

Article

Telework and Occupational Segregation in Europe

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Abstract

Occupational segregation between men and women and between rural and urban areas is a persistent driver of labor market inequality in Europe. Women and rural workers are often overrepresented in lower-paid and lower-status occupations, reflecting structural barriers to occupational mobility. This paper investigates how occupational segregation varies across gender, space, and telework status and examines the potential of telework to reduce these inequalities. Using microdata from the 2023 European Labor Force Survey, we calculate segregation indices to measure occupational segregation and monetary gains, as well as losses due to segregation. We further analyze the relationship of segregation and telework. We find the highest segregation and economic disadvantages due to segregation for rural men. Female teleworkers are less clustered in feminized roles compared to non-teleworking women, suggesting that remote work can broaden occupational opportunities. Telework shows reduced segregation when primarily working remotely, but not in hybrid settings. Our findings contribute to a better understanding of spatial and gendered labor market disparities. We further identify the potential of telework to promote a more equitable occupational integration across gender and space.

Keywords: telework; occupational segregation; gender equality; urban–rural divide; Europe



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1. Introduction

When certain groups in a society are concentrated in specific types of jobs, this reinforces structural inequalities in income, job quality, and career opportunities. Such occupational segregation is a persistent issue in European labor markets (Hamjedi, 2021).

Occupational segregation occurs when different groups are concentrated in different occupations. The distribution of individuals from a particular group across jobs does not match their share of the overall labor market. This results in overrepresentation or underrepresentation in certain types of work. These groups may be defined by gender, place of residence, race, or other characteristics (Blau et al., 2013; Del Río & Alonso-Villar, 2010). The unequal distribution across occupations is often linked to disparities in authority, pay, or status, which contribute to economic inequality (Del Río & Alonso-Villar, 2018).

Occupational segregation by gender is one of the main factors explaining the gender pay gap, as women are often placed in lower-paid, less secure, or lower-status occupations, regardless of their skills or qualifications (Del Río & Alonso-Villar, 2010).

Similar principles emerge in the context of the urban–rural divide. Urban and rural areas show divergent labor market characteristics that impact wage levels and occupational structures. Large urban areas have become agglomerations of knowledge-intensive industries that offer highly paid and creative jobs (Abel et al., 2014; Braesemann et al., 2022a; Matz

et al., 2015). The urban–rural divide does not affect all individuals equally. Spatial variation in occupational opportunities may point to additional sources of gender segregation rooted in regional labor market structures or geographic accessibility. Gender wage gaps and occupational gender segregation are often more pronounced in rural areas, where traditional gender roles and weaker childcare infrastructure reinforce unequal participation in the labor market (Olfert & Moebis, 2006).

These intersecting inequalities—between urban and rural areas and between men and women—are key drivers of labor market inequality. Particularly in the context of occupational segregation, these intersections are under-researched and therefore of interest to our study.

However, recent shifts in the organization of work may offer new opportunities for change. The COVID-19 pandemic has significantly accelerated the spread of teleworking, particularly in occupations and sectors that are suitable for digital work tasks. By decoupling work from physical location, telework has the potential to change long-standing spatial and gendered patterns of occupational segregation. For rural workers, telework can open up access to occupations previously concentrated in urban centers, effectively widening the range of jobs available without the need to relocate to bigger cities. For women, particularly those in rural areas with caring responsibilities or mobility constraints, telework can provide greater flexibility and reduce barriers to higher-quality jobs (Bond-Smith & McCann, 2022; Kanellopoulos, 2011). To our knowledge, there is no literature so far examining the impact of telework on occupational segregation, including gender and urbanization, at a European level.

In this paper, we examine occupational segregation by its spatial and gender dimensions. We also explore how men and women are segregated by teleworking status and whether telework can contribute to reducing occupational segregation between genders and between urban–rural areas. Using microdata from the European Labor Force Survey (EU-LFS) 2023, we analyze trends in occupational segregation by calculating segregation measures and connected monetary gains and losses due to segregation following Del Río and Alonso-Villar (2015). We further assess whether telework has the potential to foster more equal occupational integration across regions by computing segregation measures for each European NUTS-2 region and including these indices in a regression analysis with telework as the explanatory variable.

In this paper, we provide in Section 2 the theoretical overview of occupational segregation by gender and then connect it to degrees of urbanization, telework status, and the consequences for economic inequality in the form of monetary gains and losses. We then dive deeper into the results of previous studies to present insights on how telework can change patterns of gender segregation and the segregation of urban–rural areas. In Section 3, we describe our data and methods to measure segregation and monetary losses/gains due to segregation, as well as our approach for a multivariate analysis of regional differences in segregation and factors determining it. We then present in Section 4 the corresponding results, and in Section 5, we discuss and summarize our findings and point out limitations and the implications for future research.

2. Theoretical Background and Literature Review

2.1. Gender Occupational Segregation

Despite advances in gender equality, women are disproportionately under- and over-represented in specific occupations. Various factors have been proposed to explain this enduring segregation, including individual preferences, systemic discrimination, disparities in human capital, access to childcare and transportation, and broader family-related decisions (Blau et al., 2013; Olfert & Moebis, 2006).

Women have caught up in traditional human capital factors like education and work experience and have surpassed men in terms of education, becoming more highly educated than men in the population of economically advanced countries such as the US or in the EU (Eurostat, 2024; Meurs & Pora, 2020). However, discrimination, traditional gender roles, and personal choices lead to women's underrepresentation in fields like science, technology, engineering, and mathematics. Instead of differences in levels of education, it is the choice of the field of study that causes segregation (Bettio & Verashchagina, 2009; Charlesworth & Banaji, 2019).

Traditional gender roles also prevent women from fully catching up in labor force participation and career progress. In many families, men are still the main wage earners. Their job determines the family's location, whereas women take on more family responsibilities. This leads to several disadvantages in the labor market (Blau & Kahn, 2017). Mothers experience more career interruptions and work fewer hours, leading to less career progress. They often prefer working conditions that offer flexibility and that do not require business travel (Bettio & Verashchagina, 2009; Olfert & Moebis, 2006). This pushes women, and especially mothers, into highly feminized occupations, which makes it difficult to enter high-wage occupations where long working hours and access to informal networks are essential (Goldin, 2014). Del Río and Alonso-Villar (2010) show with their data from Spain that women's segregation is strongly driven by part-time work.

On the other hand, men are concentrated in occupations that are connected to physical attributes, like agriculture, fishery, forestry, mining, construction, machine operation, and craft work (Olfert & Moebis, 2006; Torre, 2019). Even though women are increasingly integrated into male-dominated professional occupations, their participation in blue-collar male-dominated jobs stays at very low levels (Torre, 2019). This leads to men being clustered in "blue-collar" occupations involving physical labor and machine use, whereas women are concentrated in "pink-collar" roles like service, teaching, and care (Charles & Grusky, 2004; Eurofound & European Commission Joint Research Centre, 2021). This leads to women at a European level being underrepresented in the middle of the wage distribution, where blue-collar jobs like construction or manufacturing are mainly male-dominated. Women, therefore, are more often concentrated in low-wage jobs. Gender gaps in high-paying jobs are slowly narrowing (Eurofound & European Commission Joint Research Centre, 2021).

2.2. Urban–Rural Divide

Workers are not only segregated by gender but also by the degree of the urbanization of their place of residence, leading to an economic urban–rural divide. A key feature of this divide is the declining share of rural populations across Europe, as young and highly skilled individuals increasingly leave the countryside in search of more challenging and better-paying job opportunities in urban areas (Braesemann et al., 2022a; Vitola & Baltina, 2013).

Metropolitan areas tend to specialize in high-skill occupations and are home to a disproportionate share of tertiary-educated workers. These metropolitan labor markets are concentrated in skill-based occupational clusters such as scientists, managers, engineers, and analysts. The presence of a larger market increases the diversity of potential suppliers, improves labor market efficiency through better employer–employee matching, and stimulates learning, innovation, and the diffusion of new technologies. As a result, urban agglomerations are not only more dynamic but also more attractive to both firms and skilled workers, reinforcing spatial disparities over time (Brixy et al., 2022). As a consequence of this spatial concentration of human capital, remote rural areas, particularly those far from urban centers, have experienced weak economic growth and lower wages in part due to their inability to attract or retain highly skilled workers (Abel et al., 2014). In return, these well-paid workers in high-skill jobs are also increasing the demand for low-skill services

like food, personal care, and transportation. These industries are especially increasing in cities, where they profit from a dense consumer base (Nordin et al., 2025).

2.3. Gender and Rurality

The rural–urban divide is not only economic but also infrastructural and social. Time and financial costs of distance, childcare access, the scarcity of suitable jobs, and more traditional gender norms in rural areas disproportionately affect specific demographic groups, such as women and parents. This leads to unequal opportunities in employment, occupational mobility, and overall economic participation (Brixy et al., 2022; Olfert & Moebis, 2006).

Urban regions have seen a more extensive expansion of childcare infrastructure and, therefore, lowered opportunity costs and improved mobility for urban women than for their rural counterparts. The limited mobility of rural women due to family commitments reduces their bargaining power and ability to threaten job change in wage negotiations, leading to systematically poorer employment conditions (Olfert & Moebis, 2006).

Olfert and Moebis (2006) confirm in their study on Canadian data that spatial factors such as regional industry structures, access to childcare, transport costs, and the full availability of occupations influence occupational choice, often disadvantaging women. Even when accounting for structural differences in local labor markets, the presence of children, and educational attainment, rurality itself remains a significant driver of occupational gender segregation. All rural categories studied show markedly higher segregation compared to urban areas (Olfert & Moebis, 2006).

Data from Eurostat further indicate that gender employment gaps are bigger in rural than in urban areas (Mascherini et al., 2023). These disparities are reinforced by differences in cultural attitudes toward gender equality, with urban areas generally demonstrating more progressive views and higher female representation in professional, political, and leadership roles.

2.4. Telework and Occupational Segregation

Digitalization and remote working are not only altering individual work arrangements but also driving structural transformations in labor markets. The acceleration of digital transformation since the COVID-19 pandemic has reinforced occupational polarization, reshaping the demand for digital skills and reorganizing firm structures (Eurofound, 2024). Hybrid work models are becoming institutionalized, affecting patterns of productivity, wage setting, and career progression. Moreover, forecasts suggest a sharp increase in remote digital jobs globally, with significant implications for regional competitiveness and labor market access (Sostero et al., 2020). As estimated by Sostero et al. (2020), between 33% and 44% of jobs in Europe are teleworkable. Traditionally, teleworkers have often been male managers or professionals, as telework was most widespread in digital work in the field of information and communication technology, which is mainly male dominated. However, due to recent trends and, especially, the COVID-19 pandemic, a broader mix has been shown. Teleworkers now include technicians and associate professionals but also clerical support workers, with a growing proportion of women in this group. Teleworking is no longer limited to those with permanent, full-time jobs in urban areas and is spreading to more precarious, temporary, and lower-paid positions (López-Igual & Rodríguez-Modroño, 2020).

There are big differences between European countries. While in some countries (mainly northern and western European countries), where over one-third of workers are working from home, other countries show significantly lower shares of teleworkers—around 10%—mainly in eastern and southern countries. These country differences mirror differences

in the sectors and infrastructure, level of acceptance, and offer of telework, as well as its regulation (Sostero et al., 2020; Zwysen, 2023).

Telework has long been seen as a tool for development. It enhances productivity, fosters competitiveness, creates jobs in remote areas, and can reduce rural–urban migration. It also offers employment potential for women, especially mothers, as well as low-income individuals, disabled persons, and others with limited mobility. Emerging evidence points to the transformative role remote work can play in shaping regional inequality and development (Kanellopoulos, 2011; Özgüzel et al., 2023).

2.4.1. Telework and Occupational Segregation by Gender

Telework provides time and money savings due to the omission of commuting and offers greater flexibility to balance work and family responsibilities. This enables parents to maintain their contracted working hours after having children. Since women continue to bear a larger share of childcare and domestic duties, telework can especially support mothers. When working more hours, telework helps to increase women’s labor market participation and facilitates career progress while taking on family responsibilities (Arntz et al., 2020; Chung & Van Der Horst, 2018). Longer working hours can help women access higher-paid occupations. As previous studies found a connection between female segregation and part-time work (Bettio & Verashchagina, 2009; Del Río & Alonso-Villar, 2010), increased working hours through telework could help to reduce gender segregation.

However, the use of family-friendly arrangements such as telework can still carry a stigma, as it deviates from the ideal worker norm, someone who is fully devoted to their job. This flexibility stigma tends to affect women more strongly, as they typically assume greater responsibilities for caregiving and household duties (Chung & Seo, 2024).

Arntz et al. (2020), with their German sample, and Pabilonia and Vernon (2022), with their data from the US, both reported smaller gender gaps in working hours and monthly wages amongst teleworkers, but, on the other hand, confirmed flexibility stigma as only men experience wage premiums when teleworking, which would result in an economic disadvantage.

Studies so far focus mainly on the gendered impact of telework on working hours and wages, but less on the impact on occupational segregation.

2.4.2. Telework and Urban–Rural Occupational Segregation

An increasing share of jobs stems from digital, non-location-dependent services. Information and communication technologies offer rural populations new opportunities to engage in the knowledge economy that is traditionally tied to metropolitan centers. It also offers urban residents the opportunity to avoid high housing costs in cities and move farther away from their place of work (Braesemann et al., 2022a). As a result, some rural areas have experienced population inflows in recent years, a potential reversal of the long-standing urbanization trend. This benefits individuals (e.g., through reduced living costs and improved environments), companies (e.g., via broader talent pools and decentralization), and rural communities (e.g., by attracting skilled workers and stimulating economic diversification) (Bond-Smith & McCann, 2022; Eurofound & European Commission Joint Research Centre, 2024).

However, empirical evidence suggests that many of these new rural residents maintain strong economic ties to urban centers by commuting when working in a hybrid position, particularly in more accessible rural areas close to urban centers. The more isolated regions continue to experience net outward migration and do not benefit from significant employment growth (Scott et al., 2007). Bond-Smith and McCann (2022) state that some rural regions with high natural amenities or proximity to metropolitan areas may benefit from telework, but the broader trend favors the suburbs and hinterlands of large cities

rather than remote rural zones. This is because telework lowers the cost of commuting but does not eliminate the productivity benefits of urban agglomerations, thus reinforcing the attractiveness of urban peripheries over more isolated rural areas (Bond-Smith & McCann, 2022; Özgüzel et al., 2023).

In Ireland, 9.3% of respondents of the National Remote Working Survey reported having relocated within the country due to the ability to telework. Of those, nearly two-thirds moved out of Dublin. The most popular relocation destinations include counties on the Western seaboard as well as counties in the Greater Dublin Area. Proximity to Dublin remains important for hybrid workers who must commute occasionally, helping to explain the concentration of relocations in surrounding areas (Frost, 2024).

Wong et al. (2025), using survey data from EU countries, did not find significant evidence that telework reduces urban–rural economic disparities and even showed that teleworking individuals in higher occupations tend to remain in cities. Those who show interest in relocating to rural areas because of telework are young or old workers in middle- or entry-level positions.

Braesemann et al. (2022b) analyzed worldwide data on online platform workers. According to their findings, remote work is more linked to urban areas. They argue that vocational training opportunities to develop the necessary skills for telework are mostly concentrated in large cities. Telework can only become a tool for rural economic development if the required skills are built in rural areas.

There is still no clear evidence regarding the influence of telework on one's residential location. It is a complex topic influenced by a lot of factors like family needs, better housing, and access to nature, and there are not yet clear trends since the rise of telework during the COVID-19 pandemic (Eurofound & European Commission Joint Research Centre, 2024; Hostettler Macias et al., 2022; Ory & Mokhtarian, 2006; Wong et al., 2025).

2.5. Summary

To summarize, occupational segregation reflects the structural constraints that work differently across gender and space. Women face stronger segregation than men (Del Río & Alonso-Villar, 2010), especially in rural areas, where women suffer more from reduced mobility than men (Olfert & Moebis, 2006).

Until now, the effect of telework on occupational segregation has been underresearched. Existing studies primarily examine the gendered impact of telework on wages (Arntz et al., 2020; Pabilonia & Vernon, 2022), while much less is known about how telework reshapes occupational structures. From a theoretical perspective, telework may influence segregation through competing mechanisms. On the one hand, it can reduce segregation by easing women's mobility barriers, enabling them to increase their working hours, and expanding access to male-dominated occupations requiring long working hours (Arntz et al., 2020; Chung & Van Der Horst, 2018). On the other hand, telework may also reinforce segregation if it remains concentrated in certain gendered urban-centered occupations (Braesemann et al., 2022b; Frost, 2024; Wong et al., 2025), or if flexibility stigma penalizes those (disproportionately women) who use it extensively (Chung & Seo, 2024). This duality frames our analysis: we test whether telework functions as a desegregating force or whether it reproduces existing occupational divides.

Regarding the spatial impact of telework, most studies so far focus on residential relocation and commuting times rather than on occupational segregation (Bond-Smith & McCann, 2022; Frost, 2024). However, telework may reshape urban–rural divides in complex ways. Evidence suggests that areas close to urban centers benefit the most: workers can reduce commuting without losing access to urban labor markets, and employers can draw on a wider regional talent pool (bond). In contrast, very remote rural areas often face

limited digital infrastructure and occupational opportunities, meaning that they benefit less directly from telework. Thus, telework may narrow the gap between urban and near-rural labor markets while raising questions about how to extend these benefits to more remote regions.

With this paper, we want to close these gaps by exploring gender occupational segregation, its intersection with space and teleworking status, and the connected monetary losses and gains. Additionally, we aim to analyze the impact of telework on regional differences in segregation in Europe.

3. Methodology

3.1. Data

We work with data from the European Labor Force Survey (EU-LFS) from 2023. The EU-LFS is conducted by national statistical institutes. We have data available from 27 EU countries, plus Switzerland, Iceland, and Norway, resulting in a total sample of 450,232 individuals, of which 212,527 are in the active workforce. Sample weights are used throughout the analysis.

The EU-LFS provides information on occupations based on ISCO classification. Depending on the step of our analysis, we either use the one- or two-digit code to classify occupation, including nine and forty-nine categories of occupations, respectively ([International Labour Organization, 2024](#)). We exclude armed forces, as they are difficult to compare meaningfully with civilian workers ([Welch et al., 2025](#)).

Further, it provides data on the degree of urbanization of the place of residence, which is classified into three categories: city, towns/suburbs, rural area.

Information on telework is provided in three categories: never, sometimes (less than half of their working days), and mainly (more than half of their working days). Those sometimes teleworking will be referred to as hybrid teleworkers in this article, and those mainly teleworking will be referred to as teleworkers, whose primary place of work is outside the office ([Özgüzel et al., 2023](#)).

Furthermore, information on gender, employment status, working hours, sector, working time model (full-time, part-time), contract time (fixed-term, permanent), level of education (lower secondary, upper secondary, tertiary), age, migration status, and country is included as a control variable.

3.2. Methods

Our analysis is divided into three parts. First, we run an analysis of how workers are segregated into different occupations based on gender, the degree of urbanization of their place of residence, and their teleworking status. Therefore, we explore different local and overall segregation measures on a European level. Second, we derive conclusions about monetary gains and losses due to segregation resulting in economic inequality. In the third step, we aggregate data for NUTS-2 regions to explore regional variation in segregation and factors influencing regional segregation, with a focus on the impact of telework.

3.2.1. Segregation Indices and Monetary Losses Due to Segregation

In this work, we consider two complementary types of segregation measures. The first captures the extent of segregation as the over- and underrepresentation of groups in particular occupations or regions, both at overall and local levels. The second focuses on the monetary consequences of segregation, quantifying the associated wage losses that arise from these patterns, again computed at both overall and local levels.

A local segregation index serves to capture how much a specific group is overrepresented (or underrepresented) in each unit considered, relative to its overall share in

the population. These measures do not capture the economic impact. For this purpose, other indices are used, such as index Γ , which reflects the economic cost for a group to be unequally distributed in the labor market—for example, by incorporating wages.

Alonso-Villar and Del Río (2010) offer a detailed overview of different local and overall segregation indices. In Alonso-Villar and Del Río (2017) and Del Río and Alonso-Villar (2018), they describe how to measure welfare losses of groups and the society due to segregation.

To quantify each group's degree of unevenness, we compute local segregation indices, Φ , following Alonso-Villar and Del Río (2010) and Del Río and Alonso-Villar (2022). These are based on the idea of proportionality. To analyze the segregation of a group g (women/men) in a population across a set of occupations j , we denote T as the total population size, T_j as the people employed in occupation j , C^g the size of group g , and C_j^g of the subpopulation of group g employed in occupation j . Then, two proportions are estimated: on the one hand, the proportion of g (women) in the total population T (C^g/T); on the other hand, the proportion of individuals from group g within occupation j (C_j^g/T_j). If these two quantities coincide (or are very close), there is no segregation; otherwise, the result will indicate overrepresentation ($C_j^g/T_j > C^g/T$) or underrepresentation ($C_j^g/T_j < C^g/T$). The local segregation of each group can be visualized in local segregation curves. These local segregation measures do not capture the economic impact. One way to introduce this impact is through wages. For this purpose, the ratio $\frac{w_j^g}{\bar{w}}$ between the wage of each group considered (w_j^g) and the average wage of the population analyzed, $\bar{w}$, is taken. This ratio is used in index Γ to assess the economic impact of the segregation of group g via the following expression: $\left(\frac{C_j^g}{C^g} - \frac{T_j}{T}\right) \frac{w_j}{\bar{w}}$.

Weighted by group shares, the average of the local segregation index for each occupation indicates the overall segregation index M (Del Río & Alonso-Villar, 2022). Similarly, the overall monetary loss of a society due to segregation can be obtained when summing up the losses of each disadvantaged group, which is called the FGT index (Del Río & Alonso-Villar, 2018).

The formal definitions and a more detailed mathematical treatment of the indices can be found in the appendix. Equations (A1) and (A2) define local segregation measure Φ , (A3) shows the equation of overall segregation index M , Γ is defined in (A4), and the equation of the FGT index is described by (A5) in Appendix A.

Data on occupational wages on an ISCO 1-digit level are derived per country from Eurostat (2022) based on the Structure of Earning Survey 2018, which is used to calculate monetary gains and losses due to segregation. Segregation indices themselves are calculated based on ISCO 2-digit occupational categories, excluding armed forces.

We compute the segregation indices and local segregation curves by gender and the intersection of gender and urbanization using the full sample of our data from the available European countries. For segregation by gender and teleworking status, we reduce the sample to fully teleworkable occupations based on the classification of Sostero et al. (2020). Three countries needed to be excluded when analyzing segregation by telework status, as there were too many occupations with no teleworkers.

3.2.2. Multivariate Analysis

To examine regional variation in segregation patterns across European countries and the influence of telework and rurality, we aggregate the data at the NUTS-2 regional level. We calculate normalized Mutual Information index $\tilde{M}$ following Equation (A3) divided by its maximum and FGT indices following Equation (A5) by gender, and by gender and urbanization for each NUTS-2 region r .

We then run separate linear regressions for each $\tilde{M}_r$ and FGT_r index as dependent variable Y_r . Our main explanatory variables are the share of people living in rural areas per NUTS-2 region r ($Rural_r$) and the regional share of workers reporting telework, differentiating between hybrid telework ($Hybrid_r$) and primarily telework ($Primarily_r$).

We also include a vector of control variables (C_r) covering labor market characteristics, human capital characteristics, and demographic control variables per NUTS-2 region r to account for structural differences across regions.

The labor market characteristics are the regional gender gap in working hours, female employment rate, employment rate, the share of people working in the information sector and in the primary sector, working part-time, and having permanent contracts. Human capital characteristics include the gender gap in levels of education and the share of people with a tertiary education per NUTS-2 region r . We also account for demographic factors, including the share of people living with children, mean age, the share of people with a migration background, and country.

The series of linear regressions follows Equation (1).

$$Y_r = \alpha + \beta_1 Rural_r + \beta_2 Hybrid_r + \beta_3 Primarily_r + \beta_4 C_r + u_i \quad (1)$$

Because of the incomplete data of control variables, Switzerland, Ireland, and Iceland could not be included in the regression analysis. For Austria, Germany, and The Netherlands, data were only available for NUTS-1 regions, which results in a total of 200 regions that are included in the multivariate analysis.

4. Results

4.1. Occupational Structure

We first want to give an overview of the occupational structure of the sample at a European level. Table 1 shows ISCO-classified occupations on the one-digit level sorted by their mean salary based on data from the Structure of Earnings Survey 2018 from Eurostat (2022). It also shows the share of female workers, the share of people living in rural areas, and the share of people teleworking for each occupation.

Table 1. ISCO one-digit occupations and their proportion of overall workforce, mean hourly salary, share of female workers, share of workers living in rural areas, and share of teleworkers.

Occupation	Proportion	Mean Hourly Salary	Share of Female Workers	Rurality	Share of Teleworkers
Managers	0.05	28.62	0.35	0.22	0.44
Professionals	0.23	21.36	0.54	0.16	0.49
Technicians and associate professionals	0.16	17.76	0.50	0.22	0.29
Clerical support workers	0.10	14.20	0.66	0.21	0.23
Craft and related trades workers	0.11	12.84	0.11	0.32	0.06
Skilled agricultural, forestry, and fishery	0.03	12.6	0.28	0.67	0.21
Plant and machine operators	0.07	11.45	0.18	0.34	0.02
Service and sales workers	0.16	11.16	0.64	0.25	0.08
Elementary occupations	0.08	9.65	0.53	0.27	0.02

Managers have the highest hourly salary, followed by professionals. These are also occupations where telework is most widespread. The lowest salaries are found for elementary occupations and service and sales workers, followed by the male-dominated occupations of plant and machine operators, craft and related trades workers, and skilled agricultural, forestry, and fishery workers. At the same time, these occupations show the highest shares

of rurality. With a share of 35%, women are underrepresented in management positions. The shares of females are highest for clerical support workers, service and sales workers, and professionals, especially including health and teaching professionals.

Table A1 in Appendix A shows a more detailed overview of occupations on an ISCO two-digit level and their shares of female workers, rural population, and teleworkers.

To get a picture of how telework is spread across gender and occupation, we reduce the sample to individuals that work in occupations that can potentially be done fully remote (23 ISCO two-digit occupations) according to Sostero et al. (2020). Table 2 shows the proportions of men and women by teleworking status across these teleworkable occupations aggregated on the ISCO one-digit level. Female non-teleworkers mainly work as clerical support, whereas proportions of female teleworkers are spread more evenly. Male teleworkers mainly work as professionals and managers, and male non-teleworkers are spread more evenly.

Table 2. Proportion of men and women by teleworking status within fully teleworkable occupations.

	Male No Telework	Male Telework	Female No Telework	Female Telework
Total	21.0%	23.6%	32.9%	22.6%
Managers	28.5%	32.5%	18.1%	21.0%
Professionals	18.1%	36.9%	19.2%	25.8%
Technicians and associate professionals	25.8%	18.6%	34.3%	21.2%
Clerical support workers	17.1%	6.3%	56.4%	20.2%

Note: Each row's total equals 100%.

4.2. Segregation Measures

We compute the indices of the local segregation index Φ_{α}^S and the corresponding local segregation curves by gender, by gender and their degree of urbanization, and by gender and teleworking status based on 49 ISCO two-digit classified occupations (without armed forces). In the main analysis, we focus on the European level. Table A2 in Appendix A shows the overall and local segregation measures by country. Groups with the highest segregation are marked in bold.

4.2.1. Occupational Segregation by Gender

When interpreting a segregation curve, the first decile of the female (male) distribution corresponds to 10% of the total employment and comprises the occupations where women (men) are least represented. The second cumulative decile accounts for 20% of employment and continues to include those occupations with the lowest relative presence of the target group, and so on. Consequently, the local segregation curve illustrates the degree to which the target group is underrepresented across the employment structure, assessed decile by decile (Alonso-Villar & Del Río, 2010; Del Río & Alonso-Villar, 2010).

In our case, women's segregation curve is below the one of men in the lower-middle part and seems to overlap in the upper-middle part (Figure 1). Table 3 shows that both genders are segregated, but all local indices of women are higher than for men. We therefore conclude that women are more segregated than men. The normalized Mutual Information index $\tilde{M}$ equals 0.22, of which female workers contribute 58%, even though they have lower proportions in the population shares of workers.

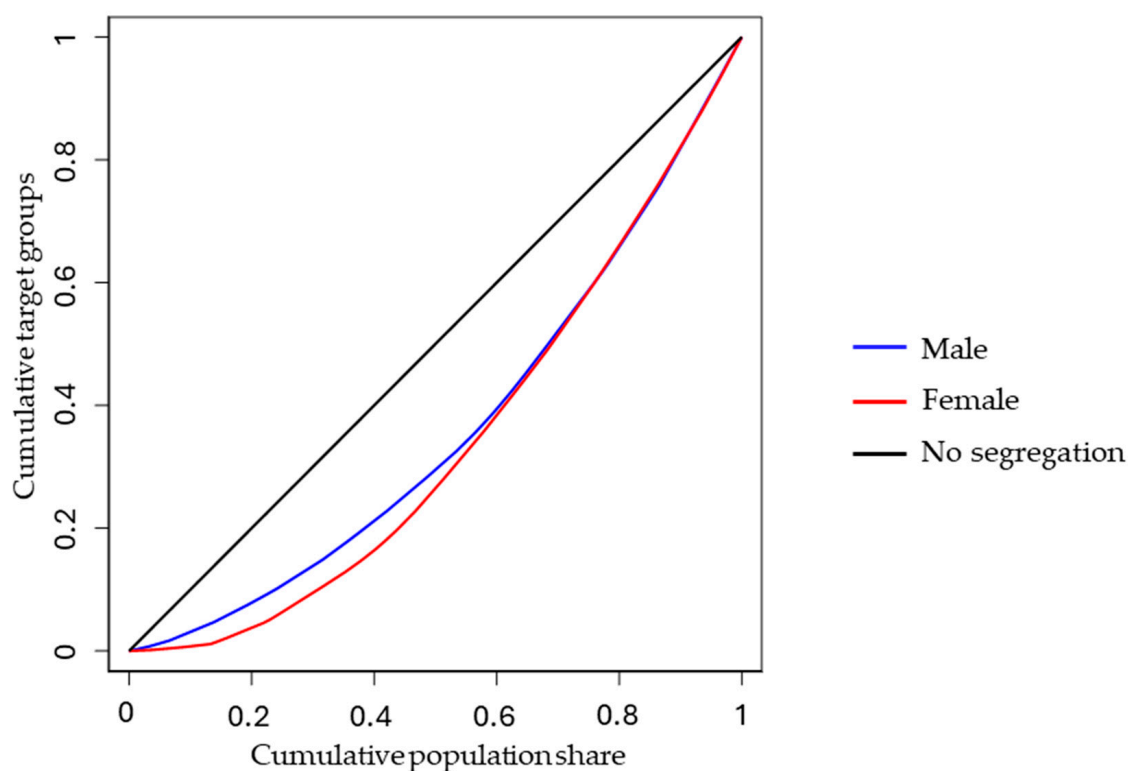


Figure 1. Local segregation curve by gender.

Table 3. Local and overall segregation indices by gender.

	Population Share (%)	Local Segregation Indices				Overall Segregation Index		
		$\Phi_{0.1}^g$	$\Phi_{0.5}^g$	Φ_1^g	Φ_2^g	M	$\tilde{M}$	Contribution to Overall (%)
Male	0.53	0.13	0.12	0.12	0.11	0.15	0.22	0.42
Female	0.47	0.28	0.23	0.18	0.15			0.58

Note: Φ_α^g provides sensitivity to disequalizing movements depending on α . It accounts for a group's underrepresentation in units for α lower than 1 and for a group's overrepresentation in a unit for α bigger than 1. $\alpha = 1$ treats under- and overrepresentation equally (see Appendix A.1).

4.2.2. Segregation by Gender and Degree of Urbanization

As the lines are crossing, Figure 2 does not allow us to clarify the relationship between groups. Therefore, local segregation index values (Table 4) must be considered. Note that the conclusions made with one index may differ from those of others since they weigh over- and underrepresentation differently. $\Phi_{0.1}^g$, which is highly sensitive to underrepresentation, shows the highest values for women in cities. The other indicated local segregation indices show the highest segregation for rural men. Only little differences among the different degrees of urbanization for females are shown. Men in cities and men in towns/suburbs are less segregated compared to the other groups. We conclude that rural men are more concentrated in occupations that are distinct from the broader occupational structure, leading to higher segregation in the full population. In contrast, (rural) women's occupational patterns are gendered and may reflect more universally present roles (e.g., in care or service work) that are not as specifically connected to rurality.

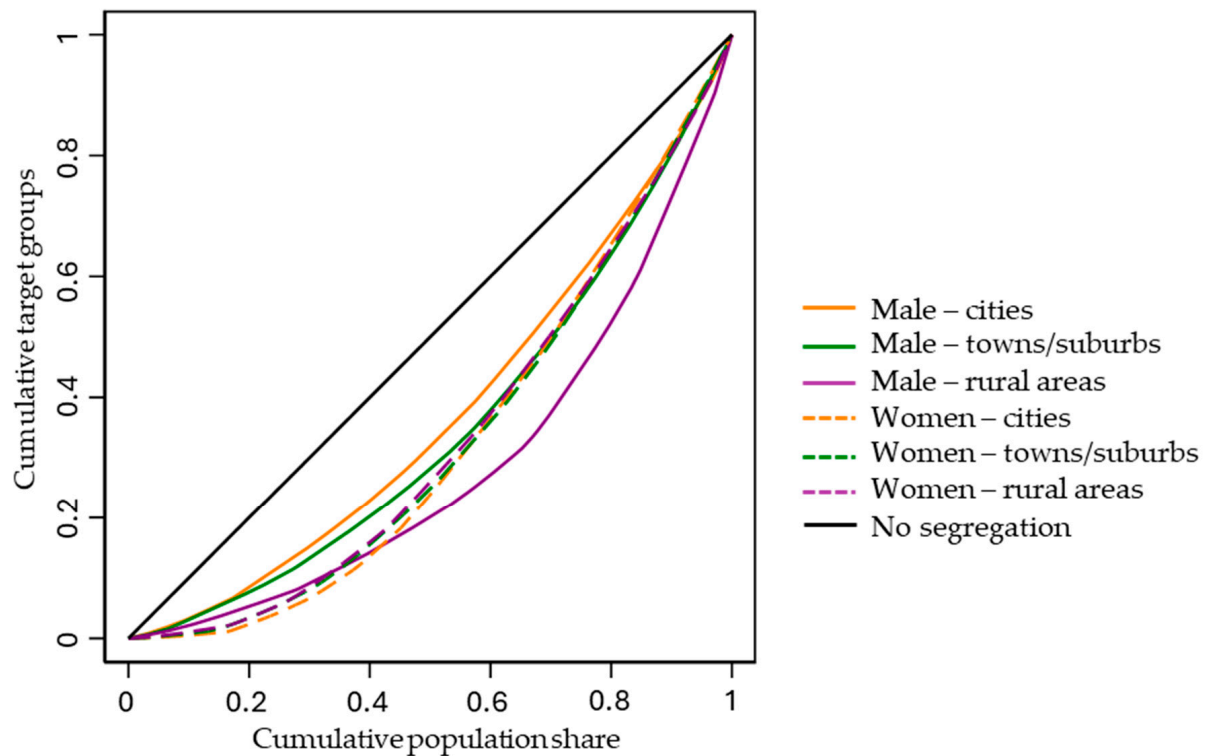


Figure 2. Local segregation curves by gender and degree of urbanization.

Table 4. Local and overall segregation indices by gender and degree of urbanization.

			Local Segregation Indices				Overall Segregation Index		
		Population Share (%)	$\Phi_{0.1}^g$	$\Phi_{0.5}^g$	Φ_1^g	Φ_2^g	M	$\tilde{M}$	Contribution to Overall (%)
Male	Cities	0.21	0.11	0.11	0.10	0.10	0.19	0.11	0.12
	Towns/suburbs	0.19	0.15	0.14	0.14	0.14			0.14
	Rural areas	0.14	0.31	0.30	0.29	0.33			0.21
Female	Cities	0.19	0.37	0.29	0.23	0.18	0.19	0.11	0.24
	Towns/suburbs	0.16	0.30	0.25	0.20	0.17			0.18
	Rural areas	0.11	0.28	0.23	0.20	0.17			0.12

Note: Φ_α^g provides sensitivity to disequalizing movements depending on α . It accounts for a group's underrepresentation in units for α lower than 1 and for a group's overrepresentation in a unit for α bigger than 1. $\alpha = 1$ treats under- and overrepresentation equally (see Appendix A.1).

The normalized Mutual Information index $\tilde{M}$ equals 0.11, with women in cities contributing most.

4.2.3. Segregation by Gender and Telework Status

For the analysis of teleworking status, we reduce the sample to occupations that are fully teleworkable according to the classification of [Sostero et al. \(2020\)](#), resulting in 13 occupations where 23% of the total workforce are active. Table 5 shows that female non-teleworkers and male teleworkers are notably more segregated than male non-teleworkers and female teleworkers. Male teleworkers are most concentrated in certain occupations, whereas female teleworkers and male non-teleworkers are spread more evenly across teleworkable occupations. This conclusion is supported by Figure 3. Connecting these results to Table 2, it uncovers that segregation is primarily driven by gendered occupational patterns and unequal access to telework. Male teleworkers are overrepresented in roles such as managers and professionals where telework is widely used, while women, especially

non-teleworking women, are concentrated in clerical and administrative positions where telework, although technically feasible, is less common in practice.

Table 5. Local and overall segregation indices by gender and teleworking status.

		Population Share (%)	Local Segregation Indices				Overall Segregation Index		
			$\Phi_{0.1}^g$	$\Phi_{0.5}^g$	Φ_1^g	Φ_2^g	M	$\tilde{M}$	Contribution to Overall (%)
Male	No telework	0.21	0.03	0.03	0.03	0.03	0.12	0.09	0.05
	Telework	0.24	0.27	0.25	0.24	0.25			0.46
Female	No telework	0.33	0.21	0.18	0.16	0.15			0.43
	Telework	0.23	0.03	0.03	0.03	0.03			0.06

Note: Φ_a^g provides sensitivity to disequalizing movements depending on α . It accounts for a group's underrepresentation in units for α lower than 1 and for a group's overrepresentation in a unit for α bigger than 1. $\alpha = 1$ treats under- and overrepresentation equally (see Appendix A.1).

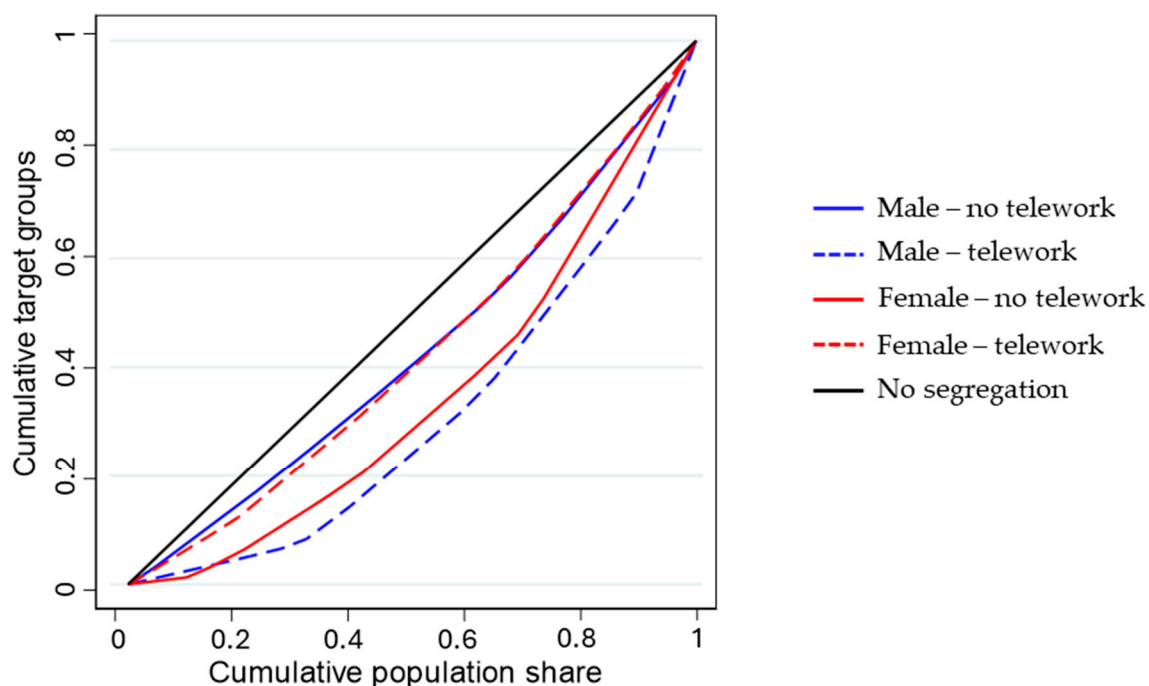


Figure 3. Local segregation curves by gender and teleworking status.

The normalized Mutual Information index $\tilde{M}$ equals 0.09, with male teleworkers contributing most.

4.3. Monetary Gains and Losses Due to Segregation

Segregation measures provide insights as to whether different groups are distributed unevenly across occupations. We now want to dive deeper and explore how segregation is connected to the monetary gains or losses of different groups.

We therefore calculate index Γ following Equation (A4), explained in Appendix A. Table 6 displays the per capita monetary gains and losses due to segregation of each group by gender, urbanization, and telework status. At a European level, men suffer small monetary losses and women experience small monetary gains due to segregation. Regarding segregation by gender and urbanization, the results show that women and men in cities have the highest monetary gains due to segregation. Rural men suffer the biggest monetary loss because of segregation, followed by rural women. When computing index Γ by gender and telework status, we limit the sample to fully teleworkable occupations. Within

these occupations, teleworking men have the biggest monetary gain due to segregation. Teleworking women and non-teleworking men have small monetary gains and women who are not teleworking suffer monetary losses due to segregation.

Table 6. Monetary gains/losses (index Γ) in terms of segregation.

Segregation by Gender		Segregation by Urbanization and Gender			Segregation by Telework Status and Gender	
$\Gamma \times 100^{(*)}$		$\Gamma \times 100^{(*)}$			$\Gamma \times 100^{(*)}$	
Gender		City	Suburbs	Rural Areas	No Telework	Telework
Men	−0.62	5.06	−2.42	−6.98	2.65	10.17
Women	0.71	5.06	−1.1	−4.22	−9.66	0.97

* {eps = 0}.

An overview of monetary gains and losses due to segregation per country is shown in Table A3 in Appendix A. Groups with the biggest monetary losses due to segregation are marked in bold.

4.4. Multivariate Analysis

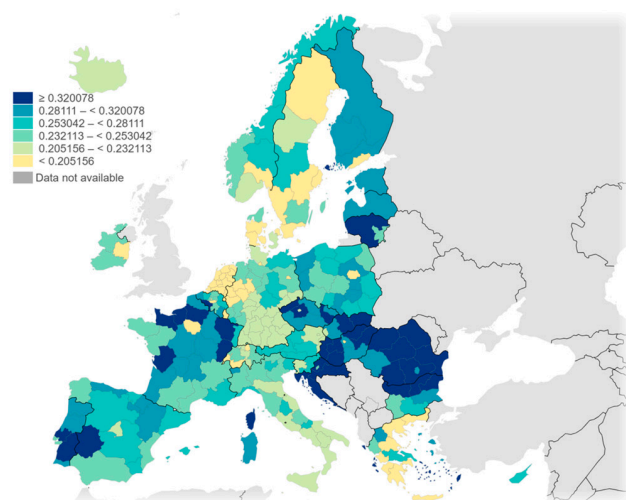
The previous measures provided evidence on segregation between gender, degree of urbanization, and teleworking status at a European level. The extent to which groups are segregated may also be influenced by the characteristics of the local labor market. To explain differences in regional occupational segregation and, especially, to quantify the impact of telework, we run a regression analysis. Therefore, we build the normalized Mutual Information index $\tilde{M}$ following Equation (A3) as explained in Appendix A.1 divided by its maximum, as well as the FGT indices following Equation (A5) (Appendix A.1) by gender and by gender and degree of urbanization for each NUTS-2 region. We calculate the share of hybrid and primarily teleworkers per region as well as the share of people living in rural areas. Further, in Section 4.2, we described control variables covering labor market, human capital, and demographic characteristics per NUTS-2 region.

Figure 4 shows the values for each region of our dependent variables—the normalized Mutual Information index $\tilde{M}$ and the FGT indices by gender and by gender and degree of urbanization—as well as our main explanatory variables: degree of rurality and telework rate. Segregation by gender is highest in regions of Romania, Lithuania, and Croatia, as well as parts of France, Portugal, Hungary, the Czech Republic, and Slovenia. Monetary losses due to gender segregation are biggest in Romania, Cyprus, southern Germany, and parts of Italy and Portugal. The intersection of gender and urbanization shows the highest values of segregation in Greece, Bulgaria, Romania, and parts of Poland, Croatia, France, and Spain. Monetary losses are strongest in Bulgaria, Romania, Poland, Cyprus, and parts of Portugal and Spain.

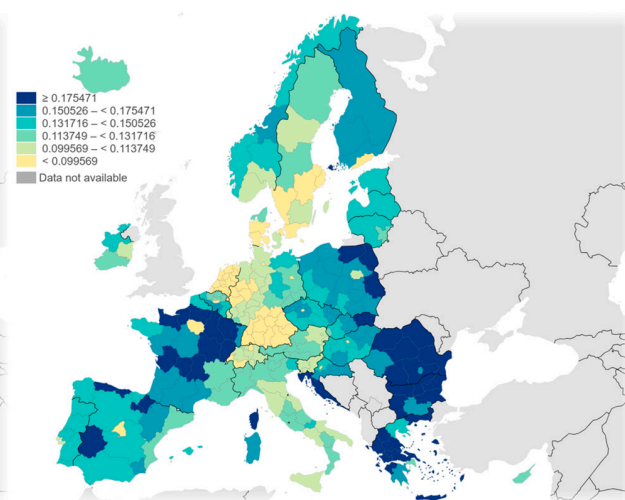
The highest teleworking rates are shown in northern countries like Finland, Sweden, Norway, Iceland; Belgium; The Netherlands; and around Paris. Low teleworking rates are shown in south/southeastern regions in southern Italy, Greece, Bulgaria, Romania, and Slovakia. Rurality shows the highest values in large parts of France and some parts of Poland, Romania, Croatia, Slovenia, and Portugal.

We run separate OLS regressions following Equation (1) using $\tilde{M}$ and FGT indices per region as dependent variables. The results are shown in Table 7.

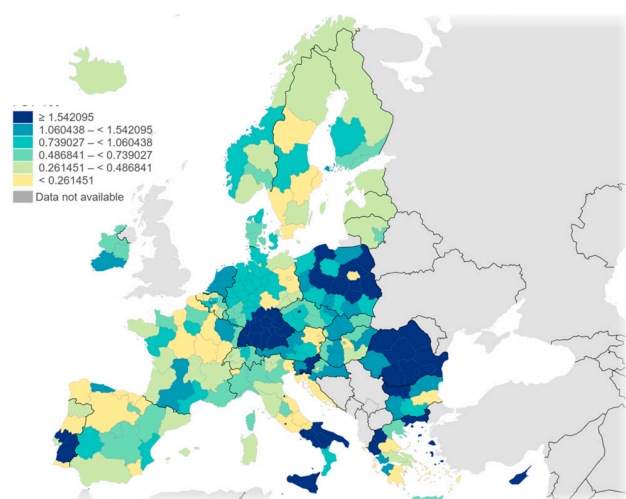
Occupational segregation by gender



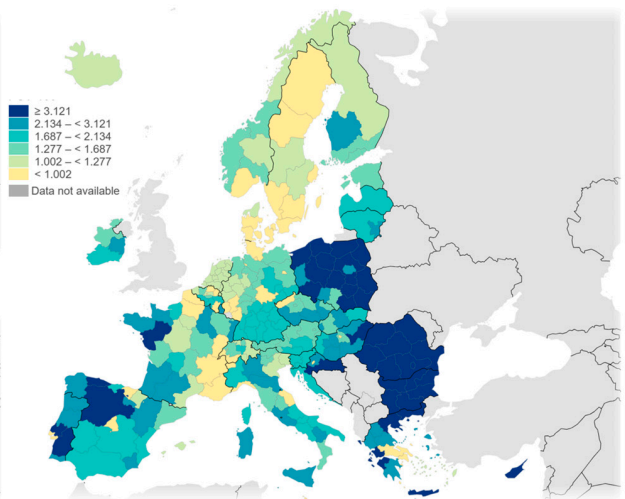
Occupational segregation by gender and urbanization



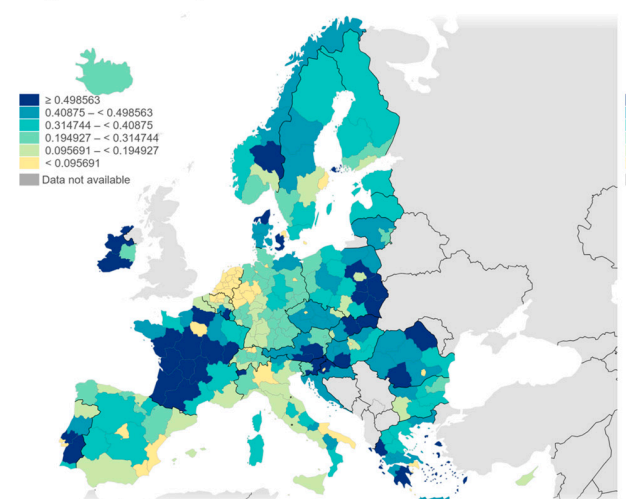
Monetary losses due to segregation by gender



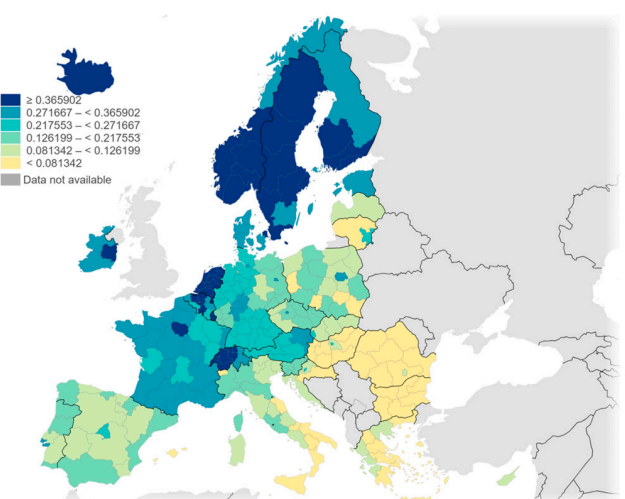
Monetary losses due to segregation by gender and urbanization



Degree of rurality



Telework rate



Verwaltungsgrenzen: © EuroGeographics © Beiträgen zu OpenStreetMap
Kartografie: Eurostat – IMAGE, 06/2

Verwaltungsgrenzen: © EuroGeographics © Beiträgen zu OpenStreetMap
Kartografie: Eurostat – IMAGE, 06/2025

Figure 4. Overall segregation index $\tilde{M}$ by gender and by gender and urbanization, index $FGT \times 100$ of monetary losses due to segregation by gender and by gender and urbanization, degree of rurality, and telework rate for each NUTS-2 region. Source: Own calculations; graphics are made with IMAGE Interactive map generator of Eurostat.

Table 7. OLS regression on segregation index $\tilde{M}$ and FGT by gender and gender and urbanization.

	$\tilde{M}$ (by Gender)		$\tilde{M}$ (by Gender and Urbanization)		FGT (by Gender)		FGT (by Gender and Urbanization)	
Rurality	0.053	***	0.026	*	0.004		0.007	
Share of hybrid telework	0.006		−0.068		0.000		0.052	*
Share of mainly teleworking	−0.426	***	−0.304	***	−0.017		−0.036	
Gender gap working hours	0.003	*	0.004	**	0.001	**	0.001	**
Female employment rate	0.377	**	−0.139		−0.044		−0.030	
Employment rate	−0.214	*	0.194	*	−0.092	***	−0.038	
Information sector	0.005		0.250		0.041		0.023	
Primary sector	−0.833	***	−0.005		0.094	***	0.277	***
Part-time rate	−0.108		−0.109		−0.005		−0.034	
Permanent contract	−0.145	**	−0.079		0.043	***	−0.004	
Gender gap in education	0.062		0.040		0.017		0.017	
Tertiary education rate	−0.395	***	−0.185	***	0.003		0.004	
Child rate	−0.288	**	−0.102		0.016		0.046	
Mean age	0.001		0.003	**	0.000		0.000	
Migration rate	−0.083		0.038		0.007		−0.019	
Country								
BE	0.054	**	0.031		0.001		0.002	
BG	−0.005		0.002		0.008		0.027	***
CY	0.008		−0.046		0.013		0.025	**
CZ	−0.011		−0.018		0.008		0.003	
DE	−0.047	**	−0.044	**	0.007		0.009	
DK	−0.103	***	−0.066	**	0.008		−0.005	
EE	0.060		0.032		0.000		0.006	
EL	−0.069	*	0.000		−0.001		−0.009	
ES	0.027		0.021		0.000		0.003	
FI	0.057	*	0.072	**	0.010	*	0.007	
FR	−0.010		0.030		0.001		−0.004	
HR	0.030		−0.026		0.001		0.000	
HU	−0.003		−0.028		0.003		0.004	
IT	−0.091	***	−0.076	***	0.002		0.001	
LT	0.053		0.025		0.001		0.012	
LU	0.008		−0.007		−0.003		0.013	
LV	0.060		0.022		0.001		0.010	
MT	−0.149	***	−0.084	**	0.000		−0.008	
NL	−0.056		−0.028		0.016	*	−0.005	
NO	−0.023		0.023		0.004		−0.004	
PL	−0.019		−0.015		0.018	**	0.019	**
PT	−0.009		−0.033		0.012	*	0.009	
RO	0.008		0.001		0.014	*	0.032	***
SE	−0.064	*	−0.018		0.004		−0.001	
SI	−0.029		−0.037		0.012		0.002	
Constant	0.680	***	−0.011		0.056	**	0.039	
R ²	0.815		0.501		0.735		0.721	

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

Rurality shows a significant positive coefficient on gender segregation, meaning that the more rural a region is, the more it is segregated by gender. The rurality of a region only has a small effect on how segregated men and women are across degrees of urbanization. Rurality does not affect monetary losses due to segregation.

Regarding telework, the share of people primarily teleworking significantly reduces segregation indices by gender and by gender and urbanization, and the coefficients of primarily teleworking on monetary losses due to segregation are negative but not significant. The share of hybrid teleworkers significantly increases FGT indices for monetary losses due to segregation by gender and urbanization. The coefficient of hybrid telework on the FGT index by gender is zero; on segregation by gender, the coefficient is positive but not significant; and on segregation by gender and urbanization, the coefficient is negative but not statistically significant.

Among the control variables, the gender gap in working hours shows positive significant coefficients when regressed on the segregation and FGT indices, indicating that bigger differences in men's and women's working hours are increasing occupational segregation and connected monetary losses. The part-time rate itself does not have significant effects. Female employment rate increases gender segregation. Higher general employment rates show lower gender segregation and monetary losses due to gender segregation. However, employment rate increases segregation by urbanization and gender. Regarding the sectoral structure, more dominance of the primary sector seems to lower gender segregation, but at the same time, it increases monetary losses due to segregation by gender and by gender and urbanization. The share of workers with a permanent contract shows a significant negative coefficient on gender occupational segregation and a significant positive coefficient for FGT index for gender segregation. Furthermore, a higher share of tertiary education lowers occupational segregation by gender and by gender and urbanization. A higher share of people with children lowers occupational segregation by gender. Mean age shows positive significant coefficients for occupational segregation by urbanization and gender.

Coefficients of countries that are significantly positive and that increase segregation are found for Belgium and Finland; negative coefficients decreasing segregation are significant for Denmark, Germany, Italy, Malta, and Sweden. Countries with positive significant coefficients on monetary losses are Bulgaria, Cyprus, Finland, The Netherlands, Poland, Portugal, and Romania.

5. Discussion and Conclusions

5.1. Segregation in the European Labor Market

This study has examined occupational segregation and inequalities based on gender, space, and telework status across European countries. Several key findings emerge.

First, across Europe, women exhibit higher occupational gender segregation than men. This aligns with the prior literature and reflects persistent structural barriers in labor markets (Alonso-Villar & Del Río, 2010; Bettio & Verashchagina, 2009; Eurofound & European Commission Joint Research Centre, 2021; Olfert & Moebis, 2006).

However, calculations of monetary losses due to segregation, an approach of Del Río and Alonso-Villar (2018) based on occupational average wages, reveal an important nuance: at the European level, men incur higher monetary losses due to segregation, which is especially driven by rural men.

This apparent contradiction—higher measured segregation among women but greater monetary losses among men—can be explained by structural differences in employment. Table 1 and, in more detail, Table A1 illustrate that female workers are overrepresented in relatively well-paying occupations such as professionals, technicians, and clerical support roles, often in the public sector like healthcare and education. These occupations together constitute nearly half of the total workforce. In comparison, the male-dominated occupations of skilled agricultural, forestry, and fishery; craft and trade workers; and plant and machine workers make up another 30% of the workforce and are more concentrated in rural areas. These sectors show lower wages than the before-mentioned occupation with

higher female representation. As a result, segregation “locks in” these mostly rural male workers within declining industries, amplifying their monetary losses.

Thus, while women are more segregated across occupations, their underrepresentation in both high- and low-paying male-dominated jobs means that the segregation “cost” is lower for them than for men in monetary terms under the framework of [Del Río and Alonso-Villar \(2018\)](#). Furthermore, unemployed or inactive women are not included in the wage distribution and, therefore, do not contribute to wage loss estimates.

Furthermore, the multivariate analysis shows that rurality is significantly associated with higher occupational segregation, consistent with the prior literature indicating more gendered labor markets in rural areas ([Mascherini et al., 2023](#); [Olfert & Moebis, 2006](#)).

Our findings suggest that occupational segregation can also disadvantage the less segregated gender group when it coincides with structurally weak labor market segments. To our knowledge, the economic disadvantages of occupational segregation for rural men have received little attention in the European literature to date. Even though studies suggest that there is a wage gap between urban and rural areas and that gender segregation and gender pay gaps in rural areas are stronger than in urban areas ([Brixy et al., 2022](#); [Mascherini et al., 2023](#); [Olfert & Moebis, 2006](#)), none of them draw a complete picture of segregation by gender and urbanization.

From a policy perspective, this highlights that segregation does not only limit women’s opportunities but can also trap rural men in shrinking, low-paying occupations. Addressing this requires policies that go beyond gender equality frameworks: regional development strategies should foster economic diversification in rural areas and provide pathways to retrain into higher-wage sectors. Without such interventions, rural segregation risks reinforcing spatial inequality.

5.2. *The Potential of Telework to Reduce Occupational Segregation*

We also highlight the complex role of telework in shaping occupational segregation of the labor market. Comparing teleworkers and non-teleworkers in fully teleworkable occupations, male teleworkers show the highest wage gains due to segregation, largely because this group is concentrated in well-paying occupations such as management and professional roles (Table 2). By contrast, female teleworkers are more evenly spread across teleworkable occupations. They show levels of segregation similar to non-teleworking men. Non-teleworking women are more narrowly concentrated in clerical support occupations, which supports this interpretation: teleworking women appear to be less occupationally clustered than non-teleworking women, which is a promising sign for the potential of telework to mitigate occupational gender segregation in the long run. However, this potential is not automatic. The fact that male teleworkers remain overrepresented in top-tier roles also indicates that access to high-quality teleworkable positions remains unequal, possibly reinforcing existing hierarchies.

The multivariate analysis shows that the share of primarily teleworking individuals in a region is significantly associated with lower occupational segregation. This suggests that sustained telework arrangements may promote gender and spatial inclusion. Primarily teleworking women and rural residents may be better able to access urban-based or male-dominated occupations, supporting more diverse occupational profiles.

By contrast, the share of hybrid teleworkers shows no significant coefficient on segregation outcomes by gender and by gender and urbanization. Hybrid telework shows a significant positive coefficient for the FGT index for segregation by gender and urbanization. This may come from already privileged groups (urban men) who are strongly represented in management positions and profiting from telework. Increased hybrid teleworking rates could reinforce the gap between privileged and less-privileged groups.

Our results suggest that hybrid telework does not reduce occupational segregation and may even reinforce existing inequalities. This aligns with the existing literature suggesting that hybrid workers often remain tied to urban centers due to segregation and do not profit rural areas (Bond-Smith & McCann, 2022; Frost, 2024; Scott et al., 2007). As hybrid workers typically remain tied to urban centers, rural areas gain little from this form of telework. At the same time, the positive FGT coefficient indicates that hybrid telework disproportionately benefits already advantaged groups—especially urban men in managerial positions. In this sense, hybrid arrangements risk becoming a privilege that consolidates existing hierarchies rather than an instrument of inclusion.

As we are controlling the prevalence of the information sector, which does not have significant coefficients, we conclude that the effects of teleworking derive from the decision to telework itself and not from its nature of being connected to digital work in general.

Further, our findings show that the gender gap in working hours influences segregation. This confirms earlier findings saying that females working part-time are most segregated into feminized jobs and thereby increase segregation (Bettio & Verashchagina, 2009; Del Río & Alonso-Villar, 2010). Here, we see the potential of telework to decrease the gender gap in working hours and thereby decrease segregation.

Overall, telework can support greater gender and spatial inclusion—but only if access to quality telework is made more equitable. Our findings highlight that rural men are among the most segregated workers in Europe. As these workers are concentrated in physically demanding jobs, there might be the risk of being left behind since the shift towards telework mainly benefits those in digital, professional, or managerial roles.

This calls for a coordinated policy agenda. For European policymakers, targeted funding for digital infrastructure in rural regions remains crucial, combined with active labor market policies that promote digital upskilling and reskilling for workers in declining manual sectors. Employers should be encouraged to open high-quality remote positions to underrepresented groups, including rural men and women seeking professional roles. Regional authorities could go further by supporting co-working hubs in small towns, which reduces isolation and provides access to digital jobs.

While primarily remote work holds potential for gender and spatial inclusion, hybrid work requires complementary policies. For example, childcare support, targeted female participation programs, and employer incentives can extend hybrid options beyond managerial roles to prevent them from reinforcing the gap between privileged and less-privileged groups.

5.3. Future Research and Limitations

Our findings have important implications for future research. First, as telework became widespread only in the wake of the COVID-19 pandemic, its long-term effects on occupational structures and gendered labor market outcomes are still unfolding. Structural changes such as family relocation, occupational mobility, or employer adaptation to telework are likely to evolve gradually. Future research should use longitudinal or panel data to track individual-level transitions in occupation, region, and telework status over time, thereby assessing whether telework facilitates lasting reductions in occupational segregation or merely reproduces existing inequalities in new forms.

Second, while most of the existing literature on occupational segregation focuses on women as the disadvantaged group, our findings suggest that rural men may also face substantial economic disadvantages due to segregation. This topic remains largely underexplored, particularly in the European context.

Finally, comparative case studies across countries or regions with differing telework regulations, infrastructure investments, childcare provisions, gender, and employment policies could provide valuable insights into the institutional conditions under which telework reduces (or reinforces) occupational segregation.

Several limitations must be acknowledged. This study relies on occupational wage data at the ISCO 1-digit level to analyze monetary losses due to segregation. This level of aggregation may reduce accuracy since it masks heterogeneity in wages across more detailed two-digit subgroups. Access to ISCO two-digit wage data would allow for a finer distinction between occupations and improve the precision of the analysis. Furthermore, as individuals' wage data are not available, we do not account for differences in wages among groups within the same occupation. Consequently, the measured segregation effects may understate or overstate the actual inequalities. Individual data would give further insight into economic inequalities.

A further limitation is the lack of information on the quality of remote jobs and on workers' motivation to engage in teleworking. Not all telework arrangements provide the same opportunities. Some may be associated with higher autonomy and career prospects, while others may involve routine tasks and fewer promotion opportunities. Similarly, workers' motivations for teleworking, like balancing care responsibilities, avoiding commuting time, or employer-imposed arrangements, can influence both their labor market outcomes and the observed patterns of occupational segregation. Without capturing these dimensions, the analysis may overlook important qualitative differences in how telework impacts inequalities.

Without panel data or instrumental variables, the analysis cannot establish causal effects of telework on segregation outcomes. Additionally, observed changes in occupational segregation may partly reflect broader COVID-related labor market disruptions rather than telework alone.

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Conflicts of Interest: The authors declare no conflicts of interest.

Appendix A

Appendix A.1

This appendix provides the formal definitions and mathematical expressions of the segregation indices used in the analysis.

We chose to measure local segregation in our analysis with the so-called local generalized entropy family Φ_{α}^g , as it provides sensitivity to disequalizing movements depending on α . It accounts for a group's underrepresentation in units for α lower than 1 and for a group's overrepresentation in a unit for α bigger than 1. $\alpha = 1$ treats under- and overrepresentation equally. Φ_{α}^g is calculated following Equation (A1), and in the special case of $\alpha = 1$, it is calculated following Equation (A2). c^g is the vector representing the number of individuals of demographic group g in each unit/occupation j (c_j^g), and t is the vector indicating the

number of individuals in each unit/occupation j (t_j). Parameter α controls the sensitivity to disproportionality and the weighting of underrepresented vs. overrepresented groups.

$$\Phi_{\alpha}^g = \frac{1}{\alpha(\alpha-1)} \sum_j \frac{t_j}{T} \left[\left(\frac{c_j^g/C^g}{t_j/T} \right)^{\alpha} - 1 \right] \quad (A1)$$

$$\Phi_1^g = \sum_j \frac{c_j^g}{C^g} \ln \left(\frac{c_j^g}{t_j/T} \right) \quad (A2)$$

Weighted by group shares, the average of local index Φ_1^g indicates the Mutual Information Index M of overall segregation, proposed by Theil and Finizsa (1971) and Del Río and Alonso-Villar (2022). M , as shown in Equation (A3), is a widely accepted index of segregation that captures the degree of unevenness in the distribution of groups across categories. It is decomposable along the group and unit dimensions.

$$M = \sum_g \frac{C^g}{T} \Phi_1(c^g; t) \quad (A3)$$

M can be expressed as the proportion of the maximum possible occupational segregation by dividing M by its maximum value. This normalized index $\tilde{M}$ is independent of the number of groups g and units j , which enables comparisons across different settings (Mora & Ruiz-Castillo, 2011). The maximum value equals $\log(\min\{J, G\})$.

In addition to the overall M and $\tilde{M}$ values, we report the contribution of each subgroup (e.g., rural women, urban men) to the overall level of segregation (Alonso-Villar & Del Río, 2010).

The local segregation of groups can be visualized in local segregation curves, where no segregation would equal the 45° line. The more segregated a group is, the more it departs from that line (Del Río & Alonso-Villar, 2022). In the case of occupational segregation, the segregation curve shows the cumulative proportion of the target group (for example, rural female workers) on the vertical axis and the cumulative proportion of employment on the horizontal axis after ranking the occupations by increasing ratios of the target group. In the case that segregation curves of different target groups do not cross, one group is more segregated than the others for any local segregation index. If the curves cross, it is necessary to take further local segregation indices into account to derive conclusions.

These segregation measures do not indicate if a group's segregation is connected to monetary (dis)advantages. We therefore include the index Γ , which measures a group's monetary losses or gains resulting from its over- or underrepresentation in occupations, based on occupational wages (Del Río & Alonso-Villar, 2015). The index Γ is based on absolute differences in proportions. It is a dissimilarity index, intuitive and easy to interpret. As shown in Equation (A4), index Γ compares the share of the group in each occupation c_j^g/C^g with the employment share of that occupation t_j/T . This represents the share of the group in case of no segregation. It then adds information on the average wages w_j per occupation, expressed as a proportion of the average wage of occupations $\bar{w}$, to quantify the earning gain or loss a group experiences due to its segregation. In the last step, all the losses and gains of the occupations of a group are summed up. The index Γ can be interpreted as the per capita gain or loss of a group expressed as the percentage of the average wage of the economy.

$$\Gamma = \sum_j \left(\frac{c_j^g}{C^g} - \frac{t_j}{T} \right) \frac{w_j}{\bar{w}} \quad (A4)$$

To measure the welfare loss of a society due to the occupational segregation of its groups, Del Río and Alonso-Villar (2018) adapted the Foster–Greer–Thorbecke (FGT) index, originally coming from poverty research, as displayed in Equation (A5). The parameter $\alpha \geq 0$ represents aversion towards inequality among groups. A higher α gives a larger weight to most disadvantaged groups. If $\alpha = 1$, FGT represents the mean well-being loss of the population. s^* is the number of individuals with well-being loss $\tilde{d}_s > 0$. $\tilde{d}$ is a vector where the group's welfare losses are ranked from high to low, and where well-being loss equals 0 for privileged groups.

$$FGT_{\alpha}(\tilde{d}) = \frac{1}{T} \sum_{s=1}^{s^*} (\tilde{d}_s)^{\alpha} \quad (A5)$$

Appendix A.2

Table A1. ISCO 2-digit occupations and their share of female workers, share of rural population, and share of teleworkers.

Occupation	Proportion of Workforce	Share of Female Workers	Share of Rural Population	Share of Teleworkers
Managers	0.04%	0.28	0.15	0.69
Chief Executives, Senior Officials, and Legislators	0.88%	0.28	0.23	0.47
Administrative and Commercial Managers	1.45%	0.43	0.17	0.57
Production and Specialized Services Managers	1.77%	0.29	0.25	0.43
Hospitality, Retail, and Other Services Managers	1.23%	0.37	0.24	0.27
Professionals	0.09%	0.49	0.07	0.63
Science and Engineering Professionals	3.67%	0.3	0.16	0.51
Health Professionals	3.13%	0.71	0.19	0.19
Teaching Professionals	5.52%	0.73	0.2	0.42
Business and Administration Professionals	4.66%	0.53	0.15	0.59
Information and Communications Technology Professionals	2.50%	0.19	0.12	0.77
Legal, Social, and Cultural Professionals	3.09%	0.61	0.14	0.5
Technicians and Associate Professionals	0.04%	0.43	0.1	0.53
Science and Engineering Associate Professionals	3.54%	0.19	0.28	0.2
Health Associate Professionals	3.07%	0.78	0.23	0.09
Business and Administration Associate Professionals	6.67%	0.55	0.2	0.41
Legal, Social, Cultural, and Related Associate Professionals	1.81%	0.59	0.23	0.25
Information and Communications Technicians	1.02%	0.16	0.14	0.5

Table A1. Cont.

Occupation	Proportion of Workforce	Share of Female Workers	Share of Rural Population	Share of Teleworkers
Clerical support workers	0.03%	0.64	0.12	0.25
General and Keyboard Clerks	4.17%	0.78	0.21	0.25
Customer Service Clerks	1.75%	0.7	0.16	0.22
Numerical and Material Recording Clerks	3.01%	0.48	0.23	0.21
Other Clerical Support Workers	0.79%	0.61	0.23	0.24
Service and Sales Workers	0.03%	0.58	0.03	0.08
Personal Service Workers	4.53%	0.59	0.24	0.08
Sales Workers	6.75%	0.66	0.24	0.07
Personal Care Workers	3.33%	0.88	0.28	0.1
Protective Services Workers	1.55%	0.18	0.24	0.04
Skilled Agricultural, Forestry, and Fishery Workers	0.00%	0.19	0.27	0.18
Market-oriented Skilled Agricultural Workers	2.67%	0.29	0.67	0.21
Market-Oriented Skilled Forestry, Fishery, and Hunting Workers	0.15%	0.07	0.59	0.15
Subsistence Farmers, Fishers, Hunters, and Gatherers	0.01%	0.2	0.89	0.29
Craft and Related Trades Workers	0.04%	0.15	0.15	0.09
Building and Related Trades Workers	3.78%	0.02	0.34	0.07
Metal, Machinery, and Related Trades Workers	3.64%	0.04	0.34	0.04
Handicraft and Printing Workers	0.46%	0.36	0.26	0.13
Electrical and Electronics Trades Workers	1.54%	0.04	0.28	0.09
Food Processing, Woodworking, Garment, and Similar	0.02%	0.41	0.33	0.06
Plant and Machine Operators and Assemblers	0.01%	0.22	0.11	0.02
Stationary Plant and Machine Operators	2.36%	0.33	0.34	0.01
Assemblers	0.83%	0.37	0.34	0.01
Drivers and Mobile Plant Operators	4.17%	0.05	0.33	0.02
Elementary Occupations	0.02%	0.4	0.17	0.06
Cleaners and Helpers	3.23%	0.84	0.22	0.02
Agricultural, Forestry, and Fishery Laborers	0.75%	0.28	0.48	0.04
Labor in Mining, Construction, Manufacturing, Transport	2.60%	0.29	0.29	0.01
Food Preparation Assistants	0.74%	0.66	0.24	0.02
Street and Related Sales and Services Workers	0.05%	0.23	0.16	0.03
Refuse Workers and Other Elementary Workers	0.95%	0.24	0.27	0.03

Note: Color intensity reflects the relative magnitude of values within each column: darker shades correspond to higher values, while lighter shades indicate lower values.

Appendix A.3

Table A2. Overall and local segregation indices by gender, degree of urbanization, and telework status per country.

	Segregation by Gender Φ_1				Segregation by Gender and Urbanization Φ_1						Segregation by Gender and Telework Status Φ_1					
	$\tilde{M}$	Men	Women	$\tilde{M}$	Men			Women			$\tilde{M}$	Men		Women		
					City	Suburb Towns	Rural Areas	City	Suburb Towns	Rural Areas		No Telework	Telework	No Telework	Telework	
AT	0.25	0.13	0.20	0.11	0.12	0.18	0.24	0.25	0.21	0.22	0.10	0.05	0.23	0.17	0.05	
BE	0.23	0.13	0.20	0.10	0.11	0.17	0.23	0.22	0.20	0.24	0.08	0.02	0.16	0.19	0.05	
BG	0.29	0.15	0.23	0.16	0.16	0.21	0.43	0.32	0.26	0.37	-	-	-	-	-	
CH	0.21	0.12	0.17	0.10	0.11	0.14	0.29	0.20	0.19	0.21	0.12	0.03	0.21	0.34	0.04	
CY	0.26	0.15	0.20	0.12	0.15	0.25	0.41	0.21	0.26	0.26	0.14	0.14	0.33	0.16	0.24	
CZ	0.29	0.14	0.25	0.13	0.15	0.15	0.25	0.31	0.27	0.28	0.13	0.09	0.30	0.21	0.11	
DE	0.21	0.12	0.17	0.09	0.09	0.15	0.26	0.19	0.18	0.19	0.10	0.06	0.23	0.20	0.05	
DK	0.17	0.10	0.15	0.09	0.09	0.13	0.25	0.19	0.15	0.18	0.09	0.03	0.14	0.29	0.05	
EE	0.29	0.19	0.22	0.13	0.18	0.25	0.29	0.24	0.28	0.24	0.10	0.15	0.22	0.19	0.06	
EL	0.17	0.08	0.17	0.13	0.16	0.12	0.32	0.27	0.26	0.31	0.08	0.05	0.42	0.05	0.44	
ES	0.25	0.13	0.21	0.12	0.11	0.19	0.38	0.25	0.21	0.22	0.07	0.03	0.27	0.09	0.05	
FI	0.24	0.16	0.19	0.12	0.17	0.20	0.36	0.19	0.26	0.24	0.11	0.08	0.17	0.40	0.04	
FR	0.24	0.15	0.17	0.11	0.12	0.17	0.28	0.20	0.21	0.19	0.12	0.05	0.28	0.26	0.05	
HR	0.32	0.17	0.26	0.16	0.22	0.21	0.32	0.34	0.33	0.31	0.12	0.14	0.53	0.13	0.05	
HU	0.31	0.15	0.24	0.15	0.18	0.18	0.36	0.33	0.26	0.30	0.11	0.13	0.41	0.12	0.10	
IE	0.22	0.11	0.17	0.11	0.15	0.15	0.22	0.20	0.22	0.22	0.11	0.12	0.19	0.32	0.03	
IS	0.22	0.11	0.20	0.13	0.11	0.37	0.36	0.23	0.30	0.30	0.11	0.11	0.15	0.45	0.08	
IT	0.22	0.10	0.22	0.10	0.09	0.13	0.25	0.29	0.21	0.23	0.07	0.04	0.32	0.11	0.04	
LT	0.30	0.18	0.21	0.14	0.17	0.36	0.33	0.26	0.28	0.25	0.08	0.10	0.25	0.11	0.06	
LU	0.19	0.10	0.16	0.11	0.28	0.17	0.16	0.36	0.24	0.21	0.11	0.06	0.19	0.29	0.10	
LV	0.30	0.20	0.21	0.15	0.21	0.21	0.36	0.24	0.27	0.27	0.09	0.12	0.29	0.12	0.11	

Table A2. Cont.

	Segregation by Gender Φ_1				Segregation by Gender and Urbanization Φ_1						$\tilde{M}$	Segregation by Gender and Telework Status Φ_1			
	$\tilde{M}$	Men	Women	$\tilde{M}$	Men			Women				Men		Women	
					City	Suburb Towns	Rural Areas	City	Suburb Towns	Rural Areas		No Telework	Telework	No Telework	Telework
MT	0.10	0.03	0.10	0.05	0.03	0.05	0.27	0.11	0.09	0.27	-	-	-	-	-
NL	0.18	0.11	0.15	0.08	0.09	0.15	0.22	0.14	0.18	0.23	0.12	0.09	0.15	0.56	0.06
NO	0.21	0.12	0.18	0.11	0.15	0.13	0.31	0.21	0.20	0.26	0.09	0.10	0.09	0.49	0.05
PL	0.25	0.14	0.22	0.15	0.17	0.18	0.33	0.33	0.26	0.27	0.10	0.07	0.35	0.12	0.09
PT	0.29	0.16	0.21	0.13	0.16	0.20	0.37	0.25	0.23	0.28	0.13	0.08	0.32	0.17	0.15
RO	0.31	0.15	0.30	0.18	0.27	0.18	0.33	0.50	0.34	0.36	0.06	0.07	0.65	0.06	0.10
SE	0.17	0.09	0.14	0.08	0.09	0.10	0.23	0.16	0.15	0.16	0.07	0.06	0.11	0.31	0.03
SI	0.24	0.13	0.22	0.11	0.15	0.13	0.20	0.29	0.26	0.21	-	-	-	-	-
SK	0.31	0.18	0.25	0.14	0.21	0.17	0.29	0.34	0.27	0.28	0.11	0.15	0.33	0.13	0.08

Note: Group with most segregation is highlighted in bold; no segregation indices of BG, MT, and SI are available for segregation by teleworking status as there are too many occupations without teleworkers.

For segregation by gender, the values of normalized Mutual Information index $\tilde{M}$ are highest for Croatia, followed by Romania, Hungary, and Slovakia. Malta shows the lowest levels of overall segregation. Women are more segregated than men in all countries, but also, men display moderate levels of segregation in most of the countries. Overall, segregation ranges from 0.10 in Malta to 0.32 in Croatia.

Comparing segregation by gender and urbanization, 15 countries (Bulgaria, Cyprus, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Latvia, Norway, Portugal, Spain, Sweden, Switzerland) show the strongest segregation for rural men, and nine countries (Austria, Croatia, Czech Republic, Italy, Luxembourg, Poland, Romania, Slovakia, Slovenia) indicate the strongest segregation for women in cities. Overall segregation ranges from 0.04 in Malta to 0.17 in Romania.

In terms of teleworking status, non-teleworking women are most segregated in 10 countries, mainly western and northern European (Belgium, Denmark, Finland, Iceland, Ireland, Luxembourg, Netherlands, Norway, Sweden, Switzerland). These are countries with relatively high shares of telework. In Greece, teleworking women are most segregated, and in the remaining countries, teleworking men are most segregated. Overall segregation ranges from 0.06 in Romania to 0.13 in Cyprus.

Appendix A.4

Table A3. Monetary gains/losses (index Γ) of groups and society (FGT) due to segregation by gender, degree of urbanization, and telework status per country.

	Monetary Losses/Gains Due to Segregation by Gender Γ^{**}			Monetary Losses/Gains Due to Segregation by Gender and Urbanization Γ^{**}						Monetary Losses/Gains Due to Segregation by Gender and Teleworking Status Γ^{**}					
	FGT *	Men		FGT *	Men			Women			FGT *	Men		Women	
		Men	Women		City	Town/ Sub.	Rural Area	City	Town/ Sub.	Rural Area		No Telework	Telework	No Telework	Telework
AT	0.70	1.33	−1.49	1.63	3.93	2.70	−1.75	3.91	−2.23	−5.14	3.85	5.15	11.57	−11.53	−0.91
BE	0.03	−0.06	0.06	1.06	3.81	−1.82	−1.77	3.12	−1.49	−0.06	4.08	−1.17	13.03	−15.39	−1.87
BG	1.15	−2.17	2.43	5.14	8.60	−6.71	−17.65	11.61	−3.20	−13.66	-	-	-	-	-
CH	0.64	1.20	−1.37	1.57	5.79	0.67	−4.49	3.51	−2.83	−5.20	3.74	0.63	10.25	−15.30	−1.49
CY	1.72	3.38	−3.50	3.96	11.24	−8.51	−11.29	1.19	−10.13	−13.70	7.96	12.45	24.40	−17.71	9.81
CZ	0.83	1.49	−1.88	2.42	10.39	−0.32	−4.13	4.67	−2.87	−6.69	5.00	8.65	12.55	−12.39	−2.29
DE	0.91	1.72	−1.94	1.53	5.60	−0.18	−1.85	2.16	−3.85	−5.87	5.12	9.35	12.63	−14.19	−2.68
DK	0.60	1.13	−1.26	1.10	3.72	0.72	−1.25	1.59	−1.59	−4.41	1.80	0.47	4.69	−8.44	−0.93
EE	0.27	0.54	−0.54	1.51	4.48	−3.34	−2.67	1.98	−3.76	−2.32	1.77	−0.06	6.20	−6.60	0.78
EL	0.71	−1.24	1.63	2.92	5.60	−1.12	−10.12	6.13	3.79	−8.34	2.08	1.78	9.93	−4.30	5.97
ES	0.28	0.52	−0.60	1.97	4.71	−2.90	−7.28	2.51	−3.90	−6.11	3.43	3.02	13.31	−8.35	3.76
FI	0.61	1.19	−1.24	2.46	7.17	−1.29	−5.53	4.01	−5.05	−6.44	2.52	−2.45	6.71	−11.94	−0.85
FR	0.56	1.09	−1.13	1.98	5.98	−0.14	−4.22	2.85	−2.30	−5.60	3.99	2.16	12.75	−14.06	1.26
HR	0.57	−1.08	1.21	3.87	11.17	−2.33	−10.49	10.88	0.16	−8.65	4.41	6.18	18.97	−9.06	2.13
HU	0.52	−0.98	1.11	3.72	12.16	−2.65	−11.95	10.75	−0.76	−7.68	3.53	6.65	11.47	−7.05	3.04
IE	0.91	−1.70	1.94	1.96	4.39	−0.49	−7.02	6.84	−0.41	−1.04	3.09	−3.14	7.93	−12.76	0.86
IS	0.39	0.71	−0.85	1.10	3.08	−6.74	−0.81	0.16	−3.01	−2.47	2.72	−1.38	5.63	−18.01	1.29
IT	0.14	−0.25	0.34	1.82	5.54	−2.00	−6.96	4.79	−1.42	−4.79	4.11	4.28	17.12	−9.75	3.54
LT	0.06	−0.13	0.13	3.28	7.09	−4.39	−7.87	6.22	−5.09	−6.25	2.60	6.92	4.24	−5.16	−2.82
LU	0.73	1.37	−1.57	2.91	15.63	−3.84	−1.16	11.45	−6.76	−3.17	2.54	−0.25	8.29	−11.03	−0.59
LV	0.42	−0.85	0.82	1.93	2.03	−0.08	−3.98	4.84	4.88	−6.08	2.87	7.74	3.10	−5.85	−2.02
MT	0.20	0.35	−0.50	0.45	0.33	0.59	−3.75	−2.00	0.88	−0.89	-	-	-	-	-

Table A3. Cont.

	Monetary Losses/Gains Due to Segregation by Gender Γ^{**}			Monetary Losses/Gains Due to Segregation by Gender and Urbanization Γ^{**}						Monetary Losses/Gains Due to Segregation by Gender and Teleworking Status Γ^{**}					
	FGT *			FGT *	Men			Women			FGT *	Men		Women	
		Men	Women		City	Town/ Sub.	Rural Area	City	Town/ Sub.	Rural Area		No Telework	Telework	No Telework	Telework
NL	1.11	2.10	−2.35	1.26	4.02	0.29	−2.98	−0.18	−4.53	−8.14	3.46	−4.64	7.87	−16.17	−3.14
NO	0.50	0.95	−1.06	1.50	5.67	−0.35	−3.68	2.37	−1.07	−5.50	2.03	−3.22	4.77	−13.38	−0.11
PL	1.40	−2.60	3.02	4.33	8.71	−2.23	−13.77	12.28	3.14	−8.13	3.72	5.51	9.52	−8.19	6.12
PT	0.12	−0.24	0.24	3.67	8.86	−3.69	−13.79	6.95	−2.49	−10.69	6.11	−1.62	17.90	−15.87	11.19
RO	2.47	−4.32	5.76	6.42	12.93	−6.31	−16.89	20.34	2.36	−11.41	1.58	2.16	10.40	−2.84	4.90
SE	0.01	−0.01	0.02	0.93	2.99	−1.03	−2.87	1.88	−0.69	−1.84	1.33	−2.47	3.00	−8.26	0.36
SI	1.33	−2.46	2.90	2.06	6.33	−1.48	−6.71	9.49	3.68	−0.49	-	-	-	-	-
SK	0.80	1.52	−1.70	2.43	12.91	1.76	−3.53	6.65	−2.28	−5.74	4.74	12.47	11.72	−10.10	−0.06

Note: Groups with highest monetary loss are marked in bold. * $\text{FGT} \times 100$, $\alpha = 1$; ** $\Gamma \times 100$, $\varepsilon = 0$.

By gender, 14 countries show higher monetary losses for men and 16 countries show higher monetary losses for women. Men are most disadvantaged in some eastern countries (Romania, Poland, Slovenia, Bulgaria) and Ireland. Women experience most monetary losses in Cyprus, The Netherlands, Germany, the Czech Republic, and Slovakia. The FGT index, indicating the average losses of a society due to segregation, is highest for Romania, Cyprus, Poland, Slovenia, and Bulgaria.

Including the aspect of urbanization, the highest monetary losses are shown for rural men in 14 countries and for rural women in 12 countries. The highest monetary gains are shown for men in cities in twenty-two countries and for women in cities in six countries. The average losses due to segregation by FGT are highest for Romania, Bulgaria, Poland, Cyprus, and Croatia.

Comparing the gains and losses of different groups regarding their telework status, non-teleworking men have the highest gains in Lithuania, Latvia, and Slovakia. In all the other countries, teleworking men have the highest monetary gains. Teleworking women have negative values in 13 countries, mainly northern, western, and central European (Austria, Belgium, the Czech Republic, Denmark, Finland, Germany, Latvia, Lithuania, Luxemburg, Netherlands, Norway, Slovakia, and Switzerland). These are countries where telework is relatively widespread. In the remaining 14 countries, teleworking women show monetary gains due to segregation. These are especially strong in Portugal, Cyprus, Poland, Greece, and Romania, countries where telework has relatively little popularity. In all the countries, non-teleworking women experience the strongest monetary losses due to segregation. The FGT indices are highest for Cyprus, Portugal, Germany, the Czech Republic, and Slovakia.

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