Smart-work and smart cities

National report – Spain

Work package 4

1. Background

The formal legislation on remote work of July 2021 in Spain was the latest development of a long trajectory of successive amendments and additions to prior legislation which was at best patchy. The diffusion of out-of-office work (OOOW) in this country was traditionally one of the lowest in Europe, so it is not surprising that the COVID emergency hit put pressure on a system that was not prepared for the scale of adaptation that became suddenly necessary. To add to those institutional inadequacies, Spain ranked low also in terms of digitalisation, which proved to be yet another hurdle to the implementation of remote work.

Before COVID, leading OOOW regions were Asturias (6.6%), Illes Balears (5.8%) and Galicia (5.5%), while the lowest ranking was Murcia (4.0%), Navarra (3.9%) and La Rioja (3.6%). Looking in detail by activity, Spain exhibited high heterogeneity across occupations and sectors. Remote work was more frequent among self-employed individuals, employees of medium-sized enterprises and among high-skill workers (i.e., directors, managers, technicians and professionals). Leading sectors were education, scientific and technical professional, real estate, information and communication, financial and insurance. Also, the incidence of remote work increases with age, primarily among individuals at or above 55-year-old (72%) followed by the 34–55-year-old group (57%), well above the 25–54-year-old group (7.7%). Looking at educational attainment, individuals with a university degree or higher are more than twice as likely to work remotely compared to those with lower education. Finally, OOOW was overrepresented in households with children (9.3%) compared to those with no children (8.3%) and single parents (8.1%).

At the early stages of the pandemic, and despite the emergency, only 31.7% of Spanish employees switched to remote work, mostly in leading regions such as Madrid and Catalonia – 26.6% and 18.5% rates of OOOW adoption during Q2 of 2020. At the other end of the spectrum, in the same period peripheral regions lagged with OOOW uptake ranging between 12.5% (Navarra) and 10.6% (Murcia). These figures would decrease systematically in Q1 and Q2 of 2021. The rate of remote work adoption at the beginning of the pandemic was higher among women (2% more than men on average) and among people between 35 and 45 years of age - the group in which childcare is more likely. The share of regular or occasional teleworkers increased notably in activities such as knowledge-intensive business services (+35% compared to before 2020), education (+32%) followed by telecommunications (+22%), finance and insurance (+20%). In contrast, in Q2 of 2020 the proportion of teleworkers was rather low in administrative and support services, as well as in sectors involving the physical handling of materials or objects, such as manufacturing.

The adoption of alternative working modalities depends on many sector-specific circumstances. According to the Survey on Equipment and Use of Information and Communication and Communication Technologies in Households 2021 (INE, 2022) for

65% of the labour force telework is not an option, especially for employees of industrial production, agriculture, construction, or hospitality. On the contrary, remote working arrangements were more prevalent activities with high intensity of technology adoption such as in professional, scientific and technical activities and financial sectors.

Despite the abruptness of the general lockdown between March and May, only 23.8% of teleworkers reported experiencing difficulties in being able to work from home. The main issued reported was not having sufficient internet connectivity at home (54.5%). This was more common among older workers, 71.4% among those aged 55-64, and 62.8% among those aged 45-54. It was also more frequent among teleworkers who lived alone (70.3%) and with children (66%). Another known problem was the difficulty of combining work and family life in the same space (35.8% of teleworkers reporting some difficulty). This was more evident for women (44.2%) than for men (27%). By type of family, this difficulty was the most relevant for families with young children (64.7%), higher than the unavailability of an adequate internet connection. Other issues included lack of ability to use teleworking tools (19%), more for women (31.8%) than men (5.5%), and problems in establishing a work routine at home (17.9%). Again, women reported this to a greater extent than men (25.3% compared to 10%).

Last but not least, a key challenge of teleworking is the blurring of boundaries between working time and free time. The availability of technologies that keep us constantly connected to the workplace is a double-edged sword, which can mean that as a rule, working hours are longer than usual. A survey carried out by Eurofound in the wake of the pandemic found that one in four teleworkers (27%) work during their free time to meet the needs of their organization, and indeed up to 30% of all workers confess to experiencing work-related concerns during their free time. To the latter must be added the problems faced by those who work at home and have young children. According to the survey, one in five (22%) of those living with children under 12 confessed that they find it difficult to concentrate at work always or from time to time.

For employers the challenges presented by the shift to mass remote working are also relevant. The absence of a direct relationship between teams has affected both emotional health and commitment and the link with the culture of the companies. New hires or changes in projects or teams have also suffered from this remote working model. According to a survey conducted by Cushman & Wakefield, which polled more than 40,000 professionals worldwide and measures the bond, or the feeling of personal connection that employees have with each other, only slightly more than half of the respondents feel connected to their co-workers. The ability to have a strong connection between co-workers is a very important component of the employee experience, especially in today's environment. A low bonding score also negatively affects connection to company culture and personal and professional development.

Given this background, the remaining of the document will explore the territorial implications of smart working. The premise is that there is very little scientific and policy

literature of reference on this as the focus has been mainly on broad economic and social aspects associated with the post pandemic. On these grounds, we propose a preliminary analysis of spatial aspects of remote working.

2. Smart cities, smart work and territorial resilience in Spain

For the purposes of the empirical analysis, we elaborate two smart-working indexes. The first is a potential accessibility measure, SW1, which originates in empirical literature on transportation geography and regional planning.[1] This approach promises a nuanced strategy to capture the territorial structures of a territory. Data availability prevented full replication of those original modelling techniques and forced us to rely on proxies such as employment structure provided by national statistical office.

2.1. Smart working potential at national level

Data for Spain were downloaded from the National Statistics Institute and comprise all active companies in all available NACE sectors. In this case applying the methodology used for the national case studies in this project was not feasible for several reasons – primarily the highly aggregated level of NACE data (not even 1 digit) and the fact that some data are classified. This prevents us from providing indicators of spatial or territorial concentration of the NACE employees/business entities similar to those of Italy or Poland. We only managed to compute local Z scores for two industries: Information and communication (NACE J) and K Financial and insurance activities (NACE K). Given the scarcity of data, these results are to be interpreted with caution.

Like in other case studies, the local Z scores highlight the concentration of companies in a territory, in particular positive values indicate concentration while negative values suggest lack of smart-working activities. On the maps, the smart-working sectors are illustrated by the J and K industries, while the traditional industries are derived from the B to E NACE groups.

Local Z scores were calculated using a mobile kernel of 90 minutes around each LAU. The time distances were weighted by a negative exponential function with a span of 30 minutes. The second indicator to capture concentration or dispersion of smart working is based on a potential accessibility model. The model incorporates a time-distance constraint of 90 minutes and a 30 minutes "half-life" decay, just like in the case of the other states.

2.1.1. *A potential accessibility to the stock of smart working employees or business entities*

The SW1 index captures 'potential accessibility', as depicted in Figures 1 and 2. Compared to the local Z scores, this indicator captures the distribution of smart-working activities in

---

[1] See
https://www.espon.eu/sites/default/files/attachments/espon_accessibility_update_2006_fr_070207.pdf

relation to the density of the hosting metropolitan areas. Figures 1 and 2 show that the metropolitan area of Barcelona is attractive and competing with Madrid in size.
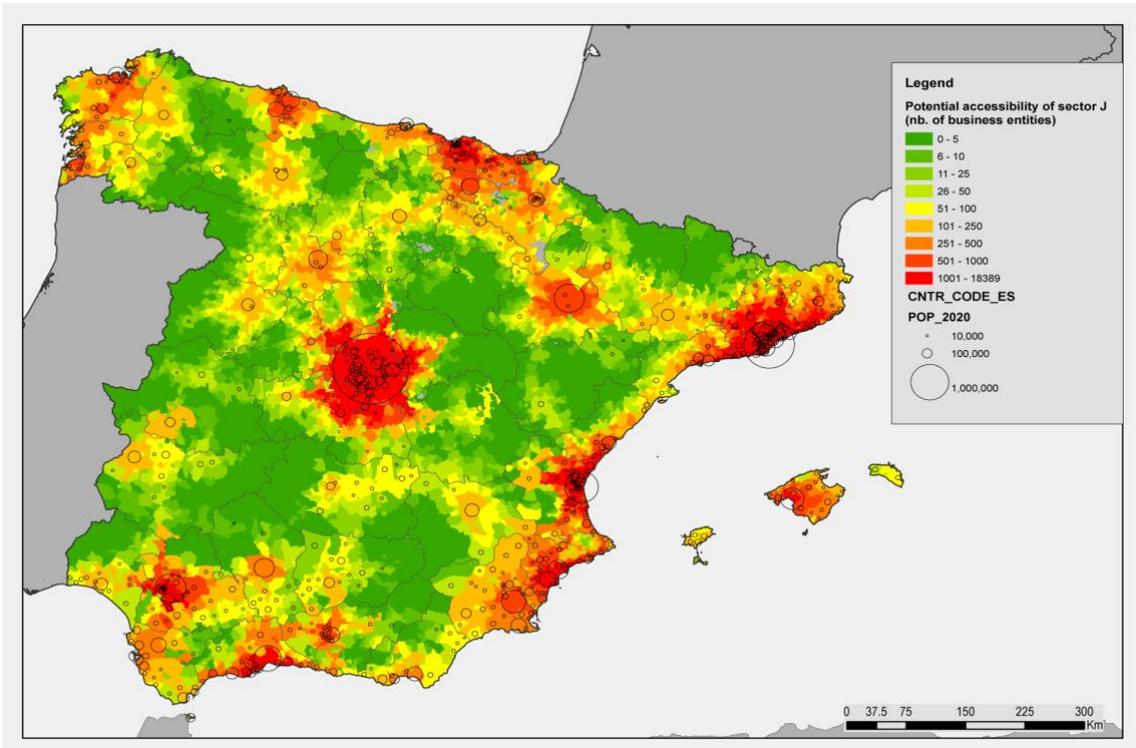
Fig.1 Potential accessibility of Information and Communication (NACE J)
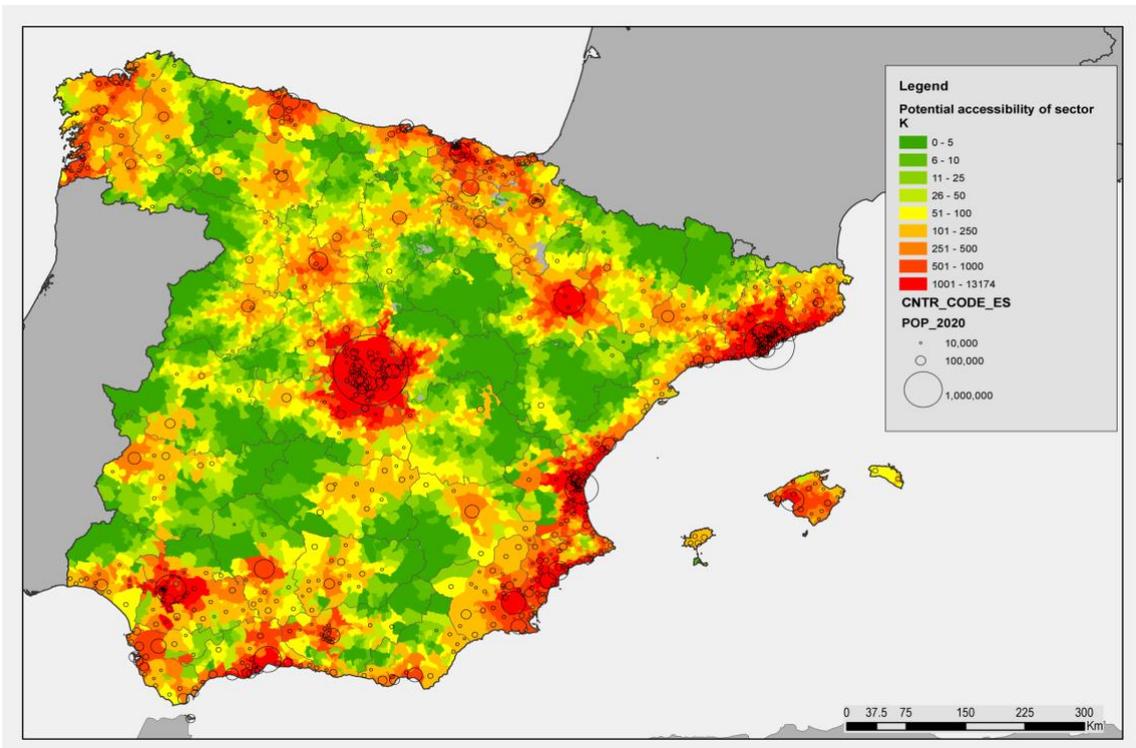
Fig.2 Potential accessibility of Financial and insurance activities (NACE K)

The other large Spanish cities and metropolitan areas (Murcia, Seville, Valencia, Malaga and Bilbao) are also triggering the installation of companies in the J industry, but to a smaller extent. Transport infrastructures coincide with the emergence of connections across cities, especially from Madrid to Seville and Malaga, by Linares, Cordoba or Granada. Territories outside of this grid are significantly underrepresented less invested by the J industry, forming the first two classes of the legend (marked with green). Their spatial stability on both the J and K industries potential accessibility maps is an indication that the diffusion of the smart working in Spain is filtered by territorial structures that might fit policy reasoning at national scale.

A second indicator, the ratio of sector specific and overall accessibility, provides interesting details. In the case of Information and Communication activities (Fig. 3) the indicator is larger than 1 only for the Madrid metropolitan area. This is to some extent surprising, considering that high tech sectors exist also in other regions (especially Catalonia and Albacete). On the other hand, this finding points to higher concentration of this type of activities in Madrid relative to other, more diversified, territories.
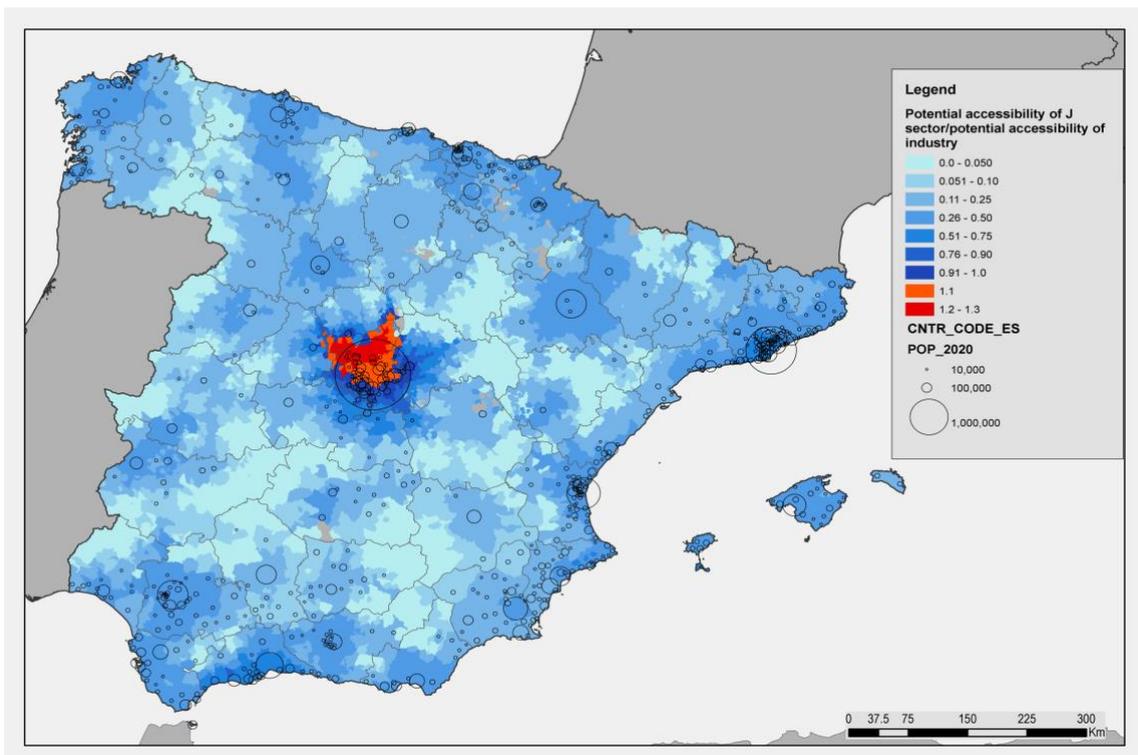
Fig. 3 - Ratio Information and Communication (NACE J)

The indicator for financial and insurance activities (Fig. 4) exhibits a different spatial pattern, with higher spatial homogeneity especially in the northern territories of Bilbao, San Sebastian and Pamplona, where the ratio is between 0.21 and 0.3. The map also highlights the widely known disparities between dense metropolitan areas like Madrid,

Barcelona, Valencia and Malaga (green) and territories that have experienced intensive outmigration and loss of population (red).
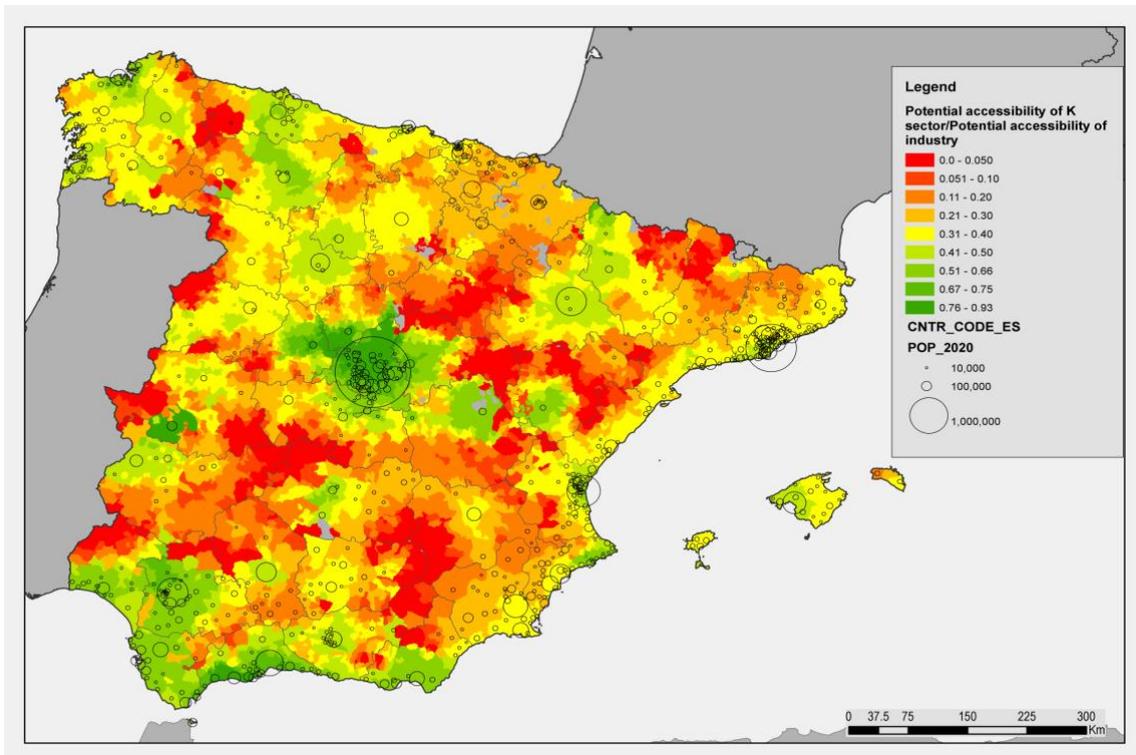
Fig. 4 Ratio Financial and insurance activities (NACE K)

2.1.2. Spatial association between smart-working and other economic activities

The second family of indicators (SW2) is computed to analyse the extent of smart-work diffusion in Spain. This is based on prior literature on local indicators of spatial association[2] that capture anomalies in the mapped values (distance to the local mean, in the negative exponential kernel of 90 minutes) and territorial triviality (data normalized with the local standard deviation). High positive or negative values of the index indicate unusual local ratios of smart-working employees, whereas values close to zero are associated to patterns within the common cases or local situations.

The local Z scores calculated for all traditional industries (NACE B-E) in Fig. 5 indicate that Spain is divided by a major North-South division (roughly a line cutting running from Salamanca to Valencia via Madrid). The territories on the north of this line are rather homogeneous, with concentration of traditional (industrial) companies in the urban LAUs and a rural space significantly less devoted to secondary activities. In the South, the territorial patterns are mixed, and while the urban concentration still prevails the rural LAUs exhibit an interesting patchwork of industrial agglomeration of companies,

---

sometimes in the outskirts of small and medium cities. It is worthwhile reiterating that data limitations suggest caution in drawing policy implications.
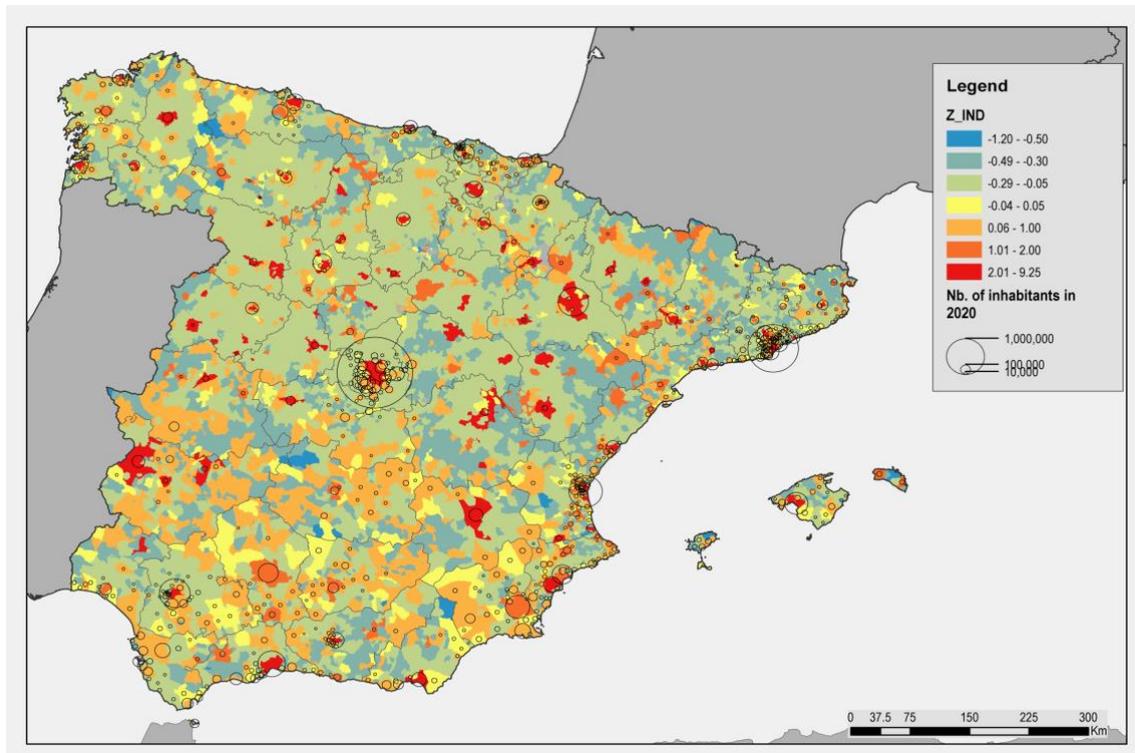
Fig 5 -SW Index 2- Local Z score for traditional sectors (NACE B-E)

The local Z scores calculated for sectors with higher propensity to remote work adoption (J and K NACE industries) present a different territorial distribution, closer to a polycentric model (Figg. 6 and 7). Thereby large metropolitan areas create a buffer zone of low attractiveness for companies in these sectors while, at the same time, the metropolitan core features a relatively high presence of these activities. Given the fact that the local Z score is based on the shares of the smart-working employees in the local totals, this situation might be a problem for planning and policy design. The articulation of these buffers has little chances to be dismantled by policies that focus on the regional scale (NUTS2), it is rather a topic of NUTS3 decision. Focusing on the metropolitan scale, an interesting insight emerges in the Eastern Coast of Spain along the Cartagena-Murcia-Alicante corridor whereby the associated indicators are relatively high and correspond in the map to a homogeneous territory of above average concentration of companies in the ICT and financial sectors. Badajoz, at the frontier with Portugal, also stands out for relatively high concentration.

As reported elsewhere, the use of this index is open to the criticism that local Z values might be more suitable for a dynamic study on intertemporal shifts in the growth or slowdown of smart work. This, unfortunately, clashes with the reality of data availability at the timing of the present report.
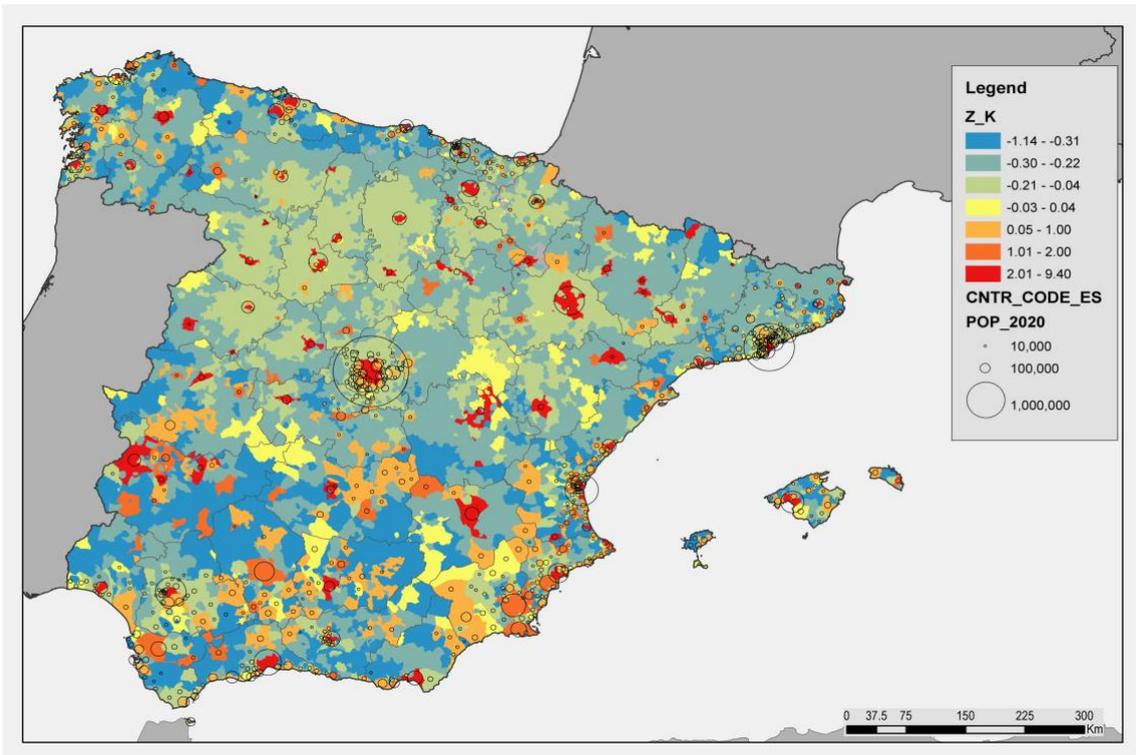
Fig 6. SW Index 2- Local Z score for Financial and insurance activities (NACE K)
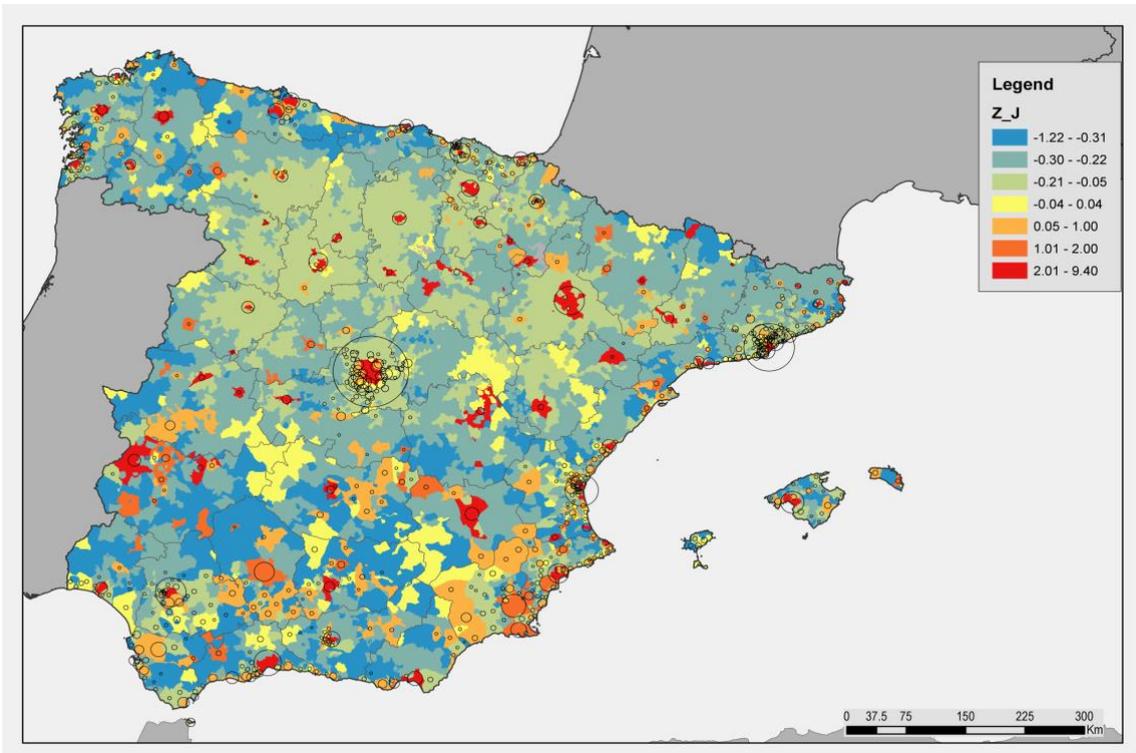
Fig 7. SW Index 2- Local Z score for Information and Communication (NACE J)

The qualitative crossing of the traditional (B to E, in the NACE classification) and the K NACE sector (Fig. 8) suggests that the diffusion of smart work depends on metropolitan territorial endowment, which is similar to that of France, Italy, Poland and Romania. The overwhelming spatial distribution of the class no.4 and the relatively reduced spatial footprint of types 1 and 2, together with the already mentioned North-South divide in Spain calls for a reflection on the role of territorial structures, which exhibit some degree of inertia over time, in the diffusion of activities that instead require a degree of adaptability. Again, given the quality of the data, the typology is highly indicative.
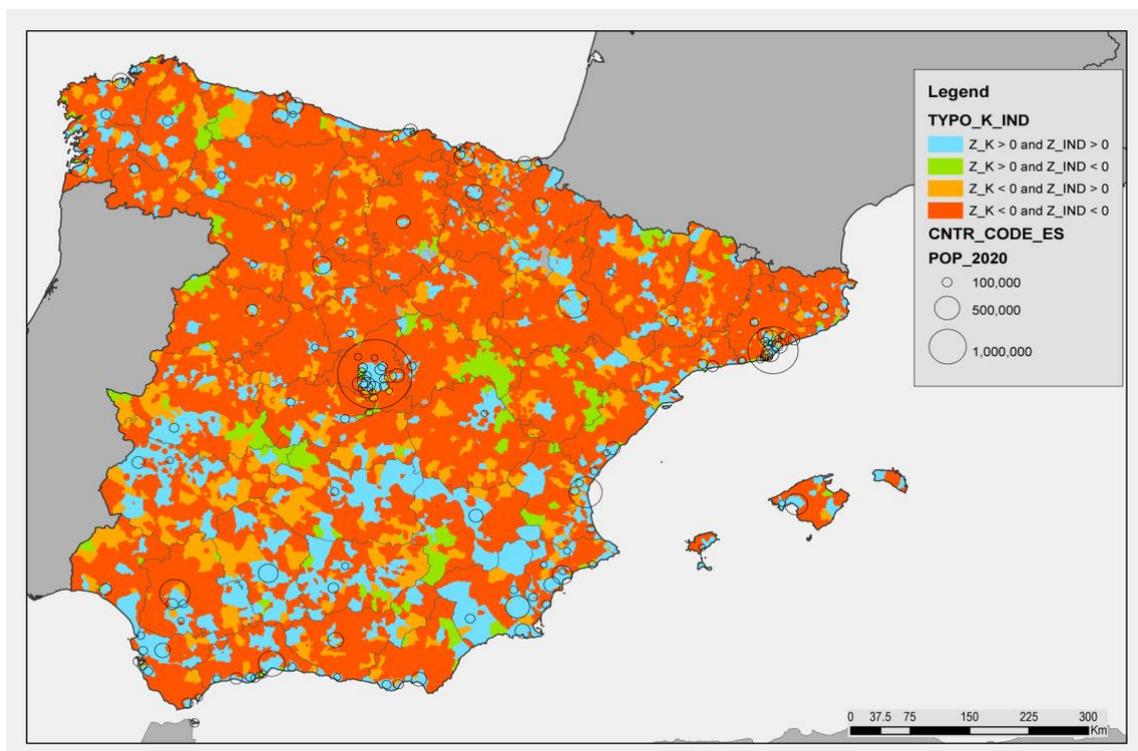
Fig. 8. Qualitative crossing of traditional (B-E NACE classification) and the K NACE industry

3. The impact of smart working on urban and regional mobility- lessons from the COVID-19 pandemic period

The most immediate benefit of the uptake of smart work during and after COVID is the reduction of commuting, which is widely known to be a source of pollution and carbon emissions, besides other negative impacts on quality of life. Millions spend time on the road during the week, and commuting to/from work is one of the main reasons. It is estimated that 1/5 of workers in Europe spend more than 90 min commuting each day, equivalent to about 29 km distance. The resurgence of commuting after the relaxation of mobility restrictions due to COVID however coincide also with changes in lifestyle all around Europe. Widespread adverse perceptions of urban residential living during

lockdown, especially for residents of small apartments, have driven a resurgence of suburban dwelling whereby larger houses afford better conditions for family life and, also, for remote work. This, however, is also a driver of commuting as families need to move, especially those with children.

Spain does not differ from these generalized trends whereby commuting time has been increasing over the last three decades. This is partly due to the propensity of highly specialized professionals to concentrate in very few productive areas in a spatially imbalanced context such as the Spanish economic landscape. One peculiarity of is that men in Spain commute longer than women, spend more time commuting back home from work (29.4 minutes for women, 31.6 minutes for men) than commuting to work (29.6 and 33.3 minutes, respectively). The only attempt to provide a framework to commuting to work in Spain is the establishment of mobility plans in 2010, a voluntary plan based on a combination of flexible working time, strategic planning to combine urban mobility and firm locations as well as shared driving schemes. As of today, however, these plans have not been implemented systematically.

For our analysis, we rely on country-specific data on mobility elaborated by Google.[3] The necessary premise of such an exploratory exercise is caution due to the quality of the data – novel but hard to check – and the urban hierarchy of any specific country. The Spanish national Statistics Institute is one of the few official bodies in Europe that provides data on the population mobility, in the frame of the experimental statistics. The data is organized at local level and allows time comparisons (2021-2020, for example). The exploration of the flows data allowed us to map the increase (or decline) in mobility for one single day – 25 December (2020 – 2021). Figure 9 indicates that a large part of the Spanish territory is in the 'stable' category, with an upward or downward variation of mobility of up to 5%. As expected, the peak of mobility change, above 50 %, is observed in proximity of the largest metropolitan areas. Some peripheral urban systems also contribute to this, for example the Andalusian corridors Huelva-Cadiz-Seville or Malaga-Granada-Almeria. Figure 9 also confirms that the spatial distribution of socio-economic activities is polarized between regions that are home to the largest cities (Andalusia, Catalonia Madrid, Comunitat Valenciana, taken together account for half of the urban population) and the rest of the territory, which has experienced significant outmigration over the last three decades. These disparities are reflected in the patterns of urban mobility, with a bias towards the top cities and to the detriment of peripheral areas.

The indications stemming from Google mobility data resonate with widely known specificities of the Spanish territories, confirming the concentration of most activities and of population in the main metropolitan areas (Madrid, Barcelona, Valencia, Zaragoza, Seville). Mobility data are aggregated by month to control for specific time trends coinciding with weekends, bank holidays, et cetera. Each of the major cities carries

---

[3] https://www.google.com/covid19/mobility/

peculiarities and, in turn, has specific functions in the broader functioning of the surrounding areas and of the national context.
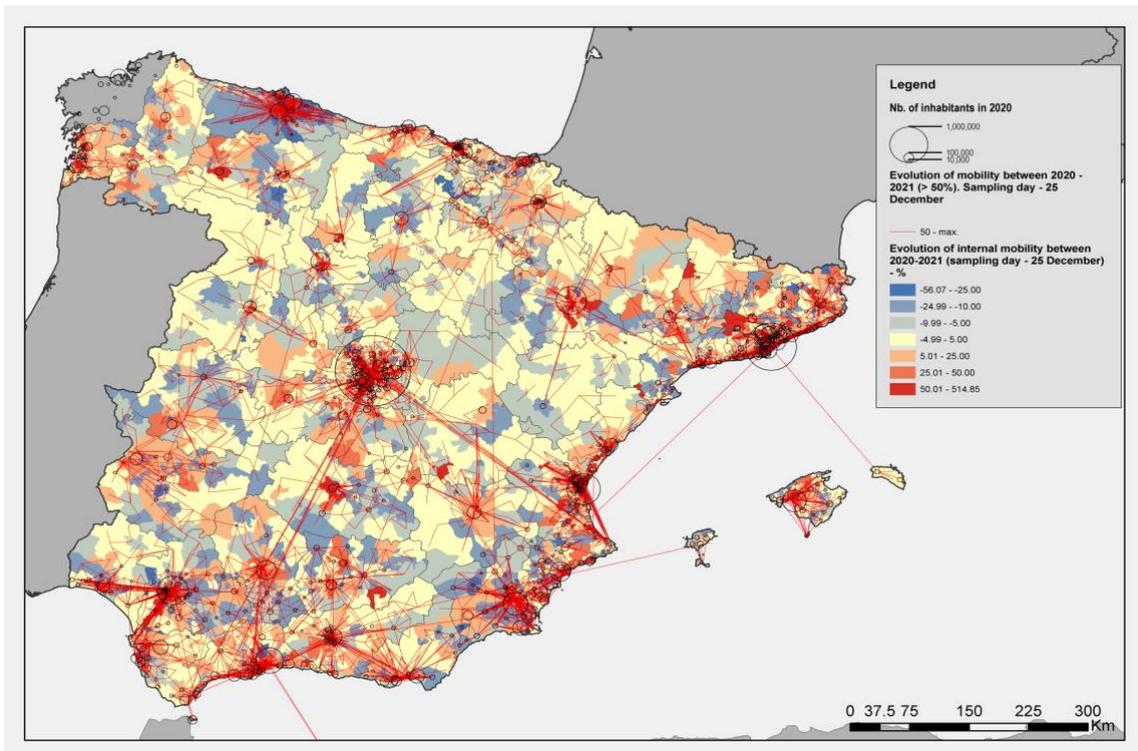
Figure 9. Evolution of mobility between 2020 and 2021
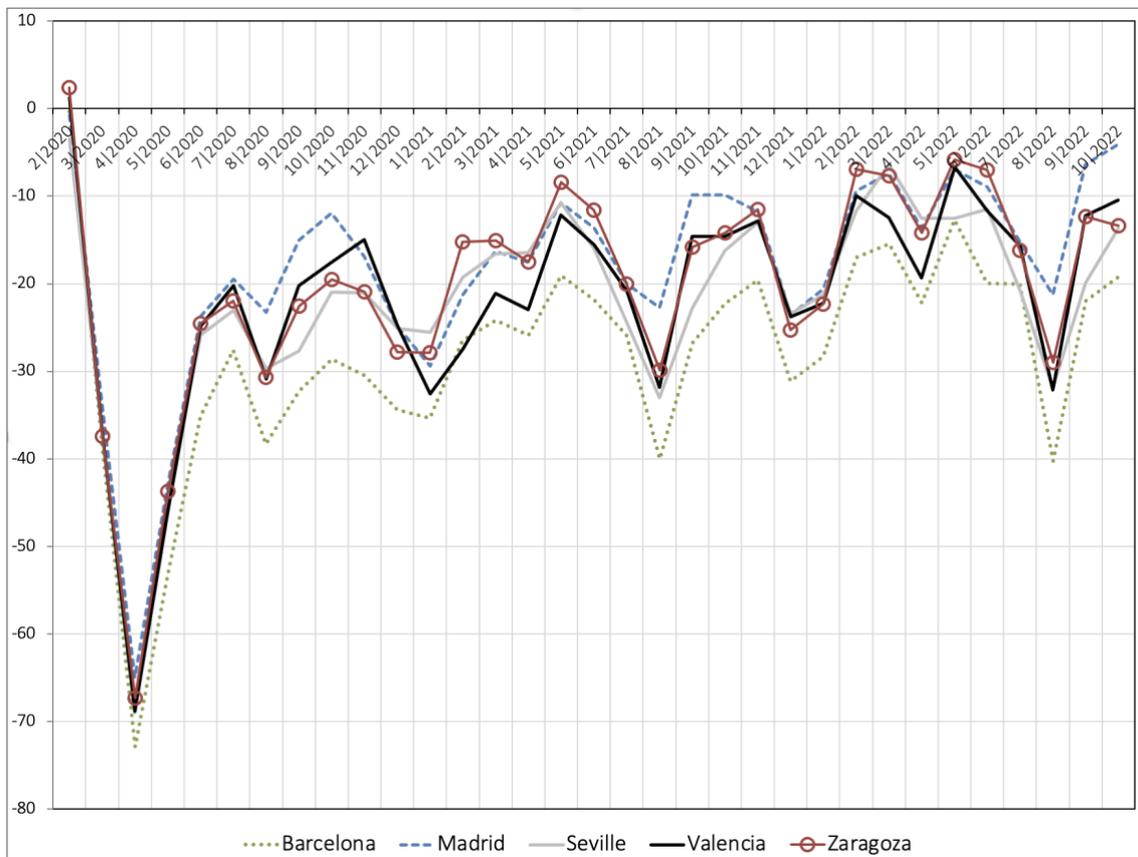
Figure 10. Trends in the workplace presence between 2020 and 2022 (selected cities)

The mobility pattern of the capital city Madrid – the political, administrative and economic centre of Spain – stands out in for suffering less severe changes over time, especially so as regards downward changes. It also exhibits the fastest recovery rate in the second half of both 2020 and 2021, thus showing greater resilience in the face of re-incidence of successive waves of COVID. Barcelona, the second largest city in the country, is a cosmopolitan hub with a wide portfolio of economic activities including hi-skill services, traditional manufacturing as well as tourism. The systematic decrease of mobility pattern (green dotted line Fig. 10) is plausibly the outcome of deeper changes in the organization of work. Official statistics from the Spanish INE (see WP1) indicate that Barcelona led the trend of remote work adoption, both during and after the COVID emergency, mostly due to concerted effort on the part of local authorities, especially the city council that has publicly pledged to tackle the environmental emergency by reorganizing mobility and by supporting experimentation of alternative working arrangements in the entire metropolitan area. The diagram seemingly captures some degree of consolidation of smart work in Barcelona. On the other hand, the rapid recovery of Zaragoza is primarily ascribed to its consolidated leadership in key industries (automotive, chemical, textile and metalworking) but also due to a leading role in logistics due to its strategic geographical position.

4. Bottlenecks in the development of smart working in Spain

Any assessment of the evolution of smart working cannot ignore the role of infrastructure which is likely to be either a major driver or a significant hurdle to the fulfilment of development potential. In this last part of the report we focus on the relative performance of local areas in internet speed, which is the key to connectivity and therefore to the diffusion of alternative work arrangements. Indeed, network performance has been often cited as a key source of concern during compulsory out of office work in the first lockdown.

In the Spanish context, the most recent data on the speed of Internet download (Fig. 11) indicate a strong correlation between economic performance. At regional scale, it is easy to identify the metropolitan areas around big cities such a Madrid (the most significant point), as well its influence in the border of medium-sized cities. It is remarkable that the influence of the metropolitan area of Barcelona stretches towards Valle del Ebro (industrial area of Zaragoza) and connects also with Bilbao in the north. On the east coast, Valencia exhibits high values together with the main cities in Andalusia, namely Sevilla and Granada. Another interesting spot is Extremadura, especially the area of Badajoz which stands in great contrast with the industrial poles and rural Spain in both Castilla-La Mancha (south east of Madrid) and Castilla y León (north west of Madrid).
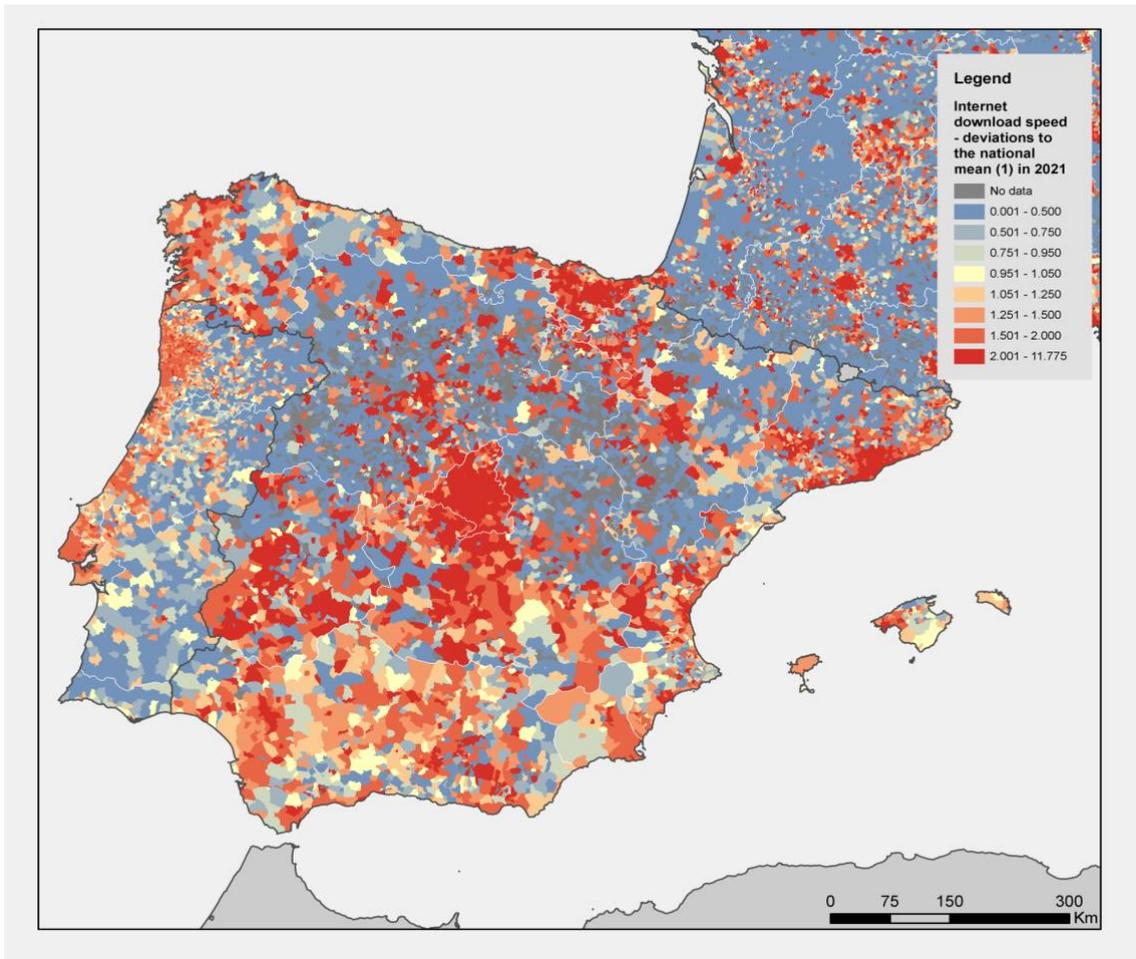
Figure 11. Internet download speed in 2021: deviations from the national mean

5. Concluding remarks

The picture that emerges from this analysis is that territorial disparities in Spain remain prominent, and have even accelerated since the COVID emergency. While there seems to be a healthy distribution of competences and of industrial specialization between the five major metropolitan areas, the gap has increased with the rest of the country. Despite an overall trend of national population growth after 2000, Spain exhibits significant patterns of population decline in rural areas in the northwest (Castile and León, Galicia, Asturias) and in territories east of Madrid (Guadalajara and Cuenca). While this is not a new phenomenon as rural depopulation started to accelerate due internal out-migration during the rapid industrialization of the 1960s, the continuing outflow of young people led to a fall in fertility beyond critical levels in some rural areas. Such a phenomenon is self-reinforcing inasmuch as thriving urban agglomerations attract progressively more talent to the detriment of small and medium cities or specific agricultural and tourism clusters in rural areas of the Mediterranean, south and north-east of the country. Internal migration patterns have also led to suburbanization, with population growth mostly concentrated around major urban agglomerations. Growing territorial disparities are a concern of both domestic and international policy makers as cumulative gaps in growth,

development and prosperity exacerbate the decline in the availability of essential services such as education and health, thus ultimately threatening social cohesion. The COVID-19 recovery plan put in place by the government in synch with the European Union in 2021 has not mitigated population decline in peripheral areas, even in spite of significant targeted investments, for example the modernization of the telecommunication infrastructure to support the diffusion of digitalisation. This is probably an indication of the need to design policies that, besides driving infrastructural growth, aim more directly at reversing the consolidated virtuous circle of decline.

From a policy perspective, two critical areas of interventions emerge from the analysis.

First, policies should promote skills development in synch with the recent legislation of remote and smart working. One is essential for the other. The 2021 law sets the course for an easier transition towards alternative forms of work arrangements but skill gaps and inadequate training have proven to be a significant hurdle throughout the pandemic. Active labour market policies and training policies, duly re-designed to boost effectiveness and efficiency, and suitably endowed, are a natural lever for ensuring the adaptability of the skill endowment in the face of fast changing circumstances. Spain has a large endowment of universities and vocational training centers that could add remote work skills to the basic curriculum for younger generations as well as promoting lifelong learning projects for older cohorts of workers in need of retraining. Such a goal calls for a concerted effort not only on the part of teaching organisations but also of regional development agencies and local councils for education.

Second, in a country with a high degree of administrative decentralization as Spain, it would be desirable for regional and local governments to coordinate their practices, sector by sector, onto a coherent regulatory framework. Long standing differences across regions in the bureaucratic protocols to i.e. undertake investment projects undermines development opportunities, especially for peripheral areas which are increasingly unable to attract resources. More than this, concerted national-local efforts are necessary to reduce growing socio-economic vulnerability. One interesting step in this direction is the recent Work-Life Balance Directive by the European Commission, a provision that seeks to redress the balance between family and career by setting minimum standards for leave entitlements and flexible work arrangements for parents and personal care workers.[4] All in all, promoting development and smart working requires broad coordination across interconnected regulatory domains such as training, employment, mobility and business.

---

[4] https://ec.europa.eu/commission/presscorner/detail/en/ip_23_2112