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Effects of public debt on health expenditures in Europe: lessons from the COVID-19 for health system resilience to face next crises

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Abstract
This study shows how high levels of public debt and deficit affect the preparedness of health systems in Europe to face COVID-19 pandemic crisis. Empirical evidence reveals that European countries with lower COVID-19 fatality rates had average lower government gross debt and deficit as a share of GDP both in 2009 and 2019 (period before the arrival of the pandemic) compared to countries with higher public debt. The analysis of findings shows that austerity policies over time in countries having high level of public debt and deficit reduce health expenditures weakening health system resilience to face pandemic crisis. Policy implications suggest continuous investments in health systems to be ready for next crises and emergencies.

Keywords: government debt, health expenditure, health system, case fatality rate, COVID-19 pandemic
JEL Classification Codes: I18, H12, H51, H60, H63

1. Introduction

Preparedness and health system resilience of countries in the presence of emergencies and crises are fundamental aspects to reduce vulnerability and negative effects in socioeconomic system (Núñez-Delgado et al., 2021; Coccia, 2020, 2021, 2022, 2022a, 2023, 2023a; Coccia and Benati, 2024; Kargı et al., 2023, 2023a). Countries with higher gross domestic product (GDP), levels of disposable income, larger tax revenues, etc. invest more economic resources

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in healthcare infrastructures, medical technologies, human resources and health services (Aba and Athes, 2016; Raghupathi and Raghupathi, 2023). However, countries with high levels of public debt and deficit have to control the public budget with austerity policies (including spending cuts and tax increases), which impact investing in health system, education and other public sectors (Alesina et al., 2019; Coccia, 2016, 2017; Karanikolos et al, 2022; Crivelli et al, 2010). Studies suggest that high levels of public debt may restrict government expenditure, especially in healthcare and education sectors (Souliotis et al., 2018). Notably, debt management policies often result in decreased health expenditure, thereby impacting the efficiency of the health system (Coccia and Benati, 2024, 2024a; Theodoropoulou, 2022). Moreover, high public debt has significative effects on the economic system and it can decrease a government's ability to respond to emergencies, crises and social problems (Essers and Cassimon, 2023).

The goal of investigation in this study is to assess whether statistical evidence supports the working hypothesis that the levels of COVID-19 fatality rate and excess of mortality in European countries can be explained by the level of general government gross debt (expressed as a percentage of GDP), which seems to have a negative impact on the operation of health systems to face crises.

2. Data

2.1. Sample

Our study focuses on a sample of 27 European countries characterized by a comparable socioeconomic structure, providing a consistent dataset suitable for robust statistical analyses. Countries under study are: Austria, Belgium, Bulgaria, Croatia, Cyprus, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, Netherlands, Poland, Portugal, Romania, Slovakia, Slovenia, Spain, and Sweden.

2.2. Variables

We examine structural indicators of the economic and health system in European countries in specific years (2009 and 2019) to assess the level and change before the COVID-19 pandemic crisis (started in February 2020 when effective drugs and therapeutic treatments lacked) and their relationship with case fatality ratio of the COVID-19 in 2020 and with excess of mortality over 2020-202. Table 1 shows the variables under study.

Table 1. Variables and sources

Variable and source	Description
Health expenditures a share of GDP (OECD, 2023)	Total expenditure on health, expressed as a share of Gross Domestic Product (GDP).
Government consolidated gross debt, as a share of GDP (Eurostat, 2024)	Government debt is defined as the total consolidated gross debt at nominal value in the following categories of government liabilities: currency and deposits, debt securities and loans.
General government deficit/surplus as a share of GDP, from 2001 to 2022 (Eurostat, 2024a)	Net lending/net borrowing as a share of Gross Domestic Product
Case fatality rate (CFR) on 30 December 2020 (JHU, 2023)	The number of deaths in COVID-19 cases is divided by the total number of people infected by COVID-19 during a specified period (Azizi et al., 2020).
Crude death rate - per 1000 persons (Eurostat, 2024b)	Death means the permanent disappearance of all evidence of life at any time after life birth has taken place. The crude death rate is the ratio of the number of deaths during the year to the average population in that year.

3. Methods

The variables in Table 1 are first examined with descriptive statistics based on arithmetic mean, standard deviation, skewness and kurtosis. After that, the average COVID-19 fatality rate in the year 2020, the inception year of the COVID-19 pandemic crisis, is employed to categorize the sample of European country into two groups:

- Group 1, Countries with *lower* COVID-19 fatality rates in 2020 than the sample arithmetic mean: Austria, Croatia, Cyprus, Czech Republic, Denmark, Estonia, Finland, Germany, Latvia, Lithuania, Luxembourg, Malta, Netherlands, Portugal, Slovakia and Sweden.
- Group 2, Countries with *higher* COVID-19 fatality rates in 2020 than the sample arithmetic mean: Belgium, Bulgaria, France, Greece, Hungary, Ireland, Italy, Poland, Romania, Slovenia and Spain.

Both the arithmetic mean and the change from 2009 to 2019 (ten years) of government gross debt and of expenditures in health system are calculated, considering countries in group 1 and 2, to assess the evolution of public debt and health expenditure before the emergence of COVID-19 pandemic crisis. The year 2009 is the starting point of current analysis because global financial and economic crisis in 2009 has generated interventions of public finance to control public debt in countries where the national burden was high, such as Italy, Greece, etc. with consequential effects on socioeconomic systems.

Moreover, a comparative analysis between group 1 and 2 is directed to support the *working hypothesis* that countries with high levels in public debts reducing health expenditure over time, can explain high case fatality rates of COVID-19 of countries (cf., Coccia and Benati, 2018).

After that, we investigate the relations among Government Gross Debt (as a percentage of GDP), health expenditures, and COVID-19 case fatality rates in European countries using the Two-Stage Least-Squares Regression method (2SLS), based on following equations:

Stage 1.

$$y_i = \alpha + \beta_1 x_i + u_i \quad (1)$$

y_i = change of health care expenditures per capita from 2009 to 2019
x_i = government gross debt, percentage of GDP in 2009, instrumental variable
u_i = error term, i = countries

Stage 2.

$$f_i = \kappa + \beta_2 fit\ y_i + \varepsilon_i \quad (2)$$

f_i = COVID-19 case fatality rate in 2020, dependent variable
$fit\ y_i = fit$ for change of health care expenditures per capita from 2009 to 2019 with Eq.1
ε_i = error term

In order to control statistical analyses just mentioned, we also calculate the excess of mortality with the following formula:

$$Excess\ Mortality\ (ExMort) = crude\ death\ rate\ per\ 1\,000\ persons\ (2020-2022, COVID-19\ pandemic\ period) - crude\ death\ rate\ per\ 1\,000\ persons\ (2016-2019, pre-pandemic\ period) \quad (3)$$

The excess of mortality is analyzed with partial correlation in relation to health expenditures as share of GDP, controlling government consolidated gross debt as a share of GDP. Statistical analyses are performed with IBM SPSS Statistics 26 ®.

4. Results

Table 2 reveals that group 1 with a lower COVID-19 fatality rate in 2020 (1.40%) than group 2 (2.83%) has in the year 2009 and 2019 higher levels of health expenditure per capita (> $3,100 per capita). From 2009 to 2019 this group 1 has a rate of growth of health expenditure per capita of 0.19. Instead, countries with a higher COVID-19 fatality rate in 2020 had in 2009 and 2019, the levels of health expenditure per capita were lower than previous group 1 (about $2,530 in 2009 and $2,600 in 2019). Moreover, this group 2 has a lower rate of growth in health expenditure per capita from 2009 to 2019 and equal to 0.09. If we consider government gross debt as % of GDP, table 1 reveals that in group 1 it is lower both in 2009 (46.80%) and 2019 (50.79%) than group 2, which has 67.22% in 2009 and 81.49% in 2019. In addition, group 1 has from 2009 to 2019 a lower growth of government gross debt (% of GDP) given by 0.12 compared to group 2 that has experienced a high growth of government gross debt (% GDP) of 0.29, generating a high burden for socioeconomic system and public finance that reduces health expenditures and negatively affects health system resilience. General government deficit/surplus (% of GDP) shows that in 2009, countries with reduced COVID-19 fatality have negative values, which are lower than countries with higher COVID-19 fatality rate (–4.99 *vs.* –8.16). Similar trend in 2019 that is –0.67 (in countries with lower COVID-19 fatality) *vs.* –1.14 (in countries with higher COVID-19 fatality).

Table 2. Descriptive statistics categorized per groups

	Countries with LOWER COVID-19 Fatality in 2020, group 1		Countries with HIGHER COVID-19 Fatality in 2020, group 2	
Variables	Mean	Std. Dev.	Mean	Std. Dev.
COVID-19 Fatality 2020 (%)	1.40	0.44	2.83	0.54
Healthcare Exp per Capita $ 2009	$3,119.79	$2,192.71	$2,609.13	$1,828.01
Healthcare Exp per Capita $ 2019	$3,376.29	$2,014.03	$2,530.77	$1,749.05
ΔHealthcare Exp per Capita $2009-2019	0.19	0.30	0.09	0.31
Government gross debt, % of GDP 2009	46.79	22.21	67.22	37.35
Government gross debt, % of GDP 2019	50.93	27.43	81.51	46.61
General government deficit/surplus, % of GDP 2009	–4.99	3.06	–8.16	3.80
General government deficit/surplus, % of GDP 2019	0.67	1.28	–1.14	2.01
ΔGovernment gross debt, % of GDP 2009-2019	0.12	0.31	0.29	0.38
ΔGeneral government deficit/surplus, % of GDP 2009-2019	–5.66	2.77	–7.03	4.41
Excess of mortality per 1000 persons	1.11	0.67	1.60	1.05

Source: authors´ elaboration

Note: Δ= the rate of change from 2009 to 2019 to assess the dynamics of health expenditures per capita, Government gross debt and government deficit/surplus before the emergence of COVID-19 pandemic crisis; Std. Dev.=Standard Deviation

Table 3 presents the results of the regression analysis using the 2SLS method. The findings clearly indicate that when countries experience a 1% increase in health expenditure per capita in 2009-2019 (predicted values, accounting for government gross debt as a percentage of GDP in 2009 in the first stage of regression), it leads to a 2.63% reduction in the COVID-19 fatality rate. The R^2 coefficient of determination explains approximately 25% of the variance in the data. Although the R^2 value is not particularly high in the model, the *F* value is statistically significant (*p*-value < 0.01), indicating that the independent variable reliably predicts the reduction in the COVID-19 fatality rate.

Table 3. Parametric estimates

	Constant	Coefficient Beta	Stand. Coeff. Beta	R_2	F
Stage 1					
Change of health care expenditures per capita US$ in 2009 – 2019 (1)	0.449***	–0.005**	–0.54	0.29	10.27**
Stage 2					
COVID-19 Case fatality rate 2020 (2)	2.383***	–2.626**	–0.502	0.25	8.41**

Source: authors´ elaboration

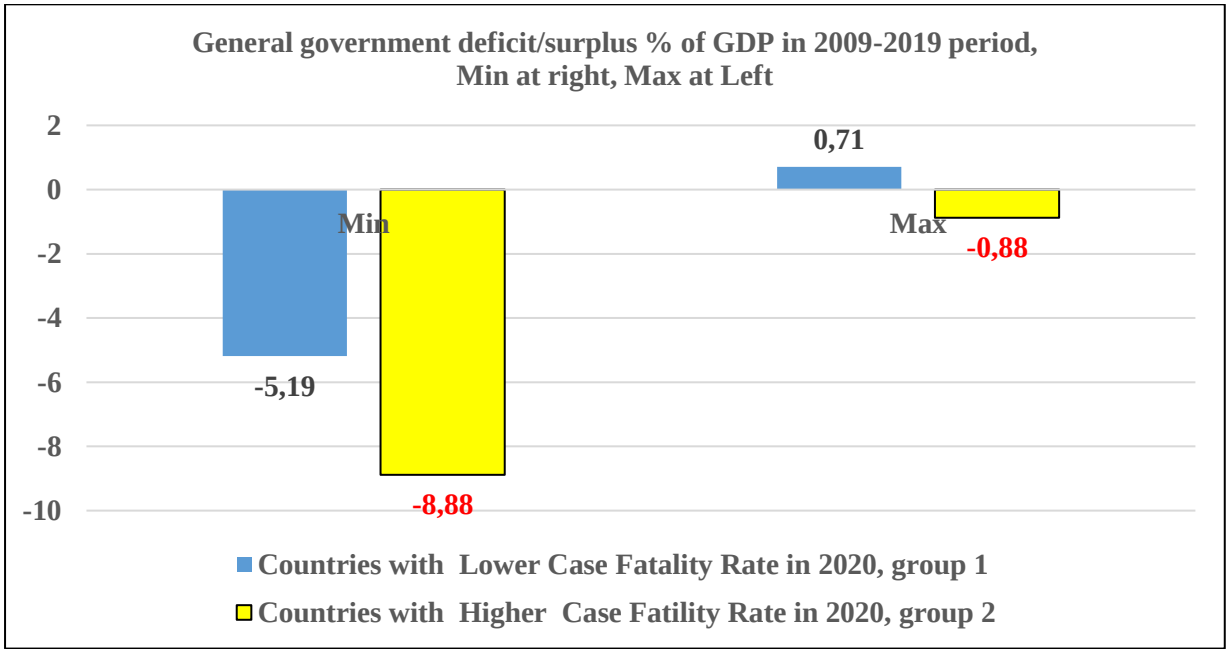
Note: Δ= the rate of change from 2009 to 2019 to assess the dynamics of health expenditures per capita, Government gross debt and government deficit/surplus before the emergence of COVID-19 pandemic crisis

Figure 1 confirms the results considering the range (min and max value) of general government deficit/surplus, % of GDP in 2009-2019. Countries with low case fatality rate have a minimum value in deficit of –5.19 as share of GDP, a lower value than –8.9 in countries with higher case fatality rate. Instead, the first group has a positive max value (surplus, +0.71), whereas group 2 has a negative max value (deficit,–0.88). This result reveals that the lower average value of public debt and deficit in European countries is associated with higher health expenditures as share of GDP and lower COVID-19 case fatality rate.

Figure 2 illustrates the estimated relationship and average line on the *y*-axis. This figure 2 provides insight into which countries fall above the horizontal line, which have a higher vulnerability in coping with the COVID-19 pandemic crisis, such as Belgium, Hungary, Spain, Poland, Slovenia, Romania, and notably Greece and Italy (these countries have a high COVID-19 fatality rate). Conversely, countries located below the average line in Figure 2 show that lower levels of public debt over time are associated with greater resilience and effectiveness in health system, leading also to a lower COVID-19 case fatality rate in 2020 (cf., Coccia, 2023; Sagan et al., 2020, 2021; OECD, 2023a).

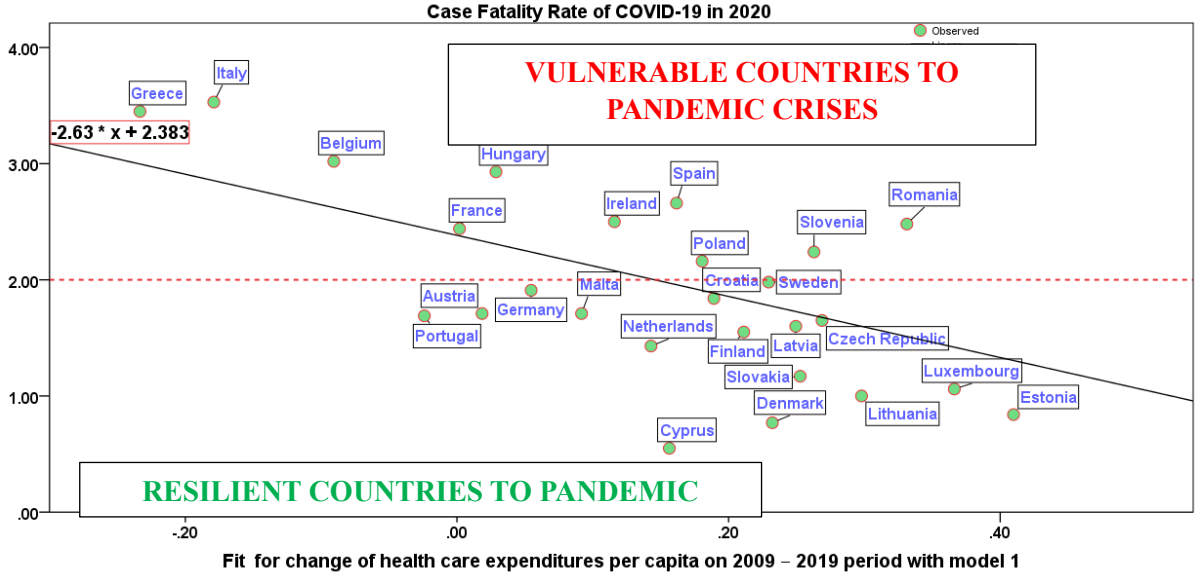
The counter check of results shows that countries with low public debt have an excess of mortality of 1.11 death rate per 1000 persons in COVID-19 pandemic (Standard Deviation, SD=0.67), whereas countries with high public debt have a higher excess of mortality of 1.60 (SD=1.05). Partial correlation of the excess of mortality (ExMort) in relation to health expenditures (HealthE) as % of GDP, controlling government consolidated gross debt GDebt (% of GDP) is $r_{ExMort,HealthE|GDebt} = -0.48$ (p-value=0.01): The growth in health expenditures has a high association with the reduction in excess of mortality during the emergencies, *ceteris paribus* the level of public debt in countries.

Figure 1. Min and Max value of General government deficit/surplus, % of GDP in countries with higher and lower COVID-19 fatality rates, which have also lower average Government debt and higher health expenditure as share of GDP to support working hypothesis



Source: authors´ elaboration

Figure 2. Regression line of COVID-19 fatality rate (CFR) in 2020 on fit for change of health care expenditures per capita in 2009 – 2019 with Eq. 1; area of vulnerable has CFR >2, area resilient countries has CFR<2. R^2= 0.25, *F*-test= 8.41 (*p*-value=0.008)



Source: authors´ elaboration

5. Discussion and implications of public finance to face next emergencies

Our data suggests that high average values of public debt and deficit in European countries lead to lower health expenditure per capita. Countries experiencing higher case fatality rates and excess of mortality observed, from 2009 to 2019, a substantial rise in public debt (0.29% of GDP), resulting in a deterioration in the overall health system. Conversely, countries with lower fatality rates, despite a lesser increase in public debt (0.12% of GDP), have a notable escalation in health expenditure, totaling 0.19% of GDP. High levels of public debt and deficit are linked to lower health expenditures and a decreased readiness of healthcare systems in addressing the COVID-19 pandemic crisis, resulting in a heightened mortality rate. Greece and Italy, for instance, exhibited substantial government debt levels as a percentage of GDP, which compromised their health systems by constraining healthcare spending and subsequently impacting their ability to promptly respond to COVID-19 pandemic crisis (cf., Sagan et al., 2020, 2021; Marginean and Orastean, 2022). According to Theodoropoulou (2022), the impact of the pandemic was severe in Greece due to substantial cuts in public spending on healthcare as part of the economic adjustment programs during the 2010s. The susceptibility of the health system stems from high public debt in certain countries, often resulting from political economic strategies based on austerity measures aimed at alleviating the burden of government debt, such as the Stability and Growth Pact (Theodoropoulou, 2022). Nickel et al. (2010) highlight that the 2008-2009 financial crisis led to a significant increase in public debt across European economies with consequential fiscal consolidation measures targeting reductions in governmental spending, including social welfare, healthcare, education and public sector salaries.

However, these governmental strategies of public debt reduction fail to take into account the nation's systemic ability to withstand crises (Burriel et al., 2020). The European Central Bank (2016) affirms that excessive government debt leads economies to be less resilient to unforeseen shocks (Fan et al., 2024; OECD, 2023a; Coccia and Benati, 2024, 2024a; Coccia, 2022, 2022a, 2023, 2023a). McKee et al. (2012) contended that numerous European governments, either voluntarily or under the direction of international institutions, have implemented strict austerity policies in reaction to substantial high levels of public debt. However, austerity measures in Europe have been economically unsuccessful, and have also adversely impacted on the healthcare sector, leading to reductions in health funding generating a systemic deterioration to face crises, such as during the COVID-19 pandemic, with consequent increases in mortality rates (Karanikolos et al., 2022). Hence, financial strategies and public finance interventions that impose limitations in various European countries with significant public debt tend to heighten systemic fragility and diminish the ability of health system resilience to effectively respond to crises (Benati and Coccia, 2022, 2022a). The fundamental implications of economic policy of these findings are that countries must decrease public debt with good governance and steer clear of austerity measures in order to allocate more resources to the healthcare sector and enhance resilience against unforeseen emergencies like the pandemic, natural calamities, conflicts, and other multifaceted and cascading disasters.

6. Concluding remarks

The COVID-19 pandemic shows gaps in disease treatment between European countries. Manifold factors generate these gaps such as the level of financing in health systems that is low in countries with high public debt when applying austerity measures over time. The statistical evidence here reveals that the case fatality rates of COVID-19 can be explained by the level of public debt that affects consequently health expenditures between European countries. In particular, the findings here suggest that countries with average high level of government debt have also lower health spending per capita and as consequence high levels of COVID-19 case fatality rate. This result is confirmed with the excess of mortality that is negative associated with health expenditures as % of GDP, controlling government gross debt: $r = -0.48$ (p-value=0.01). In short, austerity policy to keep public debt ratios in countries at prudent levels and avoid further sovereign debt crises and financial shocks lead to general cuts of expenses, included in the health sector, which expose countries to vulnerabilities to face crises.

These conclusions are of course tentative, because manifold factors of control should be considered in relationship under study here in future studies, such as density of population that has a positive correlation with incidence and mortality rate in COVID-19 (Martins-Filho, 2021; Carozzi et al., 2024). Studies also show that the risk for serious COVID-19 and other respiratory diseases depends on economic status, comorbidity, age, work and other activities that should be considered in future development of this paper (Bonanad et al., 2020; Esteve et al., 2020; Valero-Bover et al., 2023). To conclude, there is need for much more detailed research into the relations between pandemic crises, socioeconomic and demographic factors, preparedness of nations and detrimental effects in society.

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