European countries’ vulnerability to COVID-19: multicriteria decision-making techniques

Luisa Marti & Rosa Puertas

To cite this article: Luisa Marti & Rosa Puertas (2021) European countries’ vulnerability to COVID-19: multicriteria decision-making techniques, Economic Research-Ekonomska Istraživanja, 34:1, 3309-3320, DOI: 10.1080/1331677X.2021.1874462

To link to this article: https://doi.org/10.1080/1331677X.2021.1874462

© 2021 The Author(s). Published by Informa UK Limited, trading as Taylor & Francis Group.

Published online: 22 Feb 2021.

Submit your article to this journal

Article views: 2300

View related articles

View Crossmark data

Citing articles: 10 View citing articles
European countries’ vulnerability to COVID-19: multicriteria decision-making techniques

Luisa Marti and Rosa Puertas

Group of International Economics and Development, Universitat Politècnica de València, Valencia, Spain

ABSTRACT
COVID-19 has triggered an unprecedented health crisis, crippling economic activity around the world. The aim of this paper is to analyse European countries’ vulnerability to the associated consequences. The analysis will focus on three areas that a priori are expected to be most severely affected by the pandemic – health, society and work – examining the possible relationship with countries’ wealth. The multicriteria decision-making Technique for Order Preference by Similarity to the Ideal Solution (TOPSIS) will be used to generate a ranking of countries based on criteria that define each of these three areas. The findings will provide authorities with quantitative information to guide their aid policies. The results show that Eastern European countries should direct their resources towards addressing health-related and social issues. Conversely, those that have higher GDP per capita and that have been hardest hit by coronavirus will have to make changes to their labour systems in order to minimize the fallout.

1. Introduction
In the current global health crisis, the need to contain the spread of COVID-19 is forcing governments of all countries to take action, with a devastating impact on economic activity (Valle, 2020). From late March 2020, the evolution of the pandemic in different territories began to visibly differ, with Europe being the hardest hit continent in terms of deaths (27,953) and confirmed cases (437,674), followed by Asia and North America (Appendix Table A1). Faced with this situation, European Union (EU) member states are implementing policies to shore up liquidity and increase the capacity of their healthcare systems, providing assistance to the most severely affected citizens and sectors. In addition, the European Central Bank has approved the launch of an emergency programme to combat the effects of the coronavirus pandemic, with a fund of 750 billion euros to purchase private and public sector securities. This purchase programme will be in effect until the end of 2020. Moreover, the European
Commission has put together a 25 billion euro investment fund and has agreed to a more relaxed policy on budget rules to encourage public spending and the provision of support to affected businesses by their corresponding government (Nicola et al., 2020).

Numerous studies have emerged on the economic implications of the need to contain the spread of the disease; in just six months a broad literature on the subject has become available (Baker et al., 2020; Guerreri et al., 2020; Jorda et al., 2020; Maliszewska et al., 2020; McKibbin & Fernando, 2020; OECD, 2020; Orlik et al., 2020, among others). Authors such as Noy et al. (2020) concluded that most of the economic risks from COVID-19 occur in countries and regions that do not get much global attention in this pandemic – Sub-Saharan Africa, South Asia, and Central Asia. However, as 2020 comes to an end, it has been observed from European Centre for Disease Prevention and Control that the rapid spread of the virus is calling into question the measures taken by the most developed Western countries, where the second wave could surpass the devastating figures of the first.

Some studies have compared the effects of COVID-19 in different European countries. For example, Horobet et al. (2020) matched COVID-19 comorbidities with causes of death in 28 EU countries for the total population, concluding that the heat maps of EU populations’ vulnerability to diseases based on mortality indicators constitute the basis for more targeted health policy strategies in a collaborative effort at the EU level. In the same context, Kashnitsky and Aburto (2020) showed the contribution of regional differences in population age structures to the magnitude of the pandemic. Using the INFORM index for risk management developed by the European Commission, Wong et al. (2020) concluded that reducing vulnerability and enhancing capacity to cope could potentially mitigate the impact of the COVID-19 pandemic.

The concept of “vulnerability” was introduced in the early 1990s in the study of the impact of natural disasters on populations, as a test of society’s ability to make vulnerable populations resilient when disaster strikes (Horobet et al., 2020). Drake et al. (2012) argued that the vulnerability to infectious disease outbreaks is much higher in low- and middle-income countries, especially the vulnerability to mortality and morbidity risk. Cartaxo et al. (2020) compared official indicators to identify which vulnerabilities were the main determinants of the exposure risk to COVID-19 in the most and least affected countries around the world. They concluded that the highest-risk group included the US, Brazil, and India.

Against this backdrop, the aim of this paper is to identify which European countries are most vulnerable to the COVID-19 health crisis from the point of view of society, work and health. An understanding of the levels of vulnerability to COVID-19 is crucial in order to tackle its consequences and establish the most appropriate policies to soften the blow to the economy. Codagnone et al. (2020) argued that economic vulnerability is associated with a strong risk of stress and worsening mental health. They estimated that around 42.8% of the population of Italy, Spain and The United Kingdom is at risk because of the negative shocks and conditions of economic vulnerability in developed countries. Thus, focusing the analysis on European countries, this research aims to test the following hypotheses:
H1: There is a correspondence between the virulence of COVID-19 and the wealth of European countries.

H2: Countries’ vulnerability in the social, work, and health spheres affects their capacity to cope with the spread of the virus.

H3: European countries reach the same level of vulnerability in the social, labour and health spheres.

To that end, a ranking is produced for each of these three areas using the multicriteria decision-making method, Technique for Order Preference by Similarity to the Ideal Solution (TOPSIS), and comparing countries’ vulnerability to the virus with their level of wealth. An economic crisis of unprecedented scale is anticipated due to the lockdown measures implemented by authorities. An analysis of the 2018 levels of labour market insecurity, poverty and health funding make it possible to identify the most economically dependent countries and, therefore, those in greatest need of public aid. The results will enable national and international agencies to target funds towards alleviating the consequences of this pandemic.

The rest of the paper is structured as follows. Section 2 presents the methodology used in the research and the sample database. Section 3 details the results of the empirical analysis. Lastly, Section 4 explains the main findings.

2. Methodology and sample

This research uses a multicriteria decision-making technique to produce a ranking of countries based on their vulnerability to COVID-19 in both health and economic terms. Multicriteria decision-making (MCDM) methods have become established as an ideal tool for gaining a better understanding of decision-making processes, facilitating the comparison between alternatives. These techniques have been used to solve area problems such as energy, environment, sustainability, management or even well-being (Balesentitis et al., 2011; Hu et al., 2020; Kaynak et al., 2017; Mandić et al., 2017; Mardani et al., 2015) According to Triantaphyllou (2010), the central problem lies in evaluating a set of alternatives in terms of multiple criteria. MCDM has proved extremely useful for solving decision-making problems by ranking the different alternatives. As a case in point, Majumder et al. (2020) use the TOPSIS method to select the most significant risk factor and for the continuous monitoring of death due to COVID-19, while Shrestha et al. (2020) have used it to calculate a pandemic vulnerability index, creating a quantitative measure of potential global health.

TOPSIS was first proposed by Hwang and Yoon (1981). This method is based on the concept that the chosen alternative should have the shortest geometric distance from the positive ideal solution and the longest geometric distance from the negative ideal solution. An assumption of TOPSIS is that the criteria are monotonically increasing or decreasing. This method consists of seven consecutive stages, which are summarized in the following diagram (Figure 1) (Karabiyik & Kutlu, 2018).

A higher value of relative closeness indicates higher preference order, meaning the alternative in question is preferred (Lin et al., 2008; Lourenzutti & Krohling, 2016). The TOPSIS method offers two main advantages: its mathematical simplicity and substantial flexibility in the definition of the choice set. However, one drawback of
TOPSIS is the so-called inverse order problem: that is, the ranking of the alternatives is very sensitive to the composition of the sample; any alteration in it substantially modifies the results (Saaty & Sagir, 2009; Wang & Luo, 2009).

The database used in the empirical analysis comprises 29 European countries (including Norway, Switzerland, Iceland and all the EU-28 countries except for Greece and Slovakia²), with data from Eurostat for 2016, 2017 and 2018, depending on the most recently available information on the variables. The ranking of the countries is based on criteria relating to their healthcare system as well as various socioeconomic factors characterizing the observations in the sample. These criteria can be used to identify the countries that are most vulnerable to the disease and most exposed to the economic consequences stemming from the restrictive measures taken to curb the spread of the virus. The countries are the alternatives in the TOPSIS model, while the criteria are determined by the variables presented in Table 1.

To apply the method, it is first necessary to distinguish between the variables to be maximized and those to be minimized. Given the particular features of each criterion and the aim of this research, the variables to be maximized/minimized are as follows: (1) regarding health, the death rate from influenza and the average length of a hospital stay should be minimized, while the other three criteria should be maximized; (2) in terms of society, the percentage of people working from home should be maximized and the rest of the criteria minimized as they are indicators of poverty or finding it difficult to get by financially; (3) with respect to work, all the criteria should be minimized, as they relate to issues that indicate labour market insecurity and its sensitivity to adverse economic situations. In the case of self-employment, it is not entirely clear what sign should be expected. There are important advantages associated with self-employment that would support the decision to maximize it; for example, it provides an ideal path out of unemployment. According to Blundell and Machin (2020), the self-employed have been hit particularly hard by the COVID-19 crisis, with approximately three-quarters reporting less work in April 2020 than usual. Thus, it has been decided that this criteria should be minimized given the high level of risk associated with this type of work during periods of recession, when freelancers’ and small businesses’ capacity to respond to the situation and access financing are very limited.

The situation in the countries under study differs widely: none of them occupies a top position in all of the variables analysed, revealing substantial divergence among them that does not correspond to questions of wealth. Highly developed nations such as Switzerland score highest in Healthcare expenditure and Psychiatrist, as Sweden does in People working from home, while the Netherlands holds the lowest position in

![Figure 1. TOPSIS algorithm.](image-url)
Arrears on utility bills and Luxembourg in Self-employment. Conversely, Bulgaria, Romania and Latvia have their lowest scores in variables associated with health and highest in those related to society.

### 3. Results

The worldwide spread of COVID-19 led to it being declared a pandemic by the World Health Organization (2020), pointing to over 3 million cases and 207,973 deaths in 213 countries and territories in March 2020. Devastating repercussions are expected in all sectors of the economy, the intensity of which will depend on the length of the lockdown, the responsiveness of the business sector and the support measures implemented by governments. Countries with well-prepared health systems and healthy economies, and with a workforce capable of adapting to environmental circumstances, will be able to minimize the aftermath of this disease. There is a need for cooperation that extends beyond individual territories, COVID-19 knows no borders and so countries in all continents must fight together to eradicate it and mitigate its effects. However, although this is clear in theory, different governments’ particular interests often prevail. For example, France, Germany, and the Czech Republic have introduced limits on exports of protective medical equipment such as face masks, despite severe shortages elsewhere (Anderson et al., 2020). There have even been disputes within the EU over the structuring of financial instruments to assist member states.

Wealth will be a weapon of defence against the economic, social and labour market crisis beginning to emerge as a result of COVID-19. In order to gain an understanding of the differences in the sample analysed, the countries have been classified into four groups according to their level of GDP at market prices, euro per capita (GDPpc) (Table 2).

### Table 1. Main statistics for the criteria in the sample.

| Criteria | Units | Mean | Max | Min | St. Dev. |
|----------|-------|------|-----|-----|----------|
| **Health** | | | | | |
| Healthcare expenditure (2017) | Euro per inhabitant | 3,035.31 | 8,785.06 | 493.78 | 2,109.34 |
| Psychiatrists (2017)* | Per hundred thousand inhabitants | 18.65 | 51.72 | 7.77 | 8.27 |
| Healthy life years (2017) | No. years | 62.27 | 72.70 | 51.40 | 5.36 |
| Average length of a hospital stay (2017) | No. days | 7.34 | 9.80 | 4.5 | 1.38 |
| Death rate from influenza (2016) | Rate | 1.28 | 4.19 | 0.09 | 0.89 |
| **Society** | | | | | |
| People working from home (2018) | % employed persons | 10.21 | 29.40 | 0.30 | 8.04 |
| People at risk of poverty (2018) | Percentage | 21.04 | 32.80 | 12.20 | 5.35 |
| Inability to face financial expenses (2018) | Percentage | 31.77 | 55.30 | 13.90 | 10.70 |
| Arrears on utility bills (2018) | Percentage | 7.58 | 30.1 | 1.50 | 5.89 |
| Overcrowded dwellings (2018) | Percentage | 15.43 | 46.30 | 2.50 | 13.72 |
| **Work** | | | | | |
| Self-employment (2018) | Thousand persons | 1,015.55 | 4,643.00 | 20.60 | 1,380.09 |
| Part-time employment (2018) | % total employment | 16.01 | 46.80 | 1.80 | 10.46 |
| Temporary employment (2018) | % total employment | 9.44 | 22.30 | 0.80 | 5.56 |
| Precarious jobs (2018) | % active population | 21.7 | 6.90 | 0.20 | 1.77 |
| Unemployment rate (2018) | % active population | 5.23 | 13.70 | 1.90 | 2.36 |

*Psychiatrists are considered vitally important to alleviate the effects of the lockdown.
For each variable used, the year corresponding to the most recent information available is shown in parentheses.
Source: Own elaboration. Data from Eurostat (https://ec.europa.eu/eurostat/web/covid-19/data).
Figures 2 and 3 analyse the correspondence between the virulence of coronavirus and countries’ level of wealth, using figures provided by the European Centre for Disease Prevention and Control on infections and deaths due to COVID-19. Bearing in mind that the evolution of the pandemic has not been uniform over time, 70 days have been counted from the time when the country recorded an infection rate of between 0.1 and 0.3 per million people. This ensures homogenized information in terms of evolution, which is needed to be able to make cross-country comparisons.

The pandemic has spread all over the world regardless of countries’ wealth, registering extremely high figures in the US and as well as some emerging market countries. According to Baldwin and di Mauro (2020), the pandemic has affected all major economies including the G7 countries, who jointly account for 60% of world supply and demand (GDP). Fernandes (2020) concluded that the health risk (actual mortality and infection rates) is not necessarily correlated with the economic risk to the global economy. However, comparisons within Europe have shown a positive correlation between GDP and the number of confirmed COVID-19 cases per million of population (correlation coefficient = 0.71); as a case in point, Luxembourg has the highest per capita income ($98,640) and the highest number of infections (6,134 cases). On the other hand, the weaknesses of less developed European countries are

| Q1 Country | Q2 Country | Q3 Country | Q4 Country | GDPpc |
|------------|------------|------------|------------|-------|
| Bulgaria   | Estonia    | France     | Sweden     | 7,980 |
| Romania    | Portugal   | U. Kingdom | Denmark    | 10,510|
| Croatia    | Slovenia   | Belgium    | Iceland    | 12,620|
| Poland     | Cyprus     | Germany    | Ireland    | 12,950|
| Hungary    | Malta      | Finland    | Norway     | 13,690|
| Latvia     | Spain      | Austria    | Switzerland| 15,080|
| Lithuania  | Italy      | Netherlands| Luxembourg | 16,160|
| Czech Rep  |            |            |            | 19,530|

Source: Own elaboration.

Table 2. Countries divided into quartiles based on their wealth (2018).

Source: Own elaboration.

Figure 2. GDPpc and confirmed cases per million people.
offset by the fact that COVID-19 is less virulent there; the lowest number of infections is registered in Bulgaria, with only 282 cases. However, the deaths due to COVID-19 do not show such a clear relationship with GDPpc (correlation coefficient $=0.2$), as can be seen in Figure 3.

The Eastern European countries have registered the fewest deaths, and are also those in the bottom quartile of GDP, Q1. However, there is greater dispersion in the other, larger group of European nations. For example, whereas Belgium has the highest confirmed death rate per million of population and is in Q3 according to its GDPpc, Luxembourg has registered 153 deaths but holds the top position in Q4, with the highest GDPpc in Europe.

The lower rates of infections and confirmed deaths in Eastern European countries cannot be attributed to the number of tests carried out. As can be seen in Figure 4, with the exception of Luxembourg and Iceland, the approximate number of early detection tests performed by the rest of the European countries lies between 10 and 40 per thousand people, with no correlation observed with the level of wealth. For example, Lithuania – a country classified in Q1 – is among the countries that have suffered the fewest infections and deaths, and yet it is one of the countries that have performed the most tests.

The TOPSIS method can be used to obtain the relative closeness index, which, together with the distance to the positive and negative ideal solution, will provide the values needed to establish the ranking of the countries according to their vulnerability to COVID-19, understood in relation to the three proposed aspects. The results are shown in Table 3, where countries have been ranked from highest to lowest in terms of their capacity to respond to the adverse situations caused by the disease.

The groups of European countries in the bottom and middle quartiles in terms of income (Q1 and Q2, as shown in Table 2) have different vulnerabilities in the areas analysed (Table 3). They are much more vulnerable in the areas of health and society (where almost all of them hold a below-average position) than they are in terms of work. In the particular case of those classified in Q1, it is important for them to
maintain the low infection rates: their health resources and clear inability to cope with adverse economic scenarios would put them in a very precarious situation if the pandemic were to strike them with any virulence. Indeed, of the 29 countries

Table 3. Ranking of European countries’ vulnerability to COVID-19.

| Health | Society | Work |
|--------|---------|------|
| TR     | Country | CI   | Q   | TR     | Country | CI   | Q   | TR     | Country | CI   | Q   |
| 1      | Switzerland | 0.807 | Q4  | 1      | Netherlands | 0.861 | Q3  | 1      | Bulgaria | 0.901 | Q1  |
| 2      | Germany   | 0.610 | Q3  | 2      | Sweden   | 0.856 | Q4  | 2      | Czechia | 0.858 | Q1  |
| 3      | Luxembourg | 0.570 | Q4  | 3      | Iceland  | 0.828 | Q4  | 3      | Malta   | 0.850 | Q2  |
| 4      | Denmark   | 0.546 | Q4  | 4      | Luxembourg | 0.801 | Q4  | 4      | Estonia | 0.849 | Q2  |
| 5      | Austria   | 0.536 | Q3  | 5      | Denmark  | 0.787 | Q4  | 5      | Lithuania | 0.842 | Q1  |
| 6      | Norway    | 0.526 | Q4  | 6      | Belgium  | 0.758 | Q3  | 6      | Romania | 0.841 | Q1  |
| 7      | Ireland   | 0.521 | Q4  | 7      | U. Kingdom | 0.756 | Q3  | 7      | Latvia  | 0.832 | Q1  |
| 8      | Belgium   | 0.510 | Q3  | 8      | Finland  | 0.733 | Q3  | 8      | Hungary | 0.830 | Q1  |
| 9      | Italy     | 0.508 | Q2  | 9      | Austria  | 0.708 | Q3  | 9      | Ireland | 0.764 | Q4  |
| 10     | U. Kingdom| 0.507 | Q3  | 10     | France   | 0.704 | Q3  | 10     | Norway  | 0.763 | Q4  |
| 11     | France    | 0.498 | Q3  | 11     | Norway   | 0.669 | Q4  | 11     | Cyprus  | 0.760 | Q2  |
| 12     | Hungary   | 0.477 | Q4  | 12     | Switzerland | 0.668 | Q4  | 12     | Denmark | 0.753 | Q4  |
| 13     | Iceland   | 0.466 | Q4  | 13     | Ireland  | 0.663 | Q4  | 13     | Luxembourg | 0.753 | Q4  |
| 14     | Lithuania | 0.463 | Q1  | 14     | Germany  | 0.659 | Q3  | 14     | Iceland | 0.730 | Q4  |
| 15     | Sweden    | 0.461 | Q4  | 15     | Estonia  | 0.651 | Q2  | 15     | Austria | 0.726 | Q3  |
| 16     | Netherlands| 0.461 | Q3  | 16     | Portugal | 0.648 | Q2  | 16     | Slovenia | 0.675 | Q2  |
| 17     | Bulgaria  | 0.459 | Q3  | 17     | Czechia  | 0.643 | Q1  | 17     | Switzerland | 0.637 | Q4  |
| 18     | Romania   | 0.456 | Q1  | 18     | Malta    | 0.628 | Q2  | 18     | Portugal | 0.637 | Q2  |
| 19     | Poland    | 0.455 | Q1  | 19     | Slovenia | 0.584 | Q2  | 19     | Finland | 0.627 | Q3  |
| 20     | Cyprus    | 0.454 | Q2  | 20     | Spain    | 0.582 | Q2  | 20     | Sweden  | 0.624 | Q4  |
| 21     | Croatia   | 0.441 | Q1  | 21     | Poland   | 0.527 | Q1  | 21     | Belgium | 0.622 | Q3  |
| 22     | Portugal  | 0.411 | Q2  | 22     | Italy    | 0.519 | Q2  | 22     | Germany | 0.567 | Q3  |
| 23     | Spain     | 0.407 | Q2  | 23     | Cyprus   | 0.512 | Q2  | 23     | U. Kingdom | 0.564 | Q3  |
| 24     | Malta     | 0.401 | Q2  | 24     | Hungary  | 0.506 | Q1  | 24     | Croatia | 0.557 | Q1  |
| 25     | Czechia   | 0.397 | Q1  | 25     | Lithuania | 0.473 | Q1  | 25     | Netherlands | 0.555 | Q3  |
| 26     | Slovenia  | 0.383 | Q2  | 26     | Latvia   | 0.364 | Q1  | 26     | Poland  | 0.547 | Q1  |
| 27     | Estonia   | 0.344 | Q2  | 27     | Romania  | 0.314 | Q1  | 27     | France  | 0.435 | Q3  |
| 28     | Latvia    | 0.279 | Q1  | 28     | Croatia  | 0.305 | Q1  | 28     | Italy   | 0.376 | Q2  |
| 29     | Finland   | 0.267 | Q3  | 29     | Bulgaria | 0.144 | Q1  | 29     | Spain   | 0.371 | Q2  |

TR: TOPSIS Ranking; CI: Closeness index; Q: Quartile of GDPpc.
Source: Own elaboration.
analysed, Bulgaria has the lowest level of psychiatrists (7.77 per hundred), Romania registers the lowest health expenditure (493.78 euros per inhabitant) and Latvia has the lowest number of healthy life years compared to the other Europeans (51.4 years). However, all of them have an optimal employment situation: Bulgaria has the lowest value in Part-time employment (1.8%) and Romania the lowest value in Temporary employment (0.8%) and Precarious jobs (0.2%).

Conversely, the wealthiest countries in Europe (Q3 and Q4) are less vulnerable in the areas of society and health, but some show notable sensitivity in terms of work. They have been severely hit by the pandemic, as shown in Figures 2 and 3, but their level of economic development should enable them to curb the indirect consequences of the spread of the virus. These results are supported by studies such as Mogi and Spijker (2020), who conclude that the Netherlands, Switzerland and Norway all score high on the socially and economically vibrant factor and have seen their number of coronavirus infections rise quickly during March despite households being almost exclusively single-person or nuclear. However, their well-developed healthcare systems, the higher standards of healthy living, as well as the financial solvency of their citizens should help to combat the consequences of the pandemic. For example, Germany has the most hospital beds per 1,000 people (8.3) and a robust sector of private and public laboratories, of which nearly 200 have capacity for SARS-CoV-2-testing, as indicated by The Economist (2020).

In short, both the EU and the authorities in each country are morally obliged to help the most vulnerable countries, such as those in Eastern Europe, by providing public funds. Resources should be allocated to bolstering their health and social systems in case the pandemic strikes more aggressively. For their part, the wealthiest countries will have to strengthen their labour policies to improve job security, reducing temporary employment and unemployment rates, aspects that are severely afflicted in situations of economic stress.

4. Conclusions

This analysis of European countries’ vulnerability to the COVID-19 pandemic has identified the areas in which nations need to bolster their investments in order to alleviate the severity of the impact. Both domestic and EU funds should be allocated to these areas in order to ensure that their citizens are safe from the disease and, above all, protected from the related economic consequences. That said, Altig et al. (2020) argue that ongoing high levels of uncertainty do not bode well for a full and rapid economic recovery. Elevated uncertainty generally makes firms and consumers cautious, slowing investment, hiring and expenditure on consumer durables.

According to the ranking calculated here, the least vulnerable countries are those in the centre/north of the continent; specifically, Germany in terms of health and Sweden in society, in contrast to work, where Bulgaria is at the top of the ranking. Conversely, those most exposed to the consequences of the pandemic are Finland in health, Bulgaria in society and Spain in work. These latter countries are going to be the least able to cope with the repercussions of the pandemic, and therefore have the greatest need in the areas indicated.
Given all the above, we can conclude that the level of wealth influences vulnerability in the health and social spheres. However, the relationship is not so clear with respect to work; as such, this issue merits particular attention. Economic development can lead to a high level of precarious employment, the fragility of which emerges in the face of extreme situations such as the current pandemic (hypotheses 1 and 3). It has also been shown that a favourable situation in countries’ health and social spheres has not always been enough to combat the spread of this virus. Countries such as Belgium and Luxembourg, which hold high positions in terms of health and social vulnerability, have reported the highest number of deaths per million in the period analysed and highest number of confirmed cases, respectively (hypothesis 2).

Continuing on from this research, one of its main limitations should be addressed; namely, that all the countries analysed belong to the EU and have a high level of development. The analysis should thus be extended to other geographical areas with more diverse characteristics, in order to confirm the conclusions drawn here. In addition, following the study by Lenzen et al. (2020), further research should seek to demonstrate empirically whether the social and environmental consequences of the fight against the pandemic will be wider-ranging than the negative effects on employment and wealth.

Notes
1. As indicated by Karnon (2020), the economic effects of the COVID-19 crisis are predominantly falling on low-income earners.
2. These two countries have been excluded because they do not provide complete information on the variables used.
3. World Bank Data.

Disclosure statement
The authors declare that they have no conflict of interest.

References
Altig, D., Baker, S., Barrero, J. M., Bloom, N., Bunn, P., Chen, S., Davis, S. J., Leather, J., Meyer, B., Mihaylov, E., Mizen, P., Parker, N., Renault, T., Smietanka, P., & Thwaites, G. (2020). Economic uncertainty before and during the COVID-19 pandemic. Journal of Public Economics, 191, 104274. https://doi.org/10.1016/j.jpubeco.2020.104274
Anderson, M., McKee, M., & Mossialos, E. (2020). Covid-19 exposes weaknesses in European response to outbreaks. BMJ, 368, 1–2. https://doi.org/10.1136/bmj.m1075.
Baker, S., Bloom, N., Davis, S. J., & Terry, S. (2020). COVID-induced economic uncertainty [NBER Working Paper No. 26983].
Baldwin, R., & di Mauro, B. W. (2020). Economics in the time of COVID-19. A VoxEU.org Book. Centre for Economic Policy Research.
Balesentis, T., Balesentis, A., & Brauers, W. K. M. (2011). Multi-objective optimization of well-being in the European Union member states. Economic Research-Ekonomska Istraživanja, 24(4), 1–15. https://doi.org/10.1080/1331677X.2011.11517485
Blundell, J., & Machin, S. (2020). Self-employment in the Covid-19 crisis. CEP Covid-19 analysis [Paper 003]. London School of Economics and Political Science.
Cartaxo, A., Cartaxo, F., Bermejo, P., Figueiredo, M., & Nalder, D. (2020). The exposure risk to COVID-19 in most affected countries: A vulnerability assessment model. The Lancet. https://doi.org/10.2139/ssrn.3687379.

Codagnone, C., Bogliacino, F., Gómez, C., Charris, R., Montealegre, F., Liva, G., Lupiáñez-Villanueva, F., Folkvord, F., & Veltri, G. A. (2020). Assessing concerns for the economic consequence of the COVID-19 response and mental health problems associated with economic vulnerability and negative economic shock in Italy, Spain, and the United Kingdom. PLoS One, 15(10), e0240876. https://doi.org/10.1371/journal.pone.0240876

Drake, T. L., Chalabi, Z., & Coker, R. (2012). Cost-effectiveness analysis of pandemic influenza preparedness: What’s missing? Bulletin of the World Health Organization, 90(12), 940–941. https://doi.org/10.2471/BLT.12.109025

Fernandes, N. (2020). Economic effects of coronavirus outbreak (COVID-19) on the world economy [Working paper IESE Business School].

Guerreri, V., Lorenzoni, G., Straub, L., & Werning, I. (2020). Macroeconomic implications of COVID-19: Can negative supply shocks cause demand shortages? [Working Paper], 2 April.

Horobet, A., Simionescu, A., Dumitrescu, G., & Belascu, L. (2020). Europe’s war against COVID-19: A map of countries’ disease vulnerability using mortality indicators. International Journal of Environmental Research and Public Health, 17(18), 6565. https://doi.org/10.3390/ijerph17186565

Hu, M., Liu, M., & Lan, J. (2020). Decision making with both diversity supporting and opposing membership information. Economic Research-Ekonomskas Istrazivanja, 33(1), 3427–3452. https://doi.org/10.1080/1331677X.2020.1774790

Hwang, C. L., & Yoon, K. (1981). Multiple attribute decision making. Methods and applications a state-of-the-art survey. Springer-Verlag.

Jorda, O., Singh, S. R., & Taylor, A. M. (2020). Longer-run economic consequences of pandemics [Covid Economics: Vetted and Real-Time Papers, 1], 3 April.

Kaynak, S., Altuntas, S., & Dereli, T. (2017). Comparing the innovation performance of EU candidate countries: TOPSIS and AHP approaches. Gaziantep University Journal of Social Sciences, 17(1), 239–251. https://doi.org/10.21547/jss.267381

Karnon, J. (2020). The case for a temporary COVID-19 income tax levy now, during the crisis. Applied Health Economics and Health Policy, 18(3), 335–337. https://doi.org/10.1007/s40258-020-00585-6

Kashnitsky, I., & Aburto, J. M. (2020). COVID-19 in unequally ageing European regions. World Development, 136, 105170. https://doi.org/10.1016/j.worlddev.2020.105170

Kaynak, S., Altuntas, S., & Dereli, T. (2017). Comparing the innovation performance of EU candidate countries: An entropy-based TOPSIS approach. Economic Research-Ekonomskas Istrazivanja, 30(1), 31–54. https://doi.org/10.1080/1331677X.2016.1265895

Lenzen, M., Li, M., Malik, A., Pomponi, F., Sun, Y.-Y., Wiedmann, T., Faturay, F., Fry, J., Gallego, B., Geschke, A., Gómez-Paredes, J., Kanemoto, K., Kenway, S., Nansai, K., Prokopenko, M., Wakiyama, T., Wang, Y., & Yousefzadeh, M. (2020). Global socio-economic losses and environmental gains from the Coronavirus pandemic. PLoS One, 15(7), e0235654. https://doi.org/10.1371/journal.pone.0235654

Lin, M. C., Wang, C. C., Chen, M. S., & Chang, C. A. (2008). Using AHP and TOPSIS approaches in customer driven product design process. Computers in Industry, 59(1), 17–31. https://doi.org/10.1016/j.compind.2007.05.013

Lourenzutti, R., & Krohling, R. A. (2016). A generalized TOPSIS method for group decision making with heterogeneous information in a dynamic environment. Information Sciences, 330, 1–18. https://doi.org/10.1016/j.ins.2015.10.005

Majumder, P., Biswas, P., & Majumder, S. (2020). Application of new TOPSIS approach to identify the most significant risk factor and continuous monitoring of death of COVID-19. Electronic Journal of General Medicine, 17(6), em234. https://doi.org/10.29333/ejgm/7904

Maliszewska, M., Mattoo, A., & van der Mensbrugg, D. (2020). The potential impact of COVID-19 on GDP and trade: A preliminary assessment [Policy Research Working Paper, 9211]. World Bank.
Mandić, K., Delibašić, B., Knežević, S., & Benković, S. (2017). Analysis of the efficiency of insurance companies in Serbia using the fuzzy AHP and TOPSIS methods. *Economic Research-Ekonomska Istraživanja*, 30(1), 550–565. https://doi.org/10.1080/1331677X.2017.1305786

Mardani, A., Junoh, A., Nor, K., Khalilfah, Z., Zakwan, N., & Valipour, A. (2015). Multiple criteria decision-making techniques and their applications – A review of the literature from 2000 to 2014. *Economic Research-Ekonomska Istraživanja*, 28(1), 516–571. https://doi.org/10.1080/1331677X.2015.1075139

McKibbin, W., & Fernando, R. (2020). *The global macroeconomic impacts of COVID-19* [Brookings Institute], March, 1–43.

Mogi, R., & Spijker, J. (2020). The influence of social and economic ties to the spread of COVID-19 in Europe. *SoArXiv*, April 14. https://doi.org/10.31235/osf.io/s8xn.

Nicola, M., Alsafi, Z., Sohrabi, C., Kerwan, A., Al-Jabir, A., Iosifidis, C., Agha, M., & Agha, R. (2020). The socio-economic implications of the coronavirus pandemic (COVID-19): A review. *International Journal of Surgery*, 78, 185–193. https://doi.org/10.1016/j.ijssu.2020.04.018

Noy, I., Doan, N., Ferrarini, B., & Park, D. (2020). Measuring the economic risk of COVID-19. *Global Policy*, 11(4), 413–423. https://doi.org/10.1111/1758-5899.12851

OECD. (2020). Coronavirus: The world economy at risk. *OECD Interim Economic Assessment*, 1–18. https://www.oecd.org/berlin/publikationen/Interim-Economic-Assessment-2-March-2020.pdf

Orlik, T., Rush, J., Cousin, M., & Hong, J. (2020). Coronavirus could cost the global economy $2.7 trillion. Here’s how. *Bloomberg*. https://www.bloomberg.com/graphics/2020-coronavirus-pandemic-global-economic-risk/#:~:text=The%20coronavirus%20is%20going%20global,world%20economy%20to%20a%20standstill.&text=The%20economic%20fallout%20could%20include,entire%20GDP%20of%20the%20U.K.

Saaty, T. L., & Sagir, M. (2009). An essay on rank preservation and reversal. *Mathematical and Computer Modelling*, 49(5-6), 1230–1243. https://doi.org/10.1016/j.mcm.2008.08.001

Shrestha, N., Shad, M. Y., Ulvi, O., Khan, M. H., Karamehic-Muratovic, A., Nguyen, U., Baghbanzadeh, M., Wardrup, R., Aghamohammadi, N., Cervantes, D., Nahiduzzaman, K., Zaki, R., & Haque, U. (2020). The impact of COVID-19 on globalization. *One Health*, 11, 100180. https://doi.org/10.1016/j.onehlt.2020.100180

The Economist. (2020). Germany excels among its European peers. *The Economist*, April 25.

Triantaphyllou, E. (2010). *Multi-criteria decision making methods: A comparative study*. Springer.

Valle, E. (2020). *La reacción de la Unión Europea ante el COVID-19* [Working Paper FEDEA. 2020/03].

Wang, Y. M., & Luo, Y. (2009). On rank reversal in decision analysis. *Mathematical and Computer Modelling*, 49(5-6), 1221–1229. https://doi.org/10.1016/j.mcm.2008.06.019

Wong, M. C., Teoh, J. Y., Huang, J., & Wong, S. H. (2020). The potential impact of vulnerability and coping capacity on the pandemic control of COVID-19. *The Journal of Infection*, 81(5), 816–846. https://doi.org/10.1016/j.ijinf.2020.05.060

World Health Organization. (2020). *Coronavirus disease 2019 (COVID-19): Situation report. 100*. World Health Organization.

### Appendix

**Table A1.** COVID-19 data by region as of 31st March 2020.

| Region    | Total confirmed deaths due to Covid-19 | Total confirmed cases of Covid-19 |
|-----------|--------------------------------------|----------------------------------|
| Europe    | 27,953                                | 437,674                          |
| Asia      | 6,671                                 | 170,037                          |
| North America | 3,382                              | 177,742                          |
| South America | 305                                 | 11,249                           |
| Africa    | 166                                   | 5,137                            |
| Oceania   | 21                                    | 5324                             |

Source: European Centre for Disease Prevention and Control.