworking, and the frequency of this practice. One of the reasons for this divergence may be the different levels of internet connectivity available in cities, compared to towns and suburbs or rural areas, which is discussed in the next subsection.

4.4 Local internet connectivity

Internet connectivity is an important technology for economic and social development, in cities and rural areas alike. It also happens to be the essential infrastructure for remote work. In the European Union, improving internet connectivity has been a long-standing policy goal well before the pandemic: the 2010 Digital Agenda for Europe set targets for the share of European households that should benefit from broadband internet connectivity by 2020, defined as at least 30 Megabits per second (European Commission, 2010a, 2010b).

Historically, internet connectivity tends to be better in urban areas, which are more densely populated and tend to be richer, thus making the physical investments in internet infrastructure more appealing than in less densely populated rural areas. Indeed, data from user-administered connection speed tests shows that cities in the EU-27 are served by faster internet service than towns and suburbs, and in turn than areas; the urban-rural gap has even slightly increased over the years (see Figure 5 and Perpiña et al 2021 for a broader overview). Despite these differences, there has been a remarkable improvement in connection speeds across all degrees in urbanisation since 2019 (see Figure 5 below). By 2022, the average connection speed in rural areas of the EU (99.5 Mbps) was higher than what was available in cities just three years prior (66.5 Mbps in 2019). These rapid improvements most likely built on the previous decade of investments, supported in part with EU funding and aiming to reach policy targets, but were likely also accelerated by the urgency of the COVID-19 crisis, which underscored the essential nature of internet connectivity for work and access to some public services. As a result, the policy objectives for internet connectivity were further raised in 2021, with Digital Decade Policy Programme 2030, which explicitly mentioned connectivity in rural areas (European Parliament and Council of the European Union, 2022).

Figure 5: Average internet speeds by degree of urbanisation in EU



Source: Ookla Speedtest Intelligence® data, elaborated by the Joint Research Centre of the European Commission.

Could the different internet speeds available in cities, towns and suburbs, and rural areas be a constraint to remote work, particularly in rural areas? The most common tasks associated with remote work, such as browsing and video-conferencing are not especially demanding in terms of bandwidth, compared to high-definition video streaming for entertainment. The US Federal Communications Commission Broadband Speed Guide¹² for consumers indicates that the minimum download speed for “telecommuting” (that is, telework) is between 5-25 Mbps, and high-definition

¹² <https://www.fcc.gov/consumers/guides/broadband-speed-guide>

videoconferencing only requires 6 Mbps – depending on the number of users per household connection. This level of service was already widely available in 2019 cities, towns and suburbs across the EU, though not in many rural areas. By 2020 average internet speeds in rural areas already reached 50Mbps – an acceptable bandwidth for teleworking. This level of service, however, may not have been available to all rural households in the EU: Figure 5 reports EU-27 average internet speeds by territorial typology, not the share of households to access – though the two would correlate. More importantly, the underlying data shows some variation across countries and NUTS-2 regions, which is accounted for in the econometric analysis at the NUTS-2 region level in Section 6. Moreover, the regional potential for telework may depend on other structural factors, such as the differences in occupational structures across NUTS-2 regions, which is explored in the next subsection.

4.5 The regional variation of telework and potential teleworkability perspective

In the previous section, we observed a generalised increase in the prevalence of telework during the COVID-19 crisis across most European regions, especially concentrated in capital regions, and urban areas more broadly. Obviously, the direct cause behind this generalised increase in telework was COVID-19 itself, or more specifically, the need to limit social interaction to the minimum to reduce contagion and health risks. Providing labour input from home rather than in crowded workspaces was a very effective way to reduce pandemic risk. However, not all types of jobs can be done remotely: some types of jobs require direct physical manipulation of things or interaction with people. In other words, technical feasibility is a precondition for telework, and thus the main factor determining the prevalence of telework during COVID-19 was simply technical feasibility (what we have called “technical teleworkability”, as described in the ‘Data and Methodology’ section).

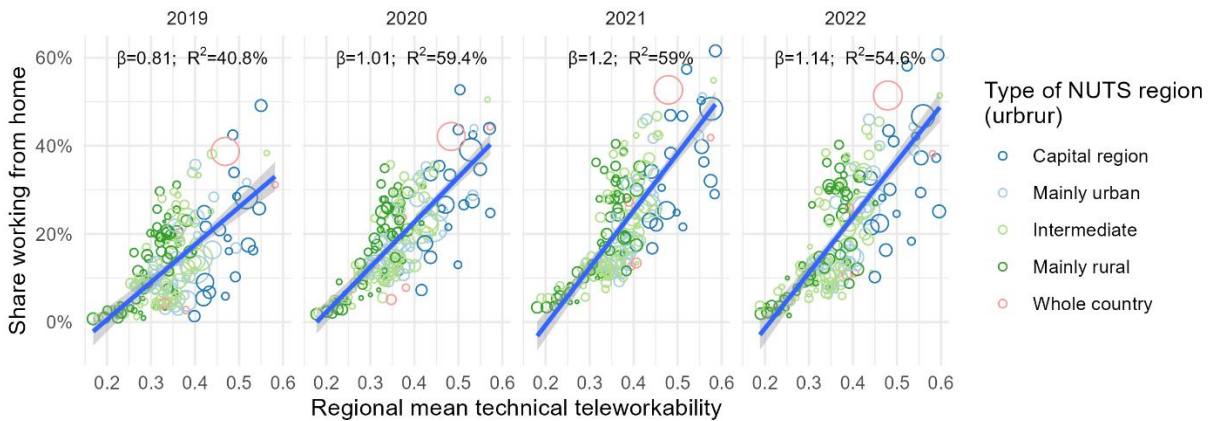
In a recent paper, we argued that COVID-19 implied a large-scale change in the nature and practice of telework across Europe (Sostero et al., 2020, 2023). Before COVID-19, technical feasibility was not an equally good predictor of the actual rate of telework for all categories of workers: for instance, there were many workers in occupations that could technically telework but rarely did so (such as mid-level clerical occupations). Our interpretation was that telework was often used as a non-pecuniary benefit or even a privilege of high-level managerial and professional jobs, rather than as an alternative mode of work. The hypothesis that the possibility of telework depended on status, as well as technical feasibility, may explain the weaker association between technical feasibility and telework before 2020. As the confinement measures during pandemic required those who could telework to do so, technical feasibility became sole determinant of telework. This large-scale experiment not only showed that telework was feasible for a much larger share of workers, but in fact contributed to the development of new practices and skills around telework, both at the manager and worker level, as well as of new managerial tools such as remote collaboration and monitoring platforms (see Fana et al. 2020). And as predicted by this argument, it was precisely mid-level clerical occupations and the like, those which were highly teleworkable but rarely teleworked before COVID-19, the ones that increased the most in the prevalence of telework after COVID-19.

A similar argument can also explain the increase in the rates of telework across European regions. Following again Sostero et al. (2020, 2023), teleworkability is mostly determined by the task content of the different occupations. Occupations that involve tasks requiring little physical interaction with things or people are the most teleworkable. But different regions have different occupational structures, mostly because of their different levels of economic development and patterns of economic specialisation: some regions may specialise in manufacturing industries which require manual labour input; or on touristic services which tend to involve direct personal interaction; or on knowledge-intensive services that require little manual input or direct social interaction and can therefore be carried out remotely. In other words, since economic specialisation results in different occupational structures, the “teleworkability” of different regions will also tend to vary. Therefore, we expect that since the COVID-19 pandemic, technical teleworkability –

aggregated at the regional level, based on the on regional occupational structure – has become an increasingly good predictor of the rate of telework at the regional level.

Figure 6 below provides a simple but effective test of this argument. It shows the change over the years in the relation between the mean regional teleworkability (horizontal axis) and the share of population actually teleworking (share of people working from home at least some of the time, vertical axis), across EU NUTS-2 regions (circles, scaled by population). As expected, the technical feasibility of telework given the occupational structure of each region has become a much better predictor of the regional prevalence of telework since 2020: the β regression coefficient of the linear regression – which measures the strength of the observed relation between mean regional teleworkability and the share of people working from home – increased sharply from 0.81 in 2019 to 1 in 2020 and 1.2 in 2021, stabilizing at 1.14 in 2022. Likewise, the R^2 coefficient – which measures the proportion of variation of regional telework that can be predicted by regional teleworkability – went from 40.8% in 2019 to 54.6% in 2022, a substantial increase in predictive capacity. Among the NUTS regions, we can distinguish several categories, based on their population density: urban regions tend to have higher values in both teleworkability and actual prevalence of telework, but they are often below the diagonal indicating higher than expected values of teleworkability, meaning that in many cases they could expand effective telework even further. On the contrary, rural regions tend to have lower values but they tend to be above the diagonal, suggesting levels of remote working slightly higher than expected given their occupational structure. This may stem from the share of agricultural work, which is not teleworkable according to our definition – it is essentially manual work – but tends to be often done from home rather than from a central workplace. In any case, for all types of regions we can see that during the COVID-19 crisis the correlation between teleworkability and telework became considerably stronger.

Figure 6: Regional correlation between technical teleworkability and regional share of work from home



Source: EU-LFS data, own analysis

Overall, this simple correlation shows that most of the regional variation in the rates of telework after COVID-19 can be explained through differences in job-level technical teleworkability. Regional levels of technical teleworkability merely reflect differences in regional occupational structures, which in turn reflect on patterns of regional economic specialisation. Regions differ widely in terms of their population density, and also in their share of employment in sectors like manufacturing, knowledge-intensive services, tourism, or agriculture — all of which entail different levels of teleworkable employment. Other regional characteristics may also be at play, such as demographic composition and internet connectivity. The next section examines the relative importance of these factors in explaining regional differences in teleworking rates, and estimates the extent to which

countries as a whole may have different levels of telework, even accounting for compositional differences.

5 Econometric analysis of the determinants of telework

The descriptive evidence presented so far shows that, on aggregate, the share of population working from home has increased substantially since before COVID-19, but that increase has been uneven across countries, regions, and degree of urbanisation. There is also evidence that the technical teleworkability index may be an increasingly good predictor of actual telework at the regional level: as shown in the previous section over the period 2019-2022 the correlation between potential telework – as measured by the technical teleworkability index – and the share of people reporting working from home in the EU-LFS is clearly increasing. This section explores what other characteristics help explain the variation in the regional rates of telework, including factors at the regional, job and socio-demographic level.

To quantify the changing relationship between regional rates of work from home and the technical teleworkability index, we estimate the following econometric model for the rate of work from home in region r of country c in year y :¹³

$$\%WFH_{r_{yc}} = (\alpha_y + \beta_y TWY_{ry}) \times I(\text{Year} = y) + \gamma \text{ regional controls}_{rc} + \delta I(\text{Country} = c) + \epsilon_{r_{yc}} \quad (1)$$

Where the variables are defined as follows:

- $\%WFH_{r_{yc}}$ is the weighted share of population working from home at least some of the time, a continuous number between 0 and 1, derived from aggregating EU-LFS data at the regional level.
- TWY_{ry} is the regional-level aggregate technical teleworkability index, computed at the regional level by aggregating the occupational-level technical teleworkability index in terms of the region's occupational structure, which may change marginally from one year to the next (e.g., due to a growth in manufacturing sector within a given region). Note that TWY_{ry} index is interacted with year dummies, $I(\text{Year} = y)$, which allows to estimate changes in the slope and the intercept in the relationship between TWY_{ry} index and the share of population working from home over time (getting us closer to replicating Figure 6 in a regression form). The baseline is set to the year 2018, to test whether there was a pre-COVID trend towards higher rates of telework already in 2019.
- regional controls $_{rc}$ include both characteristics of the regional typology and socio-demographics. Namely, the share of workers living in cities, whether it is a capital region, the share of workers who work in another region or country; and the average internet speed for each region and degree of urbanization. The socio-demographics include average age (a pseudo-continuous variable, constructed by weighting the population in the various discrete age brackets), the share of respondents who are women, those with high education, self-employed, and those in temporary employment.
- $I(\text{Country} = c)$ represents country dummies (one for each EU Member State), which captures time-invariant cross-country differences (country fixed effects), such as different

¹³ The geographic granularity is NUTS-2 for all countries where this subdivision exists, except for Germany and Austria, where data is reported at NUTS-1, and the Netherlands, where it is reported at the country (NUTS-0) level.

legal, cultural, and institutional environment. In other words, the estimation of β_y – the parameter of interest -- uses only the variation across regions of the same country.

Table 1 shows the estimates for different specifications of the model above in columns (1-3).

Column (1) shows a minimal specification with only year and country fixed-effects, which shows that the share of people working from home did increase on average, from 2020 onwards, relative to the baseline of 2018 (the constant of 20.4%). This change is even more remarkable as there is no evidence of a pre-COVID trend: in 2019, the average rate of telework was not significantly different than in 2018. Over the following years, the regional rate of telework increased by up to 10.5% percentage points in 2021; by 2022 the increment was slightly smaller but remained significantly above pre-COVID levels. Despite only controlling for country and year fixed-effects, the overall explanatory power of the model is already fairly high (R^2 of 0.816). We interpret this as evidence of both a relatively sharp structural change in the rates of telework since 2020, and to large and significant cross-country differences, which are further explored later in the section.

Table 1: Explaining regional rates of telework of people working from home
Proportion of workers teleworking in each NUTS region

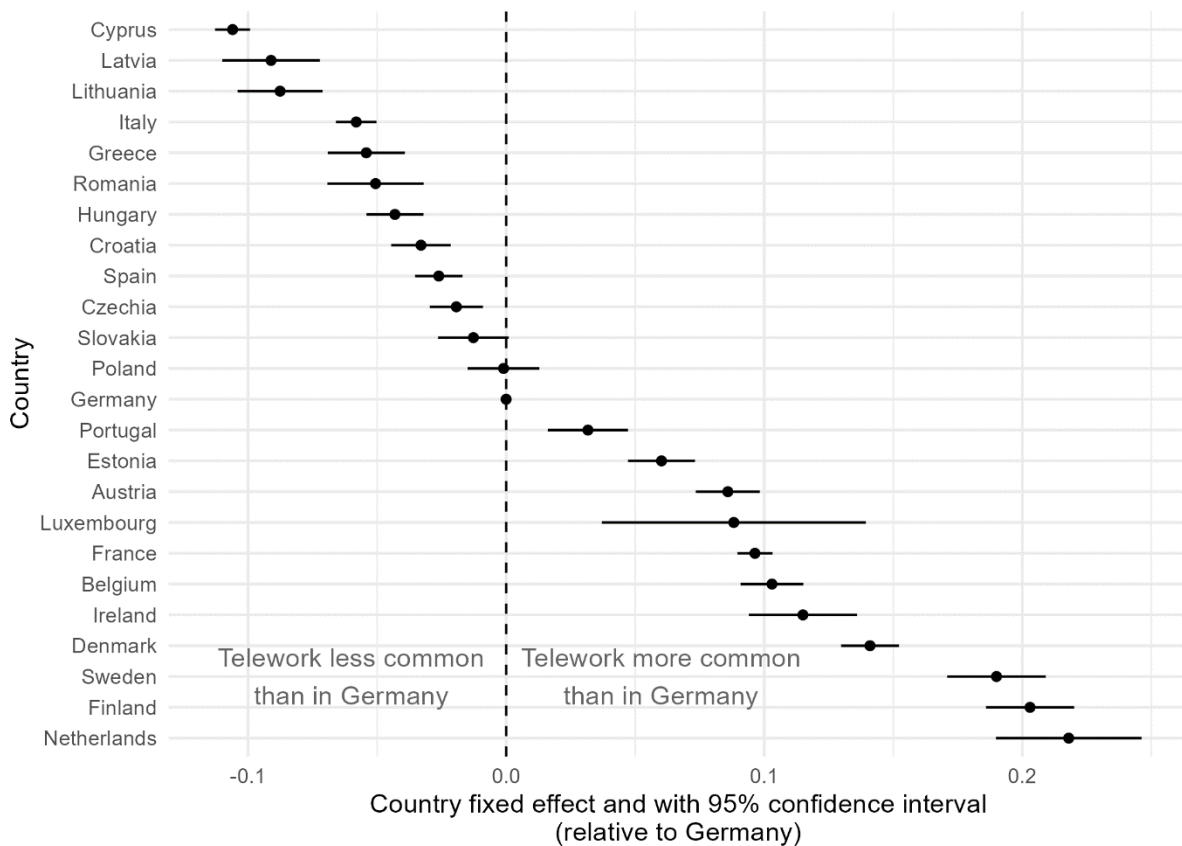
	(1)	(2)	(3)
Constant (baseline = 2018)	0.204***	0.0736***	0.434***
YEAR=2019	0.00873	-0.00718	-0.00196
YEAR=2020	0.0712***	-0.0401*	-0.0399*
YEAR=2021	0.105***	-0.115***	-0.0901***
YEAR=2022	0.0882***	-0.121***	-0.0820***
Technical teleworkability (baseline = 2018)		0.351***	0.342***
2019 # Technical teleworkability		0.0420	0.0314
2020 # Technical teleworkability		0.277***	0.300***
2021 # Technical teleworkability		0.544***	0.497***
2022 # Technical teleworkability		0.523***	0.441***
% Workers living in cities			-0.0182
Capital region			0.0126
Internet speed (Mbps)			-0.0000502
% Workers working outside region			-0.0369
% Workers working outside country			-0.0865
Median age			-0.0106***
% Female			-0.0705
% High education			0.0731
% Part-time work			0.172**
% Self-employed			0.256***
% Temporary contracts			0.0954
R^2	0.816	0.947	0.947
Observations	965	965	885

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

Column (2) captures the relation between the share of people working from home and technical teleworkability over time. In particular, the technical teleworkability coefficient is indeed a good predictor of the share of people working from home (baseline coefficient for 2018 is 0.35, significant at $p < 0.001$), and has been growing significantly during the pandemic years. By 2022, the combined coefficient (the overall slope) amounts to around 0.874 (the baseline plus the interaction coefficient for 2022 of 0.523, which is significantly different from the baseline). The overall explanatory power of the model, R^2 of 0.816 increases yet further to 0.947 when introducing

technical teleworkability index. This shows that, even after accounting for the large across-the-board shift in the rates of telework that occurred in 2020, and despite large cross-country differences, the regional occupational structure is a crucial determinant of the regional rate of telework. In general, the potential for telework of different regions ultimately depends on their occupational structure, which varies significantly across them, but is relatively stable over time. We should also note that the technical teleworkability index is time-invariant, having been computed based on pre-COVID occupational task attributes. Therefore, the increased correlation cannot result from changes in the underlying measurement of occupations characteristics, but rather with the practice of telework “catching up” with its potential, albeit at different rates across EU regions.

Figure 7: Estimated differences in average rates of telework between countries



Source: EU-LFS data, own analysis

Figure 7 plots the country fixed effects estimated using the reference specification of column (2). Using Germany as the baseline, it shows the cross-country differences in average teleworking rates, after controlling for differences in technical teleworkability and time trends. The range of variation across countries is quite sizeable (approximately 30 percentage points, from below -0.1 in Cyprus to above 0.2 in the Netherlands), and the 95% confidence intervals suggest that the cross-country differences are statistically significant, at least relative to Germany, which is the median country. The fact that there is such appreciable variance even after accounting for differences in teleworkability indicates that meaningful cross-country differences — for instance in institutions, legal frameworks, working culture, industrial relations — also contribute to explaining regional differences in telework. However, these estimates are time-invariant (by necessity of identification, given that several countries consist of a single NUTS-2 region) and thus report estimates averaged over the years. Earlier descriptive analysis (see Figure 2) has shown that telework has grown proportionately more in countries with the lowest pre-COVID levels, which may help narrow these cross-country differences over time.

Column (3) shows that the coefficients of interest, of technical teleworkability, are robust to the inclusion of additional regional controls. All these additional explanatory variables have a weaker association (a coefficient with smaller magnitude in economic sense) compared to the teleworkability coefficient. Other regional demographic characteristics defy expectations: although working from home has increased the most in cities, compared to towns and suburbs or rural areas (see Figure 4), once we control for technical teleworkability, the share of the population living in cities has no significant association with the share of people working from home. This suggests that cities are more likely to foster work from home not for intrinsic geographical reasons, but rather because they host more occupations that are teleworkable. Likewise, there does not appear to be a distinct “capital region” premium above and beyond what can be explained for by the teleworkability (and ultimately, occupational structure) of those regions. Perhaps surprisingly, the speed of internet connections, measured across different degrees of urbanization for each NUTS region and in different years, is not significantly correlated with higher rates of telework. This may be because internet speeds were already sufficient to handle the relatively modest requirements of remote work by 2020, even in many rural areas, and that they have improved even further since then (see Figure 5). Likewise, the share of people working outside the region of residence, or outside the country seem to have no effect on the share of people working from home (see Appendix 2). The regional share of workers in part-time work, on the other hand, is positively correlated with rates of telework. Relatedly, the role of self-employment, which also has a relatively large positive coefficient, is further discussed in Appendix 1.

Overall, there is no sign that controlling for regional characteristics increases the explanatory power of the model: the R^2 coefficient remains the same at 94.7. On balance, this indicates that regional teleworkability (which summarises regional occupational structure) is a parsimonious yet effective predictor of regional differences in telework.

6 Discussion and conclusions

This paper investigates the differences in telework across regions of the European Union (EU-27), and how these have changed around the COVID-19 pandemic. Using individual-level microdata from the EU Labour Force Survey, we find that nearly every NUTS-2 region in the EU has seen an overall increase in the share of the population teleworking, defined as working from home at least some of the time. At the national level, the countries with the lowest rates of telework before 2020, mostly in South-Eastern Europe and the Baltics, grew proportionally faster, hinting at a process of cross-country convergence, though large differences still remain across regions and countries. In 2021, at the peak of COVID-related confinement measures, the highest rates of telework were found in and around Northern European capital regions, where 40-50% of the population works from home at least some of the time, while the lowest rates were found in rural regions of South-Eastern countries. Throughout the EU, the rates of telework grew more in cities, compared to towns and suburbs, and rural areas. By 2022, when public-health measures were discontinued, the rates of telework declined slightly relative to their 2021 peak, but remained well above pre-COVID levels.

Among the different potential factors that could account for differences across regions and degrees of urbanisation – geography, digital infrastructure, demography and occupation – a regression analysis shows that differences in occupational structures account for the largest share of the variation. Using the occupation-level technical teleworkability index developed by Sosterio et al. (2020, 2023) we derive regional-level measures of telework potential, based on the occupational structure of the different NUTS regions. Over the years, our occupation-based measure of teleworkability has become an increasingly strong predictor of the prevalence of work from home at the regional level, explaining around 60% of total variation. This predictive power is even more notable, considering that the technical teleworkability index is a single predictor, based on time-invariant occupation attributes measured before 2018, and that the regional occupational structure tends to be relatively constant from one year to the next. Put another way, it seems that since the COVID-19 confinement measures generalized telework, the practice of working from home has

approached shares of the population that could telework all along, but did not do so before 2020. This trend of “catching-up to potential” is also visible when comparing the different rates of telework of employees and self-employed: for the same level of technical teleworkability, the self-employed have historically been more likely to telework, but the gap has substantially narrowed since 2020, suggesting that the difference in telework was not technical in nature, but more likely attributable to organizational or contractual factors.

In addition to the occupational structure, there are other factors that help explain the differences in rates of telework across regions. There remain substantial cross-country differences, which may ultimately reflect differences in institutional settings and norms. One may have expected that a higher share of people working outside their region of residence, in another region of the same country, or abroad would correlate with higher rates of telework, as they imply longer commutes. However, this does not appear to be the case. Moreover, internet connectivity speeds, measured across different degrees of urbanisation in NUTS regions, also do not correlate with higher rates of telework. However, the limited granularity of these variables may have limited the empirical analysis, as these were measured at relatively aggregate NUTS levels.

Another current limitation of the paper, which we plan to address in subsequent analysis, is the exclusive focus on the extensive margin of telework in the econometric analysis: focusing on whether people work from home or not, but not on how often they do so. The technical teleworkability index, used as the main explanatory variable, focuses on the technical feasibility of telework, and so is best used as a predictor of telework along the extensive margin. Nevertheless, there is scope to extend the analysis to distinguish between those reporting working from home “sometimes” or “usually” in the EU-LFS. The analysis of the intensive margin of telework may make use of a secondary teleworkability index developed in Sostero et al. (2020, 2023), the *social interaction index*, which is designed to capture differences in the ease of telework among those occupations that can technically work from home.

Overall, these findings point to important implications for convergence in rates of telework across regions and countries, related to differences in working conditions and the use of technology more broadly. Although the countries with the lowest levels of telework before COVID-19 increased the most in relative terms, in the long run this need not result in uniform rates of telework across countries or regions. As this paper showed, in the short run the potential for telework depends largely on regional occupational structure, which in turn ultimately results from economic specialisation. Moreover, some regions (particularly those surrounding capital cities) currently concentrate most of the potential to expand the prevalence of telework in the future – measured as the difference between the share of teleworkable jobs and the share of population currently working from home.

In terms of policy implications, these findings point to trade-offs for regional development. On the one hand, policies to expand telework in certain regions – to promote ecological sustainability or regional development – are hampered by regional patterns of economic specialisation, which appear to matter more than additional infrastructure in digital connectivity, especially for well-served localities. In the long run, if regions specialise in different economic activities and occupations, large regional differences in telework may persist, or increase even further. A continuing expansion of telework may in fact become a factor of further differentiation between the most (capital and city) and less (rural) advanced regions in Europe.

On the other hand, the broad adoption of teleworking arrangements opened to many more people additional opportunities outside urban labour markets, as it lifted the constraints to relocation among potential movers from large city centres (and notably capitals) to areas with lower cost of living, allowing for adequate spaces to work from home and higher quality of life – for instance in terms of greater presence of green areas and less pollution. However, different types of remote working arrangements have different implications for relocation potential. Hybrid work – intended as a situation in which work is performed both from the employer’s premises and from home – is indeed expected to impose a significant constraint on how far away workers would be willing to

move. However, full-time remote work could instead allow workers to live and work in a place of their choosing, suggesting a move to more peripheral and less densely populated areas. National level analysis for Europe on relocation due to the experience of remote working since Covid-19 is still very limited.

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List of figures

Figure 1: Frequency of work from home, by country and year..... 11

Figure 2: Relative growth in work from home from 2019 levels, EU-27 Member States..... 13

Figure 3: Regional share of the working population working from home at least some of the time. 14

Figure 4: Relative changes in work from home 2019–2022 15

Figure 5: Average internet speeds by degree of urbanisation in EU 16

Figure 6: Regional correlation between technical teleworkability and regional share of work from home..... 18

Figure 7: Estimated differences in average rates of telework between countries..... 21

Figure 8: Rate of telework for employees and self-employed in EU-27..... 29

Figure 9: Regional correlation between technical teleworkability and work from home, by employment status 30

Figure 10: Share of people employed outside region of residence..... 31

Figure 11: Share of people working from home, by region of work and residence..... 32

List of tables

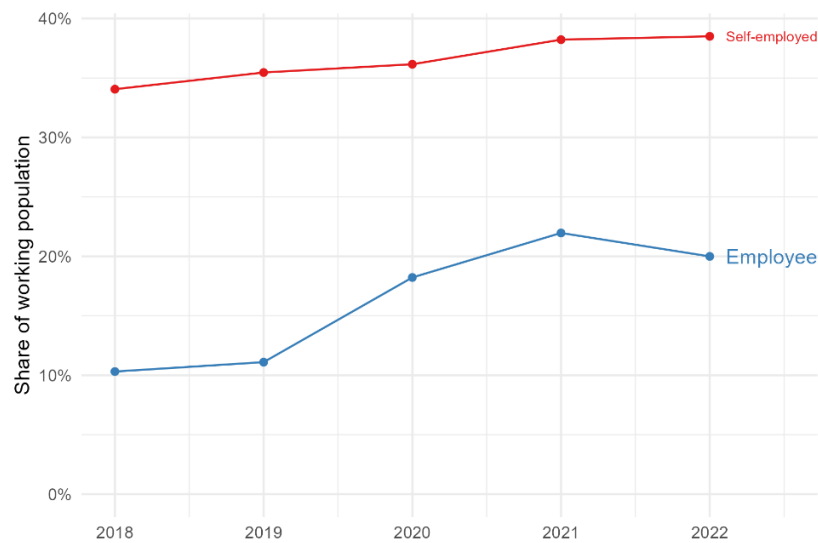
Table 1: Explaining regional rates of telework of people working from home 20

Appendix

1. Employees and self-employed

Self-employment is a significant determinant of the regional share of people working remotely (see Table 1). On average across the EU-27, around 35% of the self-employed worked from home at least some of the time before COVID-19, while only 10% of dependent employees did to. Since then, the share of employees teleworking doubled from around 10% between 2019 to over 20% and 2022 across the EU-27, narrowing the gap with the self-employed from 24.3 percentage points in 2018 to 16.2 at its narrowest, slightly broadening to 18.5 in 2022.

Figure 8: Rate of telework for employees and self-employed in EU-27



Source: EU-LFS data, own analysis

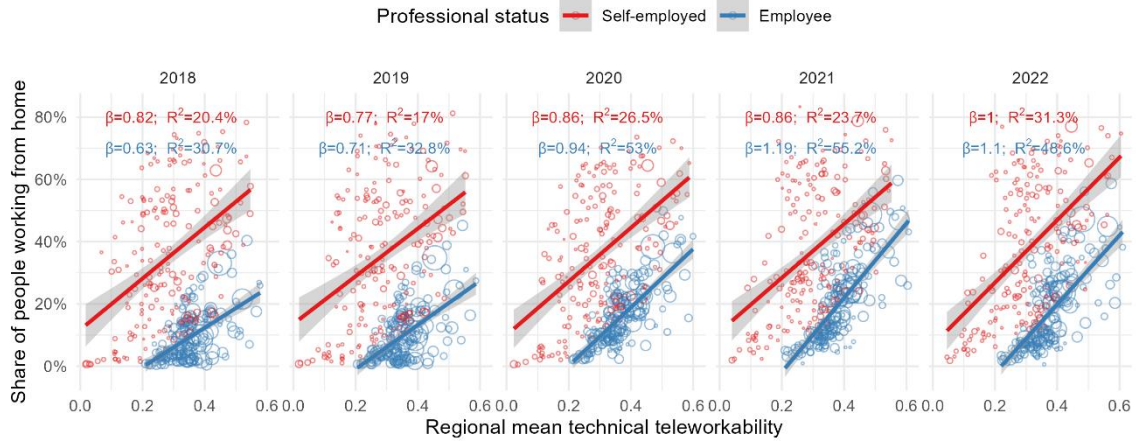
This does not simply reflect the fact that the self-employed tend to work in different occupations than employees: as shown in Sostero et al. (2020) before COVID-19 the self-employed were more likely to work from home, even within the same occupation group as their employee counterparts. This difference is apparent even accounting for technical teleworkability: the self-employed in any given teleworkable occupation are more likely to work from home than employees in the same occupation.

Figure 9 below shows the changing relation between the regional share of population working in teleworkable occupations (on the horizontal axis) – which ultimately depends on the occupational structure of the region – and the share of people who work from home at least some of the time (vertical axis). The figures are at the NUTS-2 regional level, distinguishing between employees (blue dots) and self-employed (red dots), scaled proportionally to population size. At any given level of technical teleworkability, a larger share of self-employed tended worked from home across all regions compared to employees, though the difference has somewhat narrowed since 2020. It is worth remembering that the distribution of technical teleworkability across regions has remained relatively constant over the years: it is defined with time-invariant occupational attributes last measured before 2018. Therefore, any change in the regional share of teleworkable employment can only result from changes in the regional occupational structure, which varies little from one year to the next.

The association between teleworkability and work from home, disregarding other confounding variables, shows the important difference between self-employed and employees. For the self-employed, the correlation has always been high, and has remained relatively constant over the years, with a coefficient of around 0.8. For employees, the correlation has become increasingly strong over time (the coefficient rose from 0.6 in 2018 to 1.2 in 2021), though the share of

employees working from home remains lower on average. Moreover, the goodness-of-fit of the relation has improved for employees (from 0.31 in 2018 to 0.55 in 2021), indicating that technical teleworkability is an increasingly good predictor of working from home at the regional level.

Figure 9: Regional correlation between technical teleworkability and work from home, by employment status



Source: EU-LFS data, own analysis

This trend is consistent with the observations of Sostero et al (2020), namely that for many occupations, the main constraint of work from home was not technical feasibility, but a combination of organisational, cultural and contractual factors that prevented people in teleworkable occupation from actually working from home. The difference in rates of work from home between employees and the self-employed in the same occupations resulted from the greater autonomy and latitude enjoyed by the latter. With the advent of generalised telework during the COVID-19 pandemic – which eased organisational, hierarchical and contractual constraints to remote work – the employees who could technically telework all along have gradually closed the gap with their self-employed counterparts.

2. Place of work and place of residence

While the EU-LFS is a household survey, which is not intended to capture mobility and migration from a regional perspective, it can nevertheless inform about whether the discrepancy between region of work and region of residence grew with COVID-19. This is plausible to expect as telework allowed, at least in principle, people to live further away from the place of work. At the same time, as regions are defined at a very aggregate level, data might only be suitable to capture long distance intra-country regional movements and cross-border workers commuting between border regions and neighbouring countries.

The EU-LFS microdata contain information both on the region of residence and the region of work (the region where respondents' principal paid job is carried out) at the NUTS-2 level for most countries.¹⁴ The place of work for the main job is sometimes reported at a more granular level than region of residence, and for people working in border regions of neighbouring countries may refer to a specific NUTS-2 region in a foreign country. A third variable allows to identify whether respondents work in a different country. Therefore, data allows to identify the share of workers who work in the same region as where they reside¹⁵, a different region or another country.

¹⁴ Regional variables are blanked in the Netherlands. Region of residence is available only at NUTS 1 level for Germany and Austria. Region of work abroad is blanked for Malta and Slovenia.

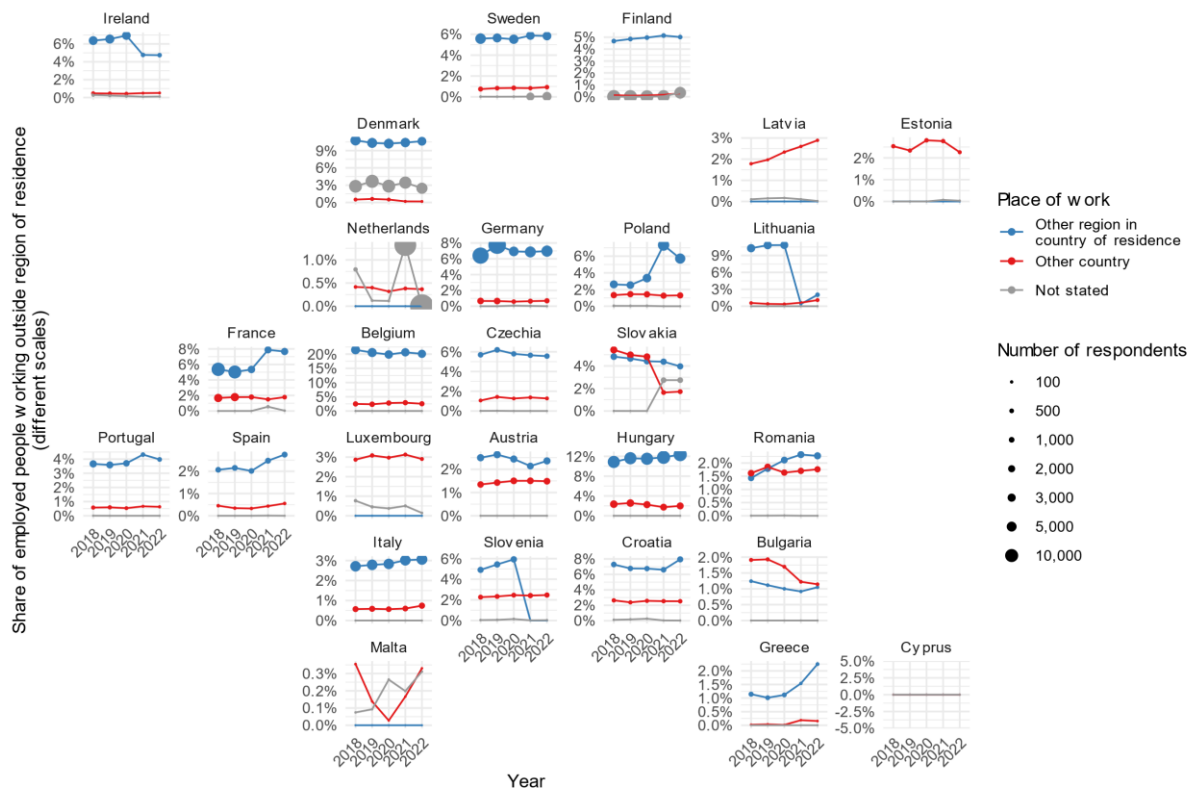
¹⁵ Either working in NUTS-2 and residing in NUTS-2, or working in NUTS-2 in residing in NUTS-1.

Figure 10 reports the share of employed people working outside the region of residence, at the Member State level, and how this changed over the period 2018-2021. The size of the bubbles indicates the number of respondents, suggesting caution with the interpretation of some results due to very limited sample size. Naturally, work-abroad rates (in red) rates vary by country, depending on geography, but concern mostly between 0.5–1.5% of respondents. The highest rate is found in Luxembourg (around 3%) and Slovakia (before 2020, around 5%). Beside these outliers, working in another country has been over the years relatively common in Hungary, Croatia, Belgium, Estonia and Slovenia, with rates over 2% of the working population.

In terms of work within the same country, but outside the region of residence (blue), Belgium is by far the country with the highest share of employed people working outside the region of residence (around 20%), followed by Hungary (around 12%). Relatively high shares (around or above 6%) are also found in Lithuania, Denmark, Sweden, Germany, France, and Czechia. Previous analysis showed that capital cities in particular absorb commuting workers from surrounding regions (Eurofound and JRC, 2019). Italy and Spain are instead among the countries with consistently and relatively low shares (less than or around 3%) of workers who work in a different region.

From a descriptive point of view, it is challenging to identify a potential Covid effect due to some breaks in trends recorded in various Member States between 2020 and 2021, which could be due to other reasons, including perhaps falling response rates (e.g., Ireland, Lithuania, Slovenia) or changes in NUTS boundaries (see e.g., Croatia). The only discernible increases in the share of employed people working outside the region of residence are found in Poland and France, albeit with considerably decreasing number of respondents in the second case.

Figure 10: Share of people employed outside region of residence



source: EU Labour Force Survey, own elaboration
Regions are NUTS-2 where available, NUTS-1 (AT and DE), or country (NL)

Source: EU-LFS data, own analysis

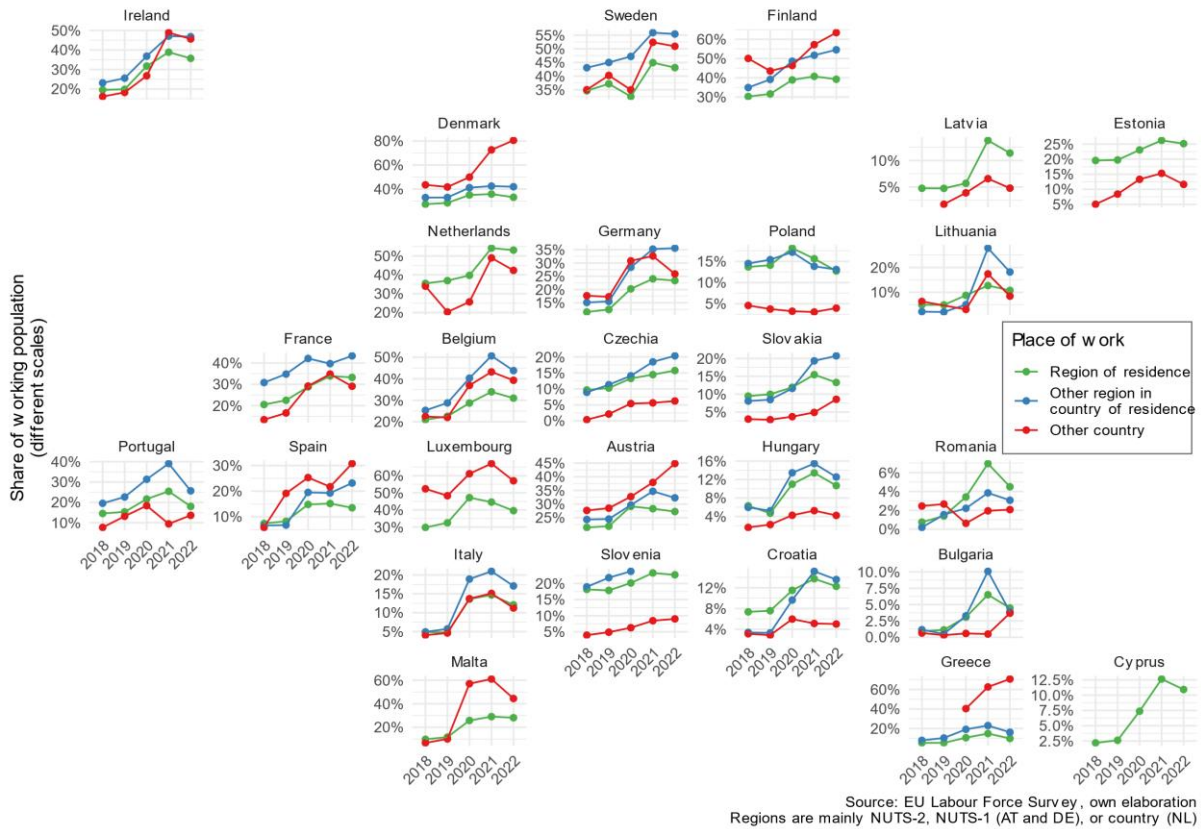
We intuitively expect that the distance between place of residence and work may affect the probability of working from home at least some of the time. Likewise, at NUTS-2 regional level of

aggregation one may expect that working abroad is on average more distant than working in another region of the same country, which in turns tends to be more distant than working in one's own region of residence. Therefore, we may expect that rates of telework may be higher for people working outside their region of residence, and higher still for those working abroad.

Figure 11 shows the share of people teleworking by place of work. While data limitations lead to the exclusion of some Member States, a first inspection of results show that working from home is not necessarily more prevalent among those working in other regions or countries, as confirmed by the non-significant coefficients in Table 1. It appears however to be the case for some countries, notably the Scandinavian countries and Germany.

Overall, such analysis would suggest that the granularity of the variables (NUTS2, in some cases 1) is not enough to answers some of the questions posed here. If the place of work and residence could be measured as detailed as actual commuting zones, results could possibly paint a different picture.

Figure 11: Share of people working from home, by region of work and residence



Source: EU Labour Force Survey, own elaboration
Regions are mainly NUTS-2, NUTS-1 (AT and DE), or country (NL)

Source: EU-LFS data, own analysis

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