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Which Jobs Are Most Vulnerable to COVID-19?
What an Analysis of the European Union Reveals

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This Research & Policy Brief presents measures of labor market exposure to COVID-19 in the European Union (EU) by identifying jobs in non-essential industries that cannot be performed from home. Jobs most at risk account for 30 percent of all EU employment. These jobs are concentrated in lagging regions; tend to be low paid and less secure; and are disproportionately held by young, poorly educated workers and migrants. In the absence of urgent large-scale remedial action, the COVID-19 crisis is likely to exacerbate preexisting socioeconomic and regional disparities.

Introduction

Implementing policies to counter the economic damage inflicted by the COVID-19 pandemic requires knowing which jobs are most vulnerable. While more than half of all confirmed COVID-19 cases are in Europe (as of April 24), not all countries or regions within the same country are affected to the same extent. This is illustrated by map 1 which shows the number of confirmed cases per 100,000 habitants for each subregion in Europe. Although the final health outcomes are unknown, they will certainly vary substantially by region. Similarly, not all workers suffer to the same extent in terms of labor market outcomes, even though almost all European economies are in lockdowns. Those workers who can work from home and those employed in essential industries that are kept open can continue to earn a living. In contrast, those who have jobs deemed non-essential that cannot be performed from home are facing the most significant job and income losses.

Based on this simple insight, this analysis constructs a new measure of labor market exposure to COVID-19 and assesses which jobs are most at risk, using data from the most recent 2018 European Labour Force Survey (EU LFS). The objective is to help governments with limited resources target their support to the regions, sectors, and occupations that are more severely affected. The analysis demonstrates that, in the absence of urgent large-scale action, the COVID-19 crisis is likely to exacerbate preexisting socioeconomic and regional disparities. Young, less-educated workers who are already in less-secure and low-paying jobs are likely to bear the brunt of the shock, with lagging regions suffering the worst losses.
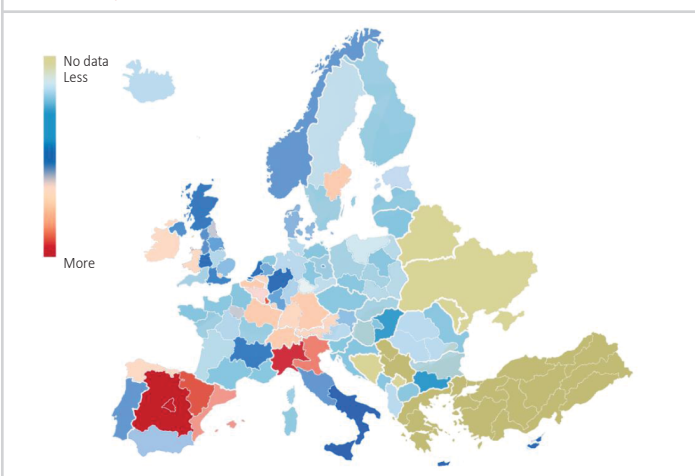
Map 1. Spread of COVID-19 in Europe: Confirmed Cases (per 100,000 habitants)

Source: Observatoire Coronavirus–Le Grand Continent (accessed April 24, 2020).

Essential Jobs

Government-mandated lockdowns establish which jobs or sectors are deemed essential to the functioning of the society and the economy. These administrative decisions are the first set of criteria that this analysis uses to determine the labor market vulnerability of workers. In most countries, for example, doctors, nurses, and other medical professionals delivering critical health care and those in industries providing essential goods and services such as food, water, electricity, and transportation are allowed—and even encouraged—to continue to go to work. While there are significant overlaps on the "essential" lists of different jurisdictions, there is, inevitably, some degree of subjectivity and variation among them. There are even differences across states within the same country, reflecting political, social, and economic priorities at the local level. In the United States, for example, the federal government has issued a list of 16 sectors that can remain open and continue to operate. This list includes sectors such as food and agriculture, health care and public services, and emergency services. In addition, many states, cities, and counties have declared their own states of emergency, ordering non-essential businesses to close. While most local governments follow the federal guidelines, some jurisdictions have produced their own list of essential activities using a detailed classification of industries.

The list of "essential sectors" used in this analysis is based on the decisions of Italy (EU) and the US states of Delaware, Minnesota, and Oklahoma, which have produced lists of which sectors are deemed essential with explicit and highly detailed NAICS (North American Industry Classification System) codes at the 6-digit level (see the reference below table 1). These announcements permit direct mapping of essential sectors allowed to stay open onto economic data that prevent the measures in this study from suffering from interpretative coding error. This study classifies a sector as essential if it was listed as being such in each of the lists issued by Italy, Delaware, Minnesota, and Oklahoma. (The qualitative pattern of results obtained is very robust to using alternative measures, such as only considering a sector as essential if it appears on at least two of the lists.) As such, the measure used here includes only those sectors that appear on all lists and are thus unanimously deemed essential. This measure most closely follows the list of essential sectors issued by Italy, one of the worst affected countries, which has put in place one of the most stringent shutdowns observed to date. Appendix table A1 presents the correlation between the different classifications in different jurisdictions.

A related complication is that some countries have issued lists of sectors that are allowed to stay open provided they follow social distancing practices (such as deliveries only, or in-person attendance only for emergencies). This analysis uses only the regulations on

Table 1. Share of 6-Digit Industries that are Considered Essential, Italy and the U.S. States of Delaware, Minnesota, and Oklahoma

| State/country	Share (percent of total number of 6-digit NAICS)	Restrictions
European Union		
Italy	48.0	507
United States		
Delaware	81.4	860
Minnesota	63.2	668
Oklahoma	78.1	826

Source: For Italy, del Rio-Chanona et al. (2020); for the United States, Delaware Division of Public Health; Minnesota Executive Department; Oklahoma Department of Commerce; and U.S. Cybersecurity and Infrastructure Security Agency.
Note: There are 1057 6-digit North American Industry Classification System (NAICS) codes in total.

strictly essential sectors. Thus, applying this study's measure of essential sectors to other areas will inevitably entail extrapolative error. Given the high correlation across the different lists and the fact that the analysis conservatively includes only those sectors that appear on all lists, this study's measure provides a decent first-order approximation of what sectors are likely to be included in lists of essential sectors issued by other jurisdictions.

The next challenge relates to the classification of industries in the EU LFS dataset. In order to create a harmonized EU-wide dataset, EU LFS provides the sector of each worker only at a relatively aggregated level (the 1-digit Nomenclature of Economic Activities (NACE) category). Therefore, this study uses the classification by 6-digit NAICS codes and maps it to 1-digit NACE industries. The weights for each 6-digit NAICS category within each 1-digit NACE industry are calculated using the detailed US employment data from the 2019 Occupational Employment Statistics (OES) issued by the US Bureau of Labor Statistics. The concordance between these two classifications is quite similar if the weights based on the individual labor force surveys of other EU countries are used. The results are shown in table 2. All the workers in several of the 1-digit categories are considered essential. These categories include utilities (such as electricity, water, and sewerage), as well as public administration, health administration, and transportation.

Map 2. Percent of Jobs Considered Essential, European Union, Norway, and Switzerland, 2018
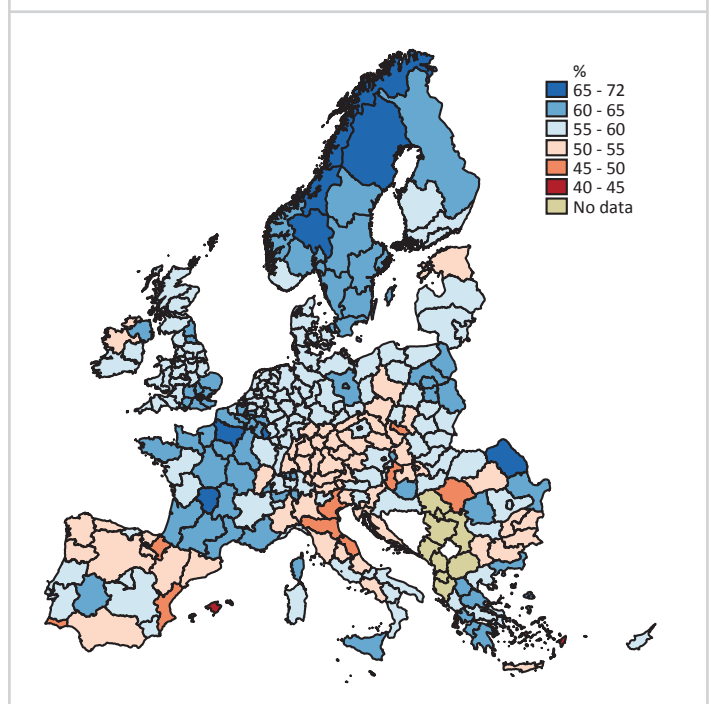
Source: Authors' calculations based on data from Eurostat, European Union Labor Force Survey (2018a).
Note: Data are for 2018.

Once the share of the essential workers in each of the NACE 1-digit sectors is determined, the share of essential workers in each of the statistical regions (Nomenclature of Territorial Units for Statistics [NUTS2] regions) within the European Union (and Norway and Switzerland) can be calculated. These shares are presented in map 2.

More than half of all jobs in the EU (58 percent) are in sectors considered essential. The share of employment in essential industries varies significantly across geographic regions and tends to increase

Table 2. Share of Labor Force Working in Essential Sectors, Italy and the U.S. States of Delaware, Minnesota, and Oklahoma

NACE-1 digit category	Employment in essential sectors (% of workers in the sector)	Sector
A	88.9	Agriculture, Forestry and Fishing
B	26.3	Mining and Quarrying
C	24.2	Manufacturing
D	100.0	Electricity, Gas, Steam and Air Conditioning Supply
E	100.0	Water Supply; Sewerage, Waste Management and Remediation Activities
F	55.7	Construction
G	20.0	Wholesale and Retail Trade; Repair of Motor Vehicles and Motorcycles
H	98.7	Transportation and Storage
I	0.0	Accommodation and Food Service Activities
J	69.4	Information and Communication
K	99.8	Financial and Insurance Activities
L	0.0	Real Estate Activities
M	80.5	Professional, Scientific and Technical Activities
N	11.8	Administrative and Support Service Activities
O	100.0	Public Administration and Defense; Compulsory Social Security
P	100.0	Education
Q	100.0	Human Health and Social Work Activities
R	0.0	Arts, Entertainment and Recreation
S	11.3	Other Service Activities
T	--	Activities of Households as Employers and for Own Use
U	--	Activities of Extraterritorial Organizations and Bodies

Source: Authors' calculations based on del Rio-Chanona et al. (2020) for Italy, and Delaware Division of Public Health; Minnesota Executive Department; and Oklahoma Department of Commerce; U.S. Bureau of Labor Statistics; and U.S. Cybersecurity and Infrastructure Security Agency for the United States.
Note: There are no concordances with 6-digit North American Industry Classification System (NAICS) for the last two Nomenclature of Economic Activities (NACE) sectors (T and U).

with income. (Darker blue means the share of essential workers among all workers is higher in that region.) The share is higher in Belgium, France, Luxembourg, the Netherlands, and the Scandinavian countries, and much lower in Southern European countries such as Italy and Spain. Furthermore, there is substantial variation within countries.

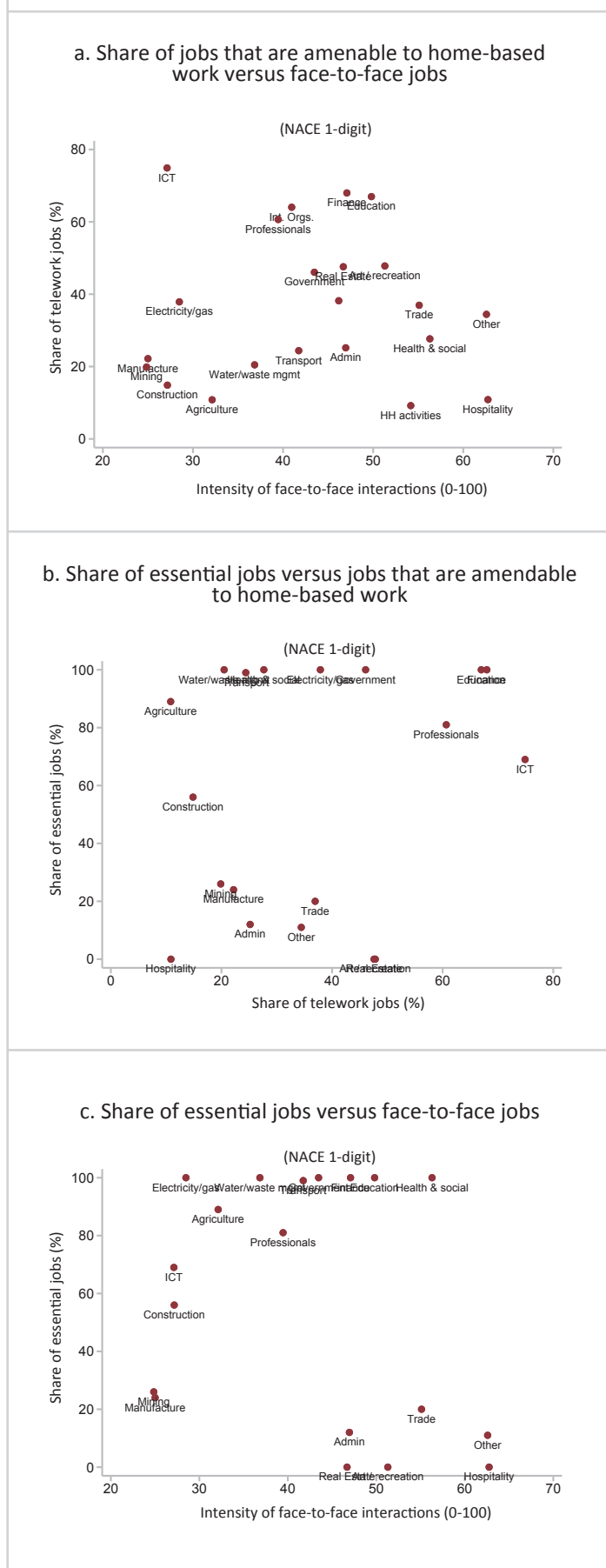## Home-Based Work and Face-to-Face Jobs

The second measure of exposure to vulnerability is based on the nature of the jobs themselves, as opposed to government mandates. Two different criteria are used in the literature. The first is the feasibility of home-based work. Dingel and Neiman (2020) use information from characteristics of more than 900 occupations based on two surveys from the US Department of Labor, Employment and Training Administration's Occupational Information Network (O*NET). When answers to those surveys reveal that an occupation requires daily "work outdoors" or that "operating vehicles, mechanized devices, or equipment is very important to that occupation's performance," they determine that the occupation cannot be performed entirely from home.   This study translates those occupations, based on the Standard Occupational Classification (SOC) system used in the United States, to the occupation classifications system used in Europe (the International Standard Classification of Occupations, ISCO-08) at the 3-digit level of granularity.

A second and related measure is based on the extent of face-to-face interactions in various occupations (Avdiu and Nayyar 2020; Blinder 2006). Blinder originally constructed his measure to determine whether an occupation could be moved offshore. He argues that those occupations that require face-to-face interaction with the consumer (such as retail, health care, or education services) or require inputs specific to a location (such as construction or agriculture) are not offshorable. This study modifies these categorizations to focus only on those occupations that require face-to-face interaction. Using the same rationale, Avdiu and Nayyar (2020) create an index of face-to-face interaction that varies from 0 to 1.

Different factors determine the amount of face-to-face interaction required in different jobs. Tasks that involve (1) establishing and maintaining personal relationships; (2) assisting and caring for others; (3) performing for or working directly with the public; and/or (4) selling to or influencing others typically require more extensive personal interaction. Consequently, these jobs are more susceptible to COVID-19–induced labor market disruptions, social distancing, and other similar behavioral changes. The feasibility of home-based work is correlated with the extent of face-to-face interaction required, as is shown in figure 1. Information, communication, and technology (ICT) and professional and scientific jobs can more easily be provided from home and require little face-to-face interaction. On the other hand, hospitality, food services, and health and social services are not amenable to home-based work and require extensive face-to-face interactions. However, in certain industries, the two measures diverge. For example, the majority of manufacturing jobs require physical presence in the place of work but do not demand extensive face-to-face interaction between workers or workers and consumers. Conversely, education services are amenable to home-based work, but they still require significant face-to-face interactions. Whether they can be performed remotely depends on technology, training of the service providers as well as willingness of students.

The relationships between how essential a sector is and the extent of home-based work, as well as face-to-face interactions, are presented in panels b and c of figure 1, respectively. Since governments (not markets) determine whether a sector is essential by decree, sectors tend to be at the extremes—they are either essential or not. In contrast, variation in the extent of home-based work or face-to-face interactions across sectors is less extreme. As can be seen in different

Figure 1. Home-Based Work versus Face-to-Face Interactions for Various Sectors

a. Share of jobs that are amenable to home-based work versus face-to-face jobs

b. Share of essential jobs versus jobs that are amendable to home-based work

c. Share of essential jobs versus face-to-face jobs

Source: Authors' calculations based on data from Eurostat, European Union Labor Force Survey (2018a).
Note: Data are for 2018. All data are at the Nomenclature of Economic Activities (NACE) 1-digit level. HH = household; ICT = information and communications technology.

Map 3. Home-Based Work and Face-to-face Interactions, European Union, Norway, and Switzerland, 2018

a. Percent of jobs that are amenable to home-based telework
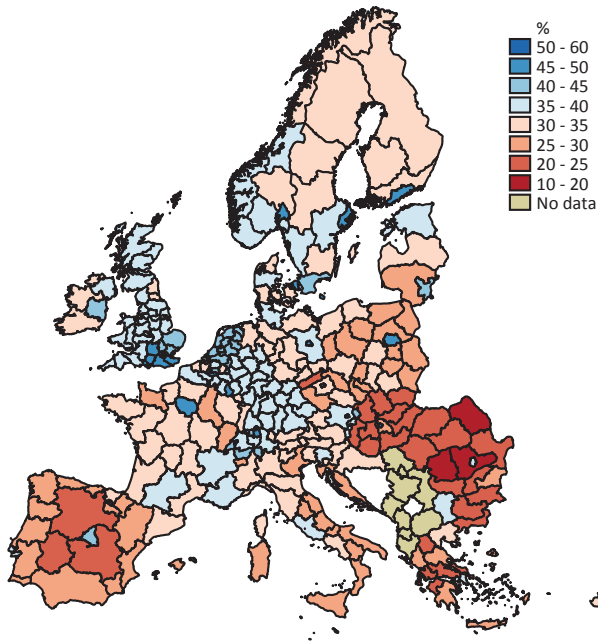
b. Intensity of face-to-face jobs (index 0-100)
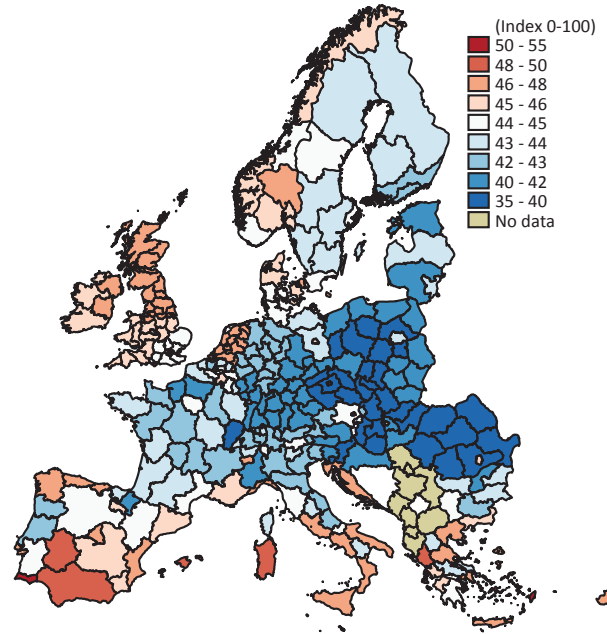
Source: For panel a, authors' calculations based on data from Eurostat, European Union Labor Force Survey (2018a) and Dingel and Neiman (2020) methodology.
For panel b, authors' calculations based on data from Eurostat, European Union Labor Force Survey (2018a) and Avdiu and Nayyar (2020) methodology.
Note: Data are for 2018.

panels of figure 1, the measure of which sectors are essential is only weakly correlated with home-based work and face-to-face interaction. This in turn implies that merely relying on whether a sector can be performed from home and/or requires face-to-face interaction will provide only a very partial picture of what jobs are at risk because of COVID-19.

In the EU, 35 percent of all jobs can be done at home (this share is very similar to Dingel and Neiman's (2020) finding that 37 percent of US jobs can be performed at home). Jobs in the ICT, finance, and education sectors are highly amenable to working from home. On the other hand, jobs in agriculture and hospitality (hotels, restaurants, bars) are less amenable to home-based work. The feasibility of

Map 4. Jobs Most at Risk, European Union, Norway, and Switzerland

a. Percent of jobs non-essential and not amenable to telework
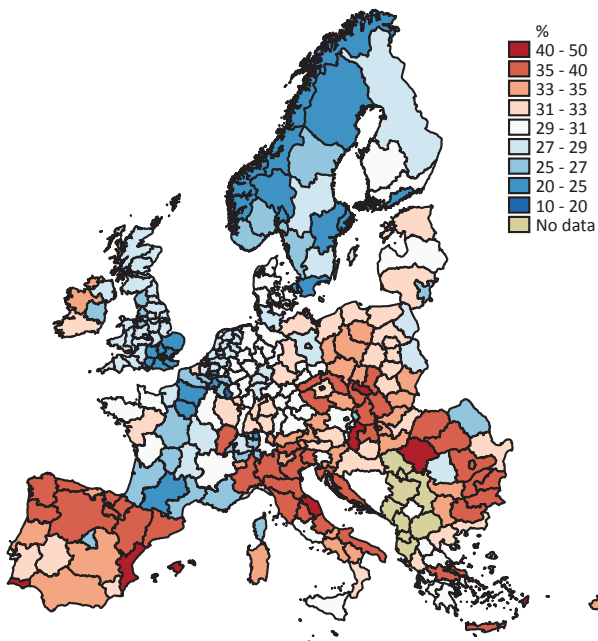
b. Percent of jobs non-essential and with extensive face-to-face interactions
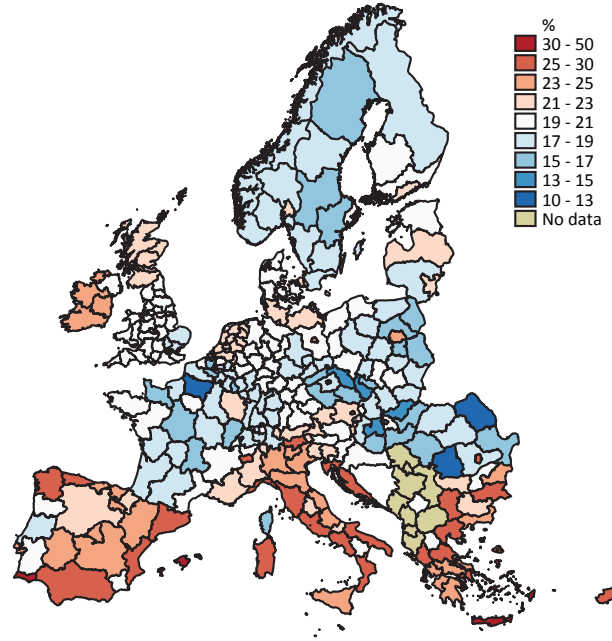
Source: Authors' calculations based on data from Eurostat, European Union Labor Force Survey (2018a).
Note: Data are for 2018.

home-based work increases with income. Richer and typically Northern European countries such as Denmark, the Netherlands, Norway, Sweden, and Switzerland are characterized by a greater prevalence of work that can be done from home, whereas the poorer Southern European countries and the new member states typically have relatively fewer jobs that can be done from home, as shown in map 3, panel a.

The prevalence of jobs requiring little face-to-face interaction is not necessarily correlated with income. In fact, it is highest in Central European countries such as Czech Republic, Hungary, and the Slovak Republic, due to a higher share of manufacturing jobs, as seen in map 3, panel b.

The next step is to combine the sectors deemed essential on the governments' lists with these two criteria, which are based on the economic nature of different jobs. Combining these measures helps identify which jobs are most at risk because of the pandemic and related remedial measures such as social distancing, decline in travel, and mandatory lockdowns. Panel a in map 4 presents the share of jobs that cannot be performed from home in non-essential industries in each statistical (NUTS2) region in the European Union. On average, such jobs account for 30 percent of all employment in the EU. The ratio is higher in Southern and Eastern Europe. It is between one-third to half of all jobs in large parts of Southern Europe (Greece, Italy, Portugal and Spain) and Eastern Europe (Czech Republic, Hungary, Romania and Slovak Republic). In contrast, the share of vulnerable jobs is significantly lower in Scandinavia, France, Germany, and the United Kingdom.

Next, the study combines the non-essential criteria with the requirement for extensive face-to-face interactions. Jobs are considered to be extensive face-to-face jobs if they require more face-to-face interactions than the average occupation. The results are presented in panel b of map 4. While the share of the vulnerable jobs is lower in this case, the overall pattern is qualitatively similar. The main exception is that Central and Eastern European countries are now less exposed because a larger share of their jobs are in the manufacturing sector. These jobs are not easily amenable to home-based telework arrangements, but they do not require extensive face-to-face interactions, either. In other words, factories can weather social distancing requirements more easily (assuming they are considered essential) when compared to many services. This can be a saving grace for Eastern European countries in this crisis.
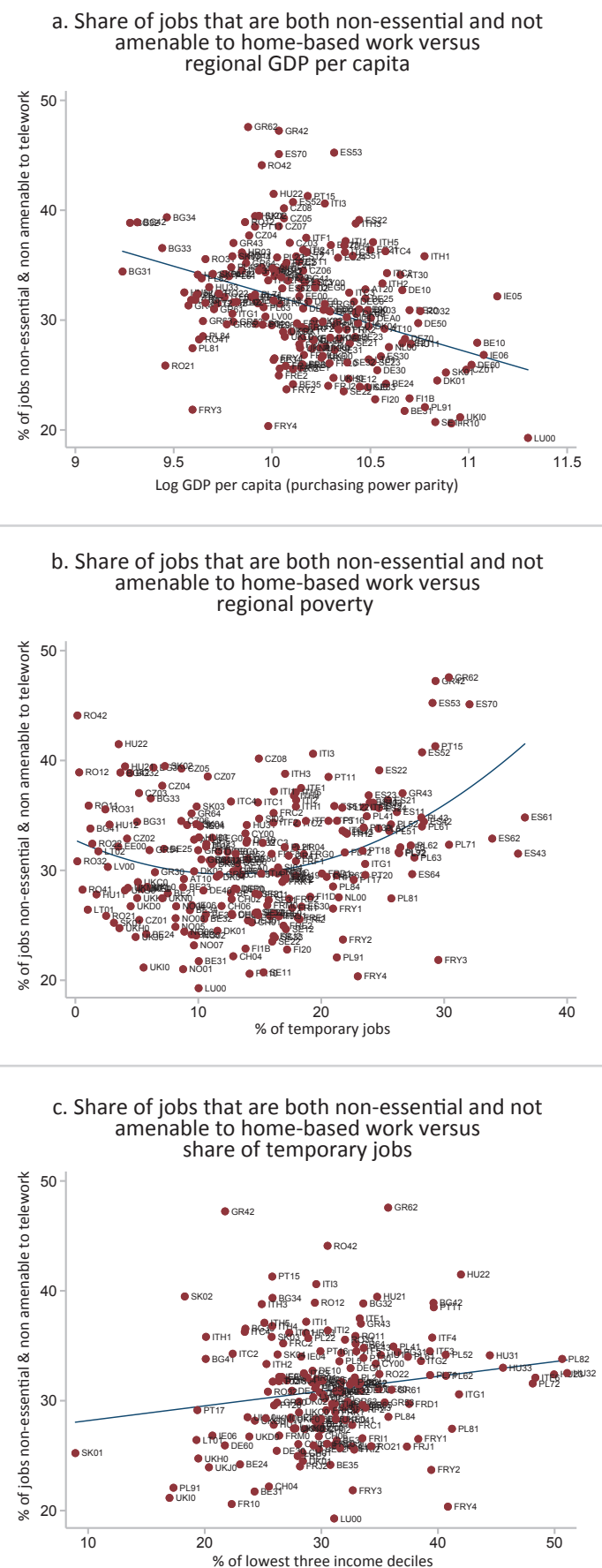
Regional Income Levels and Labor Market Vulnerability

The preceding maps point to a disturbing pattern: European regions that are already economically disadvantaged are also likely to be tormented by the greatest labor market pain inflicted by COVID-19. The share of jobs that are susceptible to losses due to COVID-19 is strongly negatively correlated with regional GDP per capita. Panel a of figure 2 plots every NUTS2 region based on the share of jobs that are both non-essential and not amenable to home-based work versus (log) GDP per capita. A 10 percent increase in regional GDP per capita is associated with a 0.5 percentage point reduction in jobs at risk.

This association between the share of vulnerable jobs and income levels also holds within countries. Panel b of figure 2 plots the share of jobs at risk against regional poverty, proxied as the share of workers in the bottom three deciles of the national earnings distribution. Clearly, poorer regions have more jobs at risk. This mean the COVID-19 crisis will likely exacerbate preexisting regional disparities.
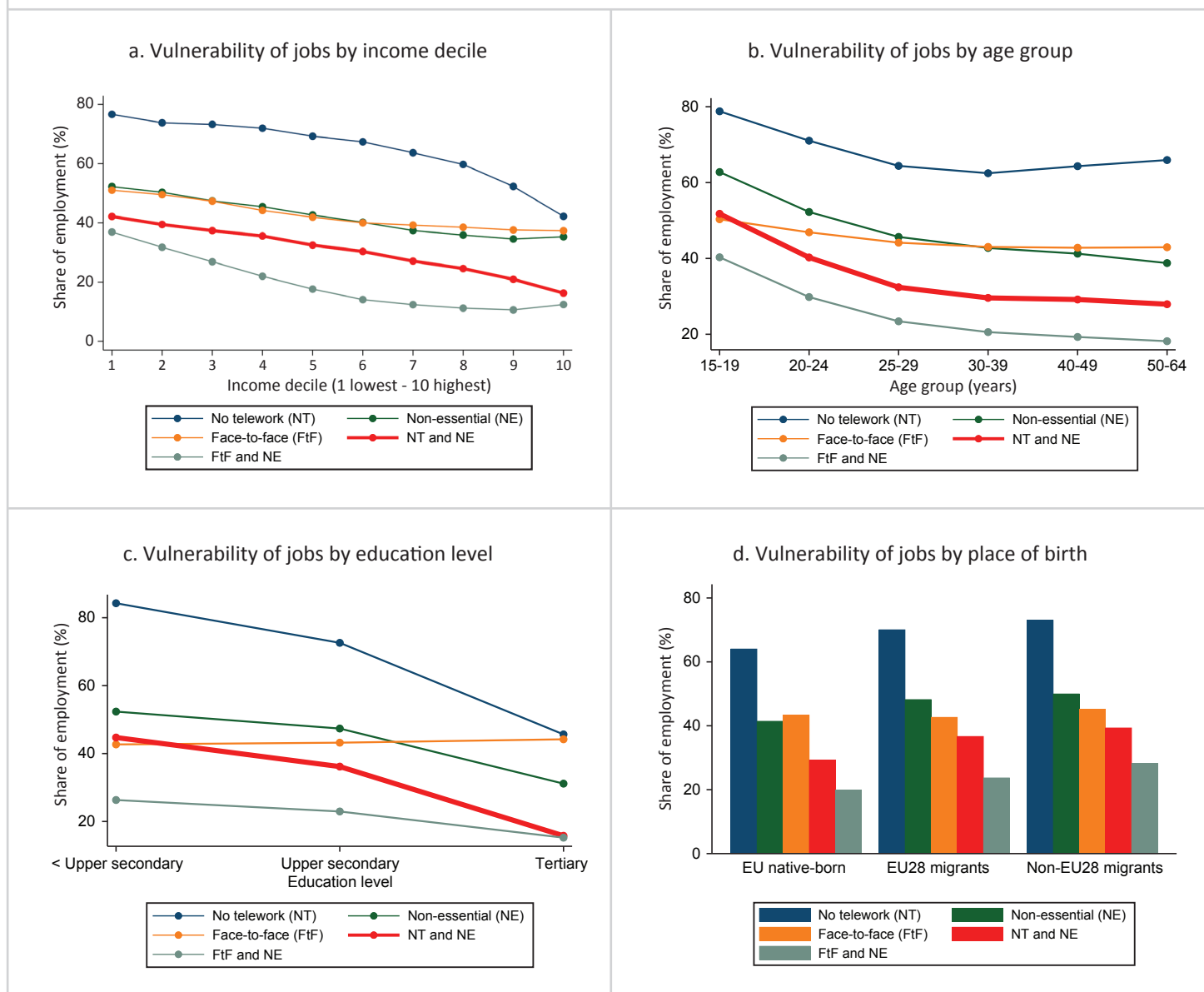
Regions most susceptible to labor market pain are the ones in which jobs already tend to be more precarious and less protected. Panel c of figure 2 documents a positive association between the share of jobs at risk and the share of temporary workers, who can be

Figure 2. Job Exposure versus Regional Development

a. Share of jobs that are both non-essential and not amenable to home-based work versus regional GDP per capita

b. Share of jobs that are both non-essential and not amenable to home-based work versus regional poverty

c. Share of jobs that are both non-essential and not amenable to home-based work versus share of temporary jobs

Source: For panel a, authors' calculations based on data from Eurostat, European Union Labor Force Survey (2018a) and National account (2018b). For panel b and c, authors' calculations based on data from Eurostat, European Union Labor Force Survey (2018a).
Note: Data are for 2018.

Figure 3. Vulnerability by Socioeconomic Status

a. Vulnerability of jobs by income decile

b. Vulnerability of jobs by age group

c. Vulnerability of jobs by education level

d. Vulnerability of jobs by place of birth

Source: Authors' calculations based on data from Eurostat, European Union Labor Force Survey (2018a).
Note: Data are for 2018.

more easily fired than workers with permanent contracts. Vulnerability to COVID-19 has induced further vulnerability in employment.

Income Distribution and Labor Market Vulnerability

This section investigates which workers are most at risk. The EU LFS reports the income decile of each wage earner in his/her respective country, so poverty comparisons can be performed. Appendix table A2 reports labor market vulnerability by European country.

Figure 3, panel a shows that workers with the lowest pay suffer the highest vulnerability. The share of workers who cannot work from home, are working in non-essential sectors, and/or are working in jobs requiring extensive face-to-face interaction all sharply decline with income. Workers in the bottom decile are more than twice as likely to be at risk than those in the top income bracket because 42 percent of all workers in the bottom earning decile are employed in jobs in non-essential industries that cannot be performed at home, whereas such jobs account for only 16 percent of employment among workers in the top income decile. Perhaps not surprisingly, the probability of being employed in a job that cannot be done from home and is non-essential is significantly larger for workers with low education

levels, as is shown in panel b of figure 3. Unlike the health risks of COVID-19, which are concentrated among the elderly and increase steeply with age, the economic risks are concentrated among the young, and decline with age, as shown in panel c of figure 3. Migrants, especially those from non-EU countries, are also more likely to be employed in risky occupations that are most exposed to COVID-19–induced job losses, as shown in panel d of figure 3.

Conclusion and Policy Recommendations

In high income European countries, COVID-19–induced labor market pain is disproportionately borne by young and poorly educated workers. These workers are already employed in low-paying jobs, live in regions that are already lagging and are subject to a greater prevalence of temporary employment contracts. The COVID-19 crisis is bound to exacerbate inequality, both within and across countries, unless dramatic remedial action is undertaken immediately.

While the insights and patterns presented in this analysis are based on the data from the European Union (EU) countries (plus Switzerland and Norway), the patterns are likely to be similar in other high-income countries such as the United States, Canada, Australia, Japan or Singapore. In contrast, labor market shocks are likely to be

different, possibly more severe in lower-income countries. There are various reasons for this conjecture. We observe lower penetration of high-speed internet services and other technologies needed to perform work at home. A larger share of the workers is employed in lower-paying, informal (face-to-face) jobs. Even manufacturing jobs, which are considered not to require face-to-face interaction in Europe, might be performed in more crowded factories. As a result, mobility restrictions like the ones imposed by many non-OECD countries, will have more severe impacts on low skilled and poorer workers.

These factors need to be considered when policy responses are designed in both high-income and developing countries. Fiscal stimulus packages can specifically target regions, sectors or occupations that specifically suffer from these labor market disturbances. Similarly, targeted cash transfer programs and social safety nets (in response to COVID-19 induced shocks) need to be designed with job vulnerability considerations in mind. Finally, in the long run, job vulnerability needs to be an explicit consideration of education and labor market policies.

Appendix. Supporting Data

Table A1. Correlation between Classifications of Essential Sectors

Jurisdiction	Consolidated	Oklahoma	Minnesota	Delaware
Oklahoma, USA	0.2060*			
Minnesota, USA	0.6457*	0.1423*		
Delaware, USA	0.1389*	0.4053*	0.2594*	
Italy	0.8813*	0.1870*	0.4735	0.1288*

Source: Author's calculations based on del Rio-Chanona et al. (2020) for Italy; and Delaware Division of Public Health; Minnesota Executive Department; and Oklahoma Department of Commerce U.S. Bureau of Labor Statistics; del Rio-Chanona (2020); U.S. Cybersecurity and Infrastructure Security Agency for the United States.
Note: Only "strict" measures of essential sectors are used for this table (all the jurisdictions deem these sectors to be essential). Correlations are calculated for the binary indicators.
* $p < 0.05$.

Table A2. Labor Market Vulnerability by European Country

Percent of total employment

Country	Not home-based jobs	Non-essential jobs	Face-to-face jobs	Not home-based and non-essential jobs	Face-to-face and non-essential jobs
Austria	66	44	43	32	19
Belgium	63	39	44	27	17
Bulgaria	72	47	43	37	21
Croatia	69	44	43	33	20
Cyprus	66	44	47	33	23
Czech Rep.	70	47	38	35	17
Denmark	62	40	46	28	18
Estonia	64	46	40	32	18
Finland	62	40	43	27	17
France	63	38	43	26	16
Germany	63	43	42	30	18
Greece	69	42	47	32	22
Hungary	71	44	40	34	17
Ireland	64	43	46	30	21
Italy	69	47	44	35	21
Latvia	67	42	44	30	19
Lithuania	66	43	42	30	18
Luxemburg	51	29	44	19	14
Netherlands	60	40	46	28	19
Norway	62	37	46	24	16
Poland	68	43	40	32	18
Portugal	69	45	44	34	20
Romania	77	42	39	33	17
Slovak Rep.	74	44	40	35	17
Slovenia	65	45	41	33	18
Spain	70	47	47	35	23
Sweden	60	37	44	24	16
Switzerland	60	40	43	26	17
United Kingdom	59	40	46	26	18

Source: Authors' calculations based on data from Eurostat, European Union Labor Force Survey (2018a).
Note: Data are for 2018.

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