

COVID-19 INCIDENCE IN EUROPE: DRIVERS AND GOVERNMENT INTERVENTIONS*

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Abstract

This study aims to identify the determinant country-level factors that impact the trend of registered death cases from the recently emerged infectious disease COVID-19, analyzing data from March 2020 to July 2020, for 40 European countries. We use four categories of indicators covering major areas of influence: health, demographic, economic, and societal/cultural indicators. We reduce the dimensionality of the data to three latent factors by applying a Principal Component Analysis method, and we employ a multiple linear regression model to estimate the effects of these factors on the trend of death rates.

The main result of the study is that a decreasing trend of death cases is the effect of a functional and citizen-oriented state, and is not only impacted by characteristics of the medical system or by individual features. Our findings also suggest that the premises for a low mortality rate are built by policies that have effects in the long- and medium-term. These policies refer to economic growth, sustainable development, healthcare, and the creation of a stable political system and an efficient administration.

Keywords: COVID-19, determinant factors, latent variables, quality of life.

1. Introduction

The year 2020 was marked by a major health shock. This was the newly emerged COVID-19, which is an infectious disease caused by a coronavirus known as SARS-V2, which has reached a pandemic level. This shock has notable consequences, both socially and economically; these are different in intensity and duration across countries and have worldwide spread. In Europe, as of 10 July, over 2.5 million infections and almost 200,000 deaths have been reported. The European countries that were most affected by this novel virus, in terms of deaths, are the UK (44,517), Italy (34,914), France (29,965), Spain (28,396), and the Russian Federation (10,843); in terms of infections the Russian Federation (707,301), Spain (299,593), UK (286,979), Italy (242,149), and Germany (198,765) are the most affected. Six countries have registered more than 100,000 cases, 15 countries have over 10,000 cases, and 19 countries have over 1,000 cases of infections.

In the European Union (EU), public health represents a common responsibility, shared between this entity and its Member States. This implies that the EU cannot directly intervene or impose decisions, but can help in complementing national health policies. Under these conditions, when the first cases of infection emerged in Europe, the Member States implemented their own intervention measures (OECD, 2020). The approaches differ from highly restrictive measures (in most of the countries) to no restrictions at all (Sweden, Netherlands) (Petridou, 2020). However, European agencies such as European Center for Disease Control (ECDC) have issued a series of recommendations, such as social distancing, risk assessment for the general population and its communication, supporting vulnerable groups, and ensuring the continuity of the business environment.

Aside from these measures, similar to those adopted in the case of other pandemics (quarantine, self-isolation, social distancing), specific factors have proven also to be of interest. These include hospitals' capacity and equipment, existing comorbidities of patients, share of the population above 65 years old, to only list a few (Capano, 2020; Capano *et al.*, 2020). Besides the general health of the population, country-level characteristics and the overall behavior of the individuals from a societal perspective can also play an important role in reducing the spread of this disease and, more importantly, in reducing its death toll (Shangguan, Wang and Sun, 2020).

This paper aims to identify the main country-level factors that impacted the trend of registered death cases, from March 2020 to July 2020, for 40 European countries. The research hypothesis is that a decreasing trend of death cases is the effect of a functional and citizen-oriented state, and is not only impacted by characteristics of the medical system or by individual features.

The research on this topic is in the early stages, so our study is adding to the scarce literature by analyzing several groups of country-level factors and considering almost all European countries. The results of our study give evidence to support our research hypothesis. The paper is structured as follows: following this introduction

are a literature review on the topic and a description of the data and the employed methodology; it ends by presenting the empirical results and the conclusions of the study.

2. Literature review

Studies on the factors influencing the COVID-19 mortality rate are scarce and are mostly in the medical area, analyzing samples of patients and their individual characteristics in relation to their response to the virus infection. This makes the literature regarding the impact of macro-factors, at least for the European countries, very thin.

Related papers focus either on the infection rate, the recovery rate, or the death rate, or a mixture of these outcomes (Balmford *et al.*, 2020). When exploring the drivers of incidence or mortality rate from COVID-19, the literature follows several directions.

In the analysis of the infection rate for COVID-19, referring to limiting its spread, the influences of economic development, inequality, and population density were considered and found to have a significant impact on the behavior of quarantined individuals (Gelfand *et al.*, 2020). Cross-country analyses of the COVID-19 infection rate consider factors such as government effectiveness, GDP per capita, population density, and cultural factors to explain differences in individual behavior towards social distancing and, by extension, the variations in the COVID-19 infection rate (Dheer, Egri and Trevino, 2020). Population density can signify a higher intensity of human interactions and, consequently, infection epicenters can arise (Myounggu *et al.*, 2020). Low income and the general lack of financial resources lead to possible increased exposure to the virus for vulnerable groups, and the social distancing measures may become ineffective (Greer *et al.*, 2020).

The differences between regional and national factors, and especially government efficiency, lead to little variations in the infection cases. Political and social factors are responsible only for certain evolutions in the infection rates, and other characteristics of the governments, such as being populist or led by women, should be considered (Bosancianu *et al.*, 2020).

Healthcare infrastructure, along with demographics, is considered to be the most important factor in explaining the infection rates from the socioeconomic factors (Farzanegan *et al.*, 2020). In addition, cultural factors are influential in maintaining social distancing in communities (Woo, 2020). The analysis of social distancing, using Google data regarding mobility in shops, parks, public transportation, and workplaces, suggest that individualism is a major factor in maintaining social distancing in communities (Huynh, 2020; Parshakov, Permyakova and Zavertiaeva, 2020).

Some papers develop predictive models for transmitting the disease, starting with the intervention measures taken by the European governments, showing that the majority of the applied measures lead to the lowering of the infection rate (Fernández-Recio, 2020). The analyses of the medical and financial strategies adopted by European countries to prevent the spread of the coronavirus show that measures based on a

general, multidimensional view of the system, in areas such as health, government, and the economy, lead to the most efficient results. These measures must target population monitoring, mass testing, social distancing, self-isolation, and suitable treatment (Goniewicz *et al.*, 2020); the most efficient measures are those applied swiftly and generally (Cheng *et al.*, 2020).

These studies and their practical implementations show that the best method for slowing down the spread of COVID-19 is social distancing by minimizing human contact. This measure can be implemented by national and local authorities through several coordinated activities such as closing cultural and sporting events, restaurants and schools, teleworking, restrictive travels, and reorganizing working spaces. Still, the swiftness and efficiency of implementing these measures, in the early stages of the spread, remain the essential elements in slowing down the incidence of COVID-19.

The analysis of the intervention measures adopted by Romania to prevent and control the virus infection shows that the swift and definitive implementation of highly restrictive measures has kept the infection rate low, although there were some factors such as international migration, international trade or gender and race discrimination that added difficulties to the process (Cretan and Light, 2020).

The diversity of the results given by the literature shows the incipient nature of the research on this topic. When analyzing country-level data, the influence factors found significant in explaining the variation of infection or death cases cover a diversity of areas: health, demographic, social, cultural, institutional, and economic. As such, we will conduct our analysis by considering factors from all those areas, by employing a technique of dimensionality-reduction of the data, in order to capture as many effects as possible from all of these determinant factors.

3. Data and methodology

The sample of the countries comprises 40 European countries, namely: Albania, Austria, Belarus, Belgium, Bosnia and Herzegovina, Bulgaria, Croatia, Czechia, Cyprus, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, Moldova, Montenegro, Netherlands, North Macedonia, Norway, Poland, Portugal, Romania, Russia, Serbia, Slovakia, Slovenia, Spain, Sweden, Switzerland, the UK, and Ukraine.

A diversity of sources was used for collecting the data: Worldometer, the World Health Organization (WHO), and the World Bank. The data regarding the death rates caused by COVID-19 were collected from Worldometer, the health-related data were collected from WHO, and the socio-economic data came from the World Bank, all at country level. The COVID-19 data cover the period from March to July 2020 and represent the number of weekly death cases per 1 million inhabitants. All the other data referring to health and socioeconomic indicators were collected for the year 2019 and are presented in detail in Table 1.

Table 1: List of determinants of the COVID-19 death rates

	Explanatory variable	Definition	Data source
Health	Comorbidities	Probability (%) of dying between age 30 and exact age 70 from any cardiovascular disease, cancer, diabetes, or chronic respiratory disease	WHO
	Hospital beds	Hospital beds (per 1,000 population)	WHO
	Physicians	Physicians (per 1,000 population)	WHO
	Nurses	Nurses and midwives (per 1,000 people)	WHO
	Health expenditure	Current health expenditure per capita (current US\$)	WHO
	Life expectancy	Life expectancy at birth, total (years)	World Bank
Demographic	Population over 65	Population ages 65 and above in the total population (%)	World Bank
	Population density	People per sq. km	World Bank
	Dependency	Age dependency ratio is the ratio of people younger than 15 or older than 64 to the working-age population – those ages 15–64 (% of dependents per 100 working-age population)	World Bank
	Immigrants (%)	International migrant stock (% of population)	World Bank
	Death rate	Death rate, crude (per 1,000 people)	World Bank
Economic	GDP per capita	GDP per capita (constant 2010 \$)	World Bank
	Unemployment	Unemployment, total (% of total labor force) (national estimate)	World Bank
	Inequality	GINI index (World Bank estimate)	World Bank
Cultural/ societal	Human Capital Index (HCI)	Human Capital Index (HCI) (scale 0–1)	World Bank
	Education	Percentage of population with intermediate level of education	World Bank
	Individualism	Preference for a loosely-knit social framework in which individuals are expected to take care of only themselves and their immediate families. The scores range from 0 (collectivistic) to 100 (individualistic).	World Bank
	Government Effectiveness	Perceptions of the quality of public services, the quality of the civil service and the degree of its independence from political pressures, the quality of policy formulation and implementation, and the credibility of the government's commitment to such policies, ranging from approximately -2.5 to 2.5.	World Bank
	Political Stability and Absence of Violence/Terrorism	Perceptions of the likelihood of political instability and/or politically-motivated violence, including terrorism, ranging from approximately -2.5 to 2.5.	World Bank
	Regulatory Quality	Perceptions of the ability of the government to formulate and implement sound policies and regulations that permit and promote private sector development, ranging from approximately -2.5 to 2.5.	World Bank
	Connectivity	Mobile cellular subscriptions (per 100 people)	World Bank
	Internet access	Individuals using the Internet (% of population)	World Bank

Source: The authors

The factors that could explain the variations in death rates across countries are numerous and diverse, and the literature on the topic is insufficient to select relevant information. Thus, we use four categories of factors in the analysis: health, demographic, economic, and cultural/societal indicators, with a total of 22 variables. The existing, scarce literature gives some evidence to support the relevancy of using these categories of factors, as were found to be significant at influencing the number of death cases from COVID-19.

The dependent variable measures the negative aspect of an infection with a highly contagious virus, SARS-CoV-2, via death cases per 1 million inhabitants, using weekly values from the first week of March until the last week of July. We estimate the trend value for the series of the 22 weeks of collected data, for each of the 40 countries in the analysis. This series of trend values is used as the dependent variable.

For the health category, we used variables to assess the health status of individuals by life expectancy and comorbidities (Bosancianu *et al.*, 2020; Parshakov, Permyakova and Zavertiaeva, 2020). The health care aspects were measured by health care resources (hospital beds, physicians, and nurses) and by health care expenditures (Anderson *et al.*, 2020; Megahed and Ghoneim, 2020; Remuzzi and Remuzzi, 2020; Gelfand *et al.*, 2020). The relevancy of analyzing the effects of health infrastructure is given by the fact that increased performance of the health system of a country can positively impact the response efficiency of the authorities to COVID-19 infection and death cases.

The demographic structure is a factor of influence in analyzing mortality rates, since an aging population has more health-related issues and higher probabilities of death in a health crisis. Thus, we considered the proportion of the population older than 65, and the age-dependency ratio as variables to assess the size of the vulnerable categories of the populations, in terms of exposure and response to the virus, and in terms of negative consequences to the health system (Dheer, Egri and Trevino, 2020; Fernandez-Recio, 2020). Population density and immigration measure agglomeration and mobility, as this is an important factor in controlling the contamination rate (Goniewicz *et al.*, 2020).

The economic determinants were selected to assess the economy's potential to have significant interventions in the case of a pandemic (Cheng *et al.*, 2020; Cretan and Light, 2020). We used GDP per capita to measure the size of the economy, and unemployment and the GINI Index to evaluate the economic disadvantages of the individuals in a country, since this aspect has been proven a potential determinant of infectious diseases (Khalatbari-Soltani *et al.*, 2020). These variables also can contribute to assessing the capacity of a country to have better responses in times of crisis.

The societal and cultural determinants measure the advancement of a society in terms of individual behaviors and beliefs (individualism), the capacity of a state to mobilize its social and economic resources to increase individual wellbeing (HCI), access to information, and the dispositions of individuals to disseminate information (cellular and internet), and the social responsibility of a government to enhance the

quality of life of its citizens (government effectiveness, political stability, and regulatory quality).

For our methodology, in order to identify the significant factors affecting the trend of the death cases, an OLS regression model was estimated. Since the sample size is rather small considering the high number of determinants, we use a factor analysis method to reduce the dimensionality of our explanatory variables to a few latent factors, namely Principal Component Analysis (PCA). We used a regression model with the following formula:

$$\text{Trend of deaths (by COVID19)} = \beta_0 + \beta_1 F + \varepsilon \quad (1)$$

where F is a vector of regressors, β_1 is a vector of the estimated parameters of the regressors, β_0 is the intercept of the model, and ε is the error of the model.

The regressors are the latent factors that were previously extracted by the PCA. Principal Component Analysis is a technique that reduces the dimensionality of a dataset by creating new, uncorrelated variables that successively maximize the total variance, increasing the interpretability and minimizing the loss of information. The newly created variables, which are latent variables, are not defined *a priori*, but by the analyzed dataset, making PCA a highly adaptive data analysis technique. The latent variables are linear combinations of the variables in the dataset that contribute to the factor formation, the coefficients for each variable being their loading scores, which magnitude gives the importance of a variable in constructing the latent factor.

4. Empirical results

The summary statistics for the interest variables are presented in Table 2; the average trend of death rates is negative, with notable differences across countries. A large degree of heterogeneity is observed also for health expenditures, GDP/capita, and population density.

In order to reduce the high dimensionality of the data, compared to the sample size, we applied PCA. The preliminary tests – Kaiser-Maier-Olkin (KMO) and Bartlett's Sphericity tests – showed that the method can be applied, since the dataset presents significant correlations.

We selected three latent factors, which cumulatively explain approximately 75% of the total variation of the dataset; the variables that make an important contribution to the formation of the three factors (i.e. which have a loading score of at least 0.5) are presented in Table 3.

The first factor (F1) explains 47% of the total variation. Observing the variables that are positively and negatively correlated with it, we consider that the first factor measures the citizens' quality of life in a certain country. High values for this latent variable suggest a high-quality climate, socially, institutionally, and economically, for living in that country.

Table 2: The descriptive statistics of the variables of interest

Variable	Mean	Maximum	Minimum	Std. Dev.	Skewness	Kurtosis
Trend_death_rate	-0.439	1.140	-3.974	1.121	-1.710	5.742
Comorbidities	15.640	25.400	8.600	5.626	0.374	1.630
Beds	5.245	11.000	2.600	1.930	0.751	3.335
Physicians	3.310	5.216	1.216	0.870	0.211	2.883
Nurses	9.112	19.461	3.633	4.242	0.827	2.806
Health_exp	2670.476	9956.260	177.408	2441.286	1.019	3.332
Life_exp	79.10	83.55	71.58	3.50	-0.57	2.09
65+ pop.	18.049	22.751	11.469	2.831	-0.475	2.205
Pop_density	151.312	1514.469	3.518	243.132	4.644	26.157
Age_dep_ratio	52.57	61.79	38.70	5.15	-0.55	3.10
Immigrants	10.933	43.964	0.913	7.865	1.976	9.388
Death_rate	10.561	15.400	6.400	2.426	0.237	2.327
GDP/cap.	32646.76	116597.3	3095.17	26735.39	1.15	3.89
Unemployment	6.769	17.313	2.014	4.067	1.415	3.952
GINI	31.430	40.400	24.200	4.213	0.088	2.090
HDI	0.72	0.81	0.53	0.07	-0.91	2.87
Education	64.739	82.265	46.797	6.716	0.173	3.693
Indiv.	51.10	89.00	20.00	20.82	-0.1	1.57
Gov_eff	74.8	99.51	28.36	19.6	-0.71	2.53
PoL_stab	65.57	96.66	6.19	20.83	-0.57	3.11
Reg_quality	77.283	99.038	25.961	18.412	-1.058	3.575
Cellular	121.884	180.693	88.013	19.236	0.782	4.033
Internet	81.991	99.010	62.553	9.211	0.054	2.292

Source: The authors

Table 3: The extracted factors and the variables that contribute to its formation

Factor	Variables	
	Positive correlation	Negative correlation
F1 – Quality of life	GDP/capita	
	Life expectancy	
	Individualism	
	Age dependency ratio	
	Health expenditures	Comorbidities
	HDI	Death rate
	Government effectiveness	
	Political stability	
	Regulatory quality	
	Nurses and midwives	
F2 – Healthcare system resources and performance	No. of physicians	
	No. of hospital beds	
	Population aged 65+	
	Age dependency ratio	
	Death rate	
F3 – Socioeconomic vulnerabilities	Unemployment	
	GINI	
	Population aged 65+	

Source: The authors

The second factor (F2) accounts for a little over 14% of the total variance, and it measures the quality of the healthcare system in terms of resources and performance. High values for the second factor imply good quality of the healthcare system.

The third and final factor (F3), which explains around 12.5% of the total variance, expresses the socioeconomic vulnerabilities, a country with high values for this variable suggesting that it has important economic vulnerability issues.

To analyze the effects of these three latent factors on the death rates' trend, we estimate the OLS regression model between these variables (see Table 4).

Table 4: OLS estimates of the effect on the trend of the death rates

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	-0.439680	0.153807	-2.858644	0.0070
F1	-0.581924	0.155767	-3.735871	0.0006
F2	-0.048746	0.155767	-0.312942	0.7561
F3	-0.208189	0.155767	-1.336545	0.1898
R-squared	0.305569	Mean dependent var		-0.439680
Adjusted R-squared	0.247700	S.D. dependent var		1.121531
S.E. of regression	0.972763	Akaike info criterion		2.877286
Sum squared resid	34.065620	Schwarz criterion		3.046174
Log likelihood	-53.545720	Hannan-Quinn criter.		2.938351
F-statistic	5.280338	Durbin-Watson stat		2.464703
Prob(F-statistic)	0.004026			

Source: The authors

The estimated equation that shows the relationship between the trend of the death rates and the three factors is:

$$TREND = -0.439 - 0.581 * F1 - 0.048 * F2 - 0.208 * F3 \quad (2)$$

The estimated model respects the classical assumption of a regression model (see Table 5 for heteroskedasticity testing and Table 6 for serial correlation testing).

Table 5: Results of Breusch-Pagan-Godfrey heteroskedasticity test

F-statistic	1.026126	Prob. F(3,36)	0.3925
Obs*R-squared	3.150979	Prob. Chi-Square(3)	0.3689

Source: The authors

Table 6: Results of Breusch-Godfrey Serial Correlation LM Test

F-statistic	1.894117	Prob. F(2,34)	0.1660
Obs*R-squared	4.009961	Prob. Chi-Square(2)	0.1347

Source: The authors

The results presented in Table 4 show that we only have one significant effect on the trend, which is the effect of the first factor (the quality of life in a country). The negative sign of the coefficient reflects that a high quality of life reduces the trend of the weekly death rates. This finding highlights the importance of a functional and citizen-oriented state, with high economic performance and responsible governments, and with citizens who trust the state's institutions, when acting to control and prevent the contamination with a deadly virus.

From the second and third factor, the effects on the trend of the death rates are non-significant, with the adequacy of the healthcare system in terms of resources and performance and the socio-economic vulnerabilities of a country being eclipsed in importance by the overall quality of living, thus confirming our research hypothesis.

5. The possible responses of national governments

The level of mortality in the case of a pandemic can be influenced by two types of measures taken by the authorities (Alam, 2020; Dodds *et al.*, 2020). The measures with medium- and long-term effect, applied in ways that are unrelated to the occurrence of a pandemic, will be used as support in this eventuality and have an effect on society and the economy as a whole (Bailey *et al.*, 2020), or at least on a system such as healthcare or administration. These measures will increase the resilience of a system to all sorts of shocks and crises, not just pandemics (Mintrom and O'Connor, 2020). Measures with a short-term effect are taken at the time of the pandemic and have an immediate effect, with specificities on certain issues.

In this context, we use only macro-level variables as drivers to explain the COVID-19 mortality rate. Since this type of variable does not manifest important time variations and therefore offers no possibilities for their immediate change, our findings suggest that the premises for a low mortality rate are built by policies that have effects in the long- and medium-term. These policies refer to economic growth, sustainable development, and healthcare, and to creating a stable political system and an efficient administration (Mikolai, Keenan and Kulu, 2020).

The first two policies should be a constant concern for the governments of the world; the ways to accomplish the goals of economic growth and sustainable development can be achieved through a variety of tools such as: stimulating investment, creating an attractive business environment for entrepreneurs, increasing competitiveness, price liberalization, economic openness, etc. (Pramiyanti and Mayangsari, 2020).

The healthcare policies are twofold. First, these policies concern the prevention and control of the evolution of chronic diseases (Christensen and Læg Reid, 2020a, 2020b). Prevention refers to measures related to the health education of the population, awareness campaigns on risk factors, and encouraging regular health checks. Policies regarding the control of the evolution of chronic diseases refer to educating patients about the severity of diseases and their possible consequences, developing the ability to self-monitor their health status, providing resources for monitoring, and creating national databases (Gagliano *et al.*, 2020).

Secondly, these policies aim to ensure the resources of the functioning of the medical system, both from the perspective of the necessary medications, medical devices, reagents, etc., as well as the investments in medical infrastructure and human resources (Maor and Howlett, 2020).

Lastly, we find that actions toward creating a stable political system and an efficient administration contribute to reducing mortality by making institutions work properly, and ensuring that decision-making is efficient and transparent at all levels and that citizens have a high degree of trust in institutions (Van Bavel *et al.*, 2020).

The last two categories of policies, at least, can also contribute to increasing the positive impact of short-term policies due to the fact that there are resources in the health system, and that there are institutional mechanisms to allow the application of measures imposed by the pandemic (Mei, 2020). At the same time, measures will be better understood and accepted by the population with a higher level of health education of the population and a higher degree of citizen's trust in political decision-makers (Singh and Avikal, 2020).

6. Conclusions

This paper aims to identify factors that can explain the trend of death cases from COVID-19 for a sample of 40 European countries, from March 2020 to July 2020. Four categories of factors were considered: health, demographic, economic, and societal/cultural factors. The main finding of this paper is that a functional, citizen-oriented state can significantly influence, in a positive manner, the variation over time of death cases registered due to COVID-19.

There are important limitations to our study, the most notable one being the fact that we explain the variation in the death rates by using latent, unobservable factors, which allows us to estimate a cumulative effect from a group of variables, but it leads to the loss of their individual contributions. Another important limitation is the fact that we do not consider some relevant variables regarding the specific public health interventions that governments apply in order to lower contamination rates. Also, since the data are in the early stages of collecting and normalization, the definitions regarding registered cases may vary in time and across countries, leading to possible biased results.

The number of deaths from COVID-19 does not present any stable pattern, alternatively registering increases and decreases. This, together with the diversity of influence factors at the country level, which are justifiable only by the empirical findings, gives the results of the studies little power of generalization. A more detailed and complete database and sample should be built in order to arrive at a more generalized and robust conclusion.

Another important limitation of our findings refers to the reported data on mortality cases from COVID-19. The main issues are the lack of a unified approach among countries to declaring what constitutes a COVID-19 death; the unrecorded deaths caused by COVID-19 (mainly because of insufficient testing or the lack of an epi-

miological investigation); and the delay between countries in terms of reporting cases in the early stages of the spread.

There is no generally applicable mixture of policies to overcome the pandemic of COVID-19; instead, there are country-specific approaches. The efficiency and the appropriate response to the health crisis are determined by a set of policies that are adapted to national characteristics. An extremely difficult decision for policymakers involves combining and coordinating policies and instruments of action, which are seemingly incongruous and chosen by different participants. In these conditions, in the absence of precious time for the adoption of new models of public governance, the decisive actors should limit themselves to achieving maximum efficiency and the improvement of the existing national policies for overcoming the pandemic.

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