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Adding fuel to the fire? Inequality and the spread of COVID-19*

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Abstract

The pandemic has progressed differently across the world. Using monthly data on COVID-19 cases and fatalities, we evaluate whether income inequality is an important factor in explaining cross-country differences in the spread and mortality of the virus. The results show that income inequality is positively correlated with the number of COVID-19 cases. Higher income inequality is associated with a more rapid spread of the virus and an increase in the number of cases, indirectly increasing mortality rates as well. Also, higher levels of inequality are associated with reduced effectiveness of social distancing measures in containing new infections. Thus, elevated inequalities place societies in a more vulnerable position to confront this pandemic, and more unequal countries would need more robust public responses to contain the spread of the virus.

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1 Introduction

Inequality has become one of the defining issues of our time, receiving increasing attention from scholars, policymakers, media and the general public alike. The rise in inequality within countries in the last four decades — due to globalization, the emergence and diffusion of new technologies and significant policy and institutional changes — is well documented. In the United States, for example, the income share of the bottom 50% declined from 20% in 1980 to 12.5% in 2017, while the share of the top 1% increased from about 10% to slightly over 20% in the same period (Chancel, 2021). In Europe and major developing countries, such as China and India, income inequality has followed a similar trend albeit at a different pace, while in Latin American and sub-Saharan countries, such as Brazil and South Africa, income inequality has remained at very high levels (Alvaredo *et al*., 2018).

Not surprisingly, there has been a rising interest in understanding the reasons for and implications of so many falling behind while a few others get ahead (Piketty, 2014; Milanovic, 2016). A wide range of studies in different disciplines has emerged that look into the social, economic and political outcomes of inequality (United Nations, 2020). Inequality has been found to affect such different aspects as economic growth, health and well-being, social mobility, social capital, crime, voter turnout and education, among others (d'Hombres *et al*., 2012). The debate over the policy toolkit to combat inequality has also gained considerable traction in the academic and political spheres (Blanchard and Rodrik, 2021; Atkinson, 2015).

This paper aims to shed light on the role of national income inequality levels in explaining the spread of and mortality from COVID-19 across countries. There are several channels through which income inequality can impact the spread of the virus. Higher income inequality is associated with worse population health conditions (Pickett and Wilkinson 2015), which make for a more fertile ground for an infectious disease. More unequal societies may also have health systems less prepared for mass population service and, by the same token, less population with access to health services, making them less prone to seek medical care or able to access preventive healthcare. There are stark differences in healthcare access, even among developed economies. While most European countries have achieved universal or near universal health coverage for a core set of medical services, in the United States, 8 per cent of the population (26 million people) did not have health insurance in 2019 (Keisler-Starkey and Bunch, 2020).

Moreover, if more unequal countries have smaller social safety nets in place, this could translate into a lower capacity to readily target and support those in greater financial need, such as those more exposed to the virus due to low-paying high-contact jobs and lower wealth. It could also translate into relatively more people having deficient access to sanitation, housing and other goods and services that are essential in preventing the spread of infectious diseases. In addition, inequalities influence social distancing, as poorer households are less capable of observing physical distancing and ensuring the effective implementation of lockdowns, which was shown to lead to a disproportionate increase in COVID-19 incidence and fatality rates (Lingam and Sapkal, 2020).

Elevated inequality is also correlated with lower levels of trust in others and social capital (Gould and Hijzen, 2016), which can fuel doubt in official health information. Ultimately, lower confidence in public institutions can undermine the compliance of the population with mandatory health measures. Previous studies related to the influenza pandemic, for example, have shown that protective behaviours such as wearing a face mask, washing hands and intentions to receive a vaccine are related to confidence in governmental authorities and the existence of social capital (Chuang *et al*., 2015). Social capital can affect the adoption of healthy behaviours during an outbreak through community norms, diffusion of health information and provision of support by cohesive social networks (Kim *et al*., 2006). Lastly, as inequality and institutional quality tend to be inversely related (Savoia *et al*., 2010), more unequal countries with weaker institutions could be less able to readily enforce effective mitigation and containment measures.

In this paper, we investigate whether income inequality accounts for some of the differences in COVID-19 infection and mortality rates observed between countries[1]. Our premise is that income inequalities are positively correlated with cases and related deaths. In addition, we analyse whether inequality affects the effectiveness of social distancing measures implemented by countries in curbing new infections. Our hypothesis is that more unequal countries would have lower responsiveness of COVID-19 cases with respect to social distancing measures. The paper is organized as follows. Section 2 examines basic descriptive statistics regarding the spread of the virus and income inequality and briefly discusses the literature. Then, section 3 describes the empirical approach and section 4 discusses the main econometric results. Finally, section 5 provides some concluding remarks.

2 COVID-19 and inequality

Table 1 provides statistical information regarding the dynamics of COVID-19 cases and related deaths per 100,000 people and income inequality for countries with available data. At the fourth month following the first case in each country, the average number of cumulative cases per 100,000 people is higher for countries with relatively lower levels of inequality than for more unequal countries. This reflects that, as expected, structural factors such as inequality were less impactful at the early stages of the outbreak. In countries with Palma ratio[2] below 1.6, the average number of cases is above 120, while for countries with Palma ratio above 2.1 it is below 85. A similar situation is observed for the average number of deaths. This pattern between countries with low- and high-income inequality is similar when using the Gini coefficient.

Table 1
Inequality and COVID-19 cases and related deaths

				4 months		7 months	
	Interval	**Average**	**Countries**	**Cases**	**Deaths**	**Cases**	**Deaths**
Palma Ratio							
Low inequality	0.9 – 1.5	1.2	71	123.5	7.4	309.8	12.5
Medium inequality	1.6 – 2.0	1.8	35	64.7	1.5	267.7	5.2
High inequality	2.1 – 7.0	3.0	41	82.8	2.5	506.3	15.4
Total	0.9 – 7.0	1.9	147	-	-	-	-
Gini coefficient							
Low inequality	24 - 39	33.1	96	104.3	5.8	295.9	10.2
Medium inequality	40 - 44	41.9	32	95.1	2.4	399.1	12.2
High inequality	45 - 63	50.4	32	62.5	2.2	457.7	12.5
Total	24 - 63	38.3	160	-	-	-	-

Source: Authors' own elaboration based on data from Johns Hopkins University and World Development Indicators (World Bank) accessed on 30 October 2020.

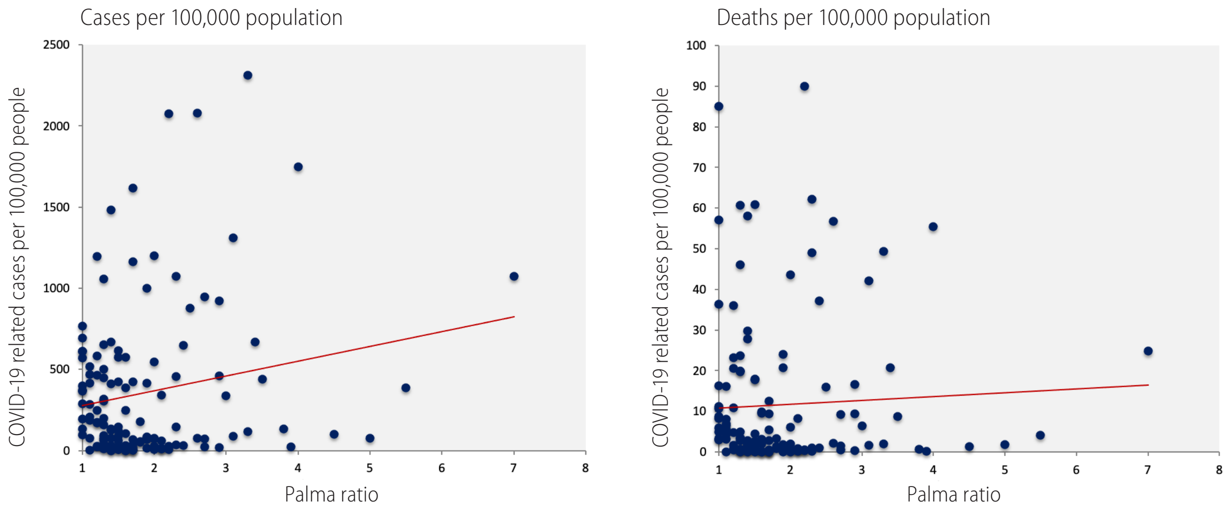
Note: Cases and deaths correspond to the average among countries of the number of cumulative cases and deaths, respectively, per 100,000 people at the fourth and seventh month of the epidemic.

1 There are different ways to measure socioeconomic inequalities with one alternative measure being wealth inequality. For the purposes of this analysis, we prefer to use measures of income inequality as they connect more directly with labour market conditions. Different working conditions across occupations and sectors seem to have played a crucial role in social distancing possibilities and, thus, on the transmission of the virus.

2 The Palma ratio corresponds to the share of national income of the 10% highest earners over the share of national income of the 40% lowest earners.

Seven months into the pandemic, once the virus has sufficiently spread, the picture is fully reversed. In countries with relatively lower levels of income inequality (Palma ratio below 1.6), the average number of cases is about 310. In more unequal countries (Palma ratio above 2.1), the average number of cases is above 500. Thus, countries with higher income inequality tend to display a higher number of cases and deaths (adjusted for time since the first case) compared to countries with lower levels of inequality. Also, the correlation between the Palma ratio and cases is relatively stronger than with deaths (see figure 1). Though the inequality categories in table 1 are constructed arbitrarily and there is significant variation in cases and deaths among countries with similar levels of income inequality, the information is also indicative that income inequality can play a role in fuelling contagions as the virus becomes more prevalent in society. In the next section, we describe the empirical approach to analyse the correlation of income inequality and COVID-19 cases and related deaths more systematically.

Figure 1
COVID cases and related deaths and Palma ratio



Source: UN DESA based on data from Johns Hopkins University and World Development Indicators (World Bank).
Note: Cumulative number of cases and deaths at the seventh month of the epidemic for each country.

There are prominent examples of countries with relatively high levels of income inequality that have been battered by COVID-19. In the developed world, the United States has suffered severe impacts from the pandemic. In the developing world, notable examples are Brazil, Mexico and South Africa, which rank among those with higher income inequality according to our data. As of May 2021, these three countries accounted for a disproportionately higher share of the cumulative global death toll (21 per cent), given their share of the global population (5 per cent). Some countries with moderate or high levels of inequality witnessed, however, less severe impacts from the pandemic. For example, several countries with high income inequality in Africa have reportedly largely escaped the virus, such as Angola, Benin, Cameroon, Central African Republic, Malawi, Republic of Congo and South Sudan, which have less than 3000 confirmed cases of COVID-19 per million population as of August 2021 and a Gini coefficient above 44. To some extent, this can be attributed to their relatively low levels of integration with the world economy.

Since the outbreak of the pandemic, a few studies have emphasized the association between inequality and differences in mortality rates across countries due to the COVID-19 pandemic. For example, Elgar *et al.*, (2020) shows that for a 30-day period after a country registers its tenth COVID-19 death, mortality was positively related to income inequality, controlling for population size, age structure and wealth. It also shows that countries with lack of social capital, such as civic engagement and confidence in state institutions, tend to have a higher number of deaths, consistent with previous studies for the SARS and H1N1 pandemics.

Some studies have shown how non-income inequalities correlate with novel coronavirus infection and mortality within countries. In the United States, poorer and more unequal areas tended to have higher infection and mortality rates, with some of these effects being due to racial differences since the COVID-19 pandemic has disproportionally impacted minorities (African American and Latino/Hispanic) (Brown and Ravallion, 2020; Irwin *et al*., 2020). In Brazil, population of African origin were more likely than the white population to have COVID-19 symptoms and to lose their jobs or face pay cuts during the pandemic (Nassif-Pires et al., 2020). The overlap of racial inequalities with income and educational inequalities exacerbated the disparities in the risk of infection, while the persistence of unequal access to healthcare increased the severity of illness and the number of deaths (Islam *et al*., 2020)[3].

3 Empirical approach

In order to analyse the correlation between inequality and COVID-19 cases and related deaths, we specify the following equations:

$$\log(\text{Cases}_{i,t}) = \alpha_i + \delta_t + \delta\text{Cases}_{i,t-1} + \theta\text{Inequality}_i + \beta X_i + \varepsilon_{i,t} \quad (1)$$

$$\log(\text{Deaths}_{i,t}) = \alpha_i + \delta_t + \delta\text{Cases}_{i,t-1} + \theta\text{Inequality}_i + \beta X_i + \varepsilon_{i,t} \quad (2)$$

where i and t represent countries and months since the first case in each country, respectively. The dependent variables, and $Cases_{i,t}$ and $Deaths_{i,t}$, are the cumulative number of COVID-19 cases and related deaths, respectively, per 100,000 people till month t in country i. To measure income inequality at the country level, we use the Palma ratio, which compares the income shares of the highest (10%) and lowest (40%) earners, and the Gini coefficient[4]. As control variables, we include the cumulative number of cases in country i in t-1 months since the first case, $Cases_{i,t-1}$, and a vector X of country characteristics, which includes the share of population living below the national poverty line, total population[5], and share of urban population[6]. Annex 2 presents summary information on these variables. Our hypothesis is that the more unequal an income distribution is, the worse are the outcomes related to the pandemic in terms of infections and deaths, independently of the share of people living in poverty in the country. Hence, we use an absolute poverty measure, which allows

3 Previous studies have shown that income inequalities within countries play a crucial role in the spread of infectious diseases. During the Spanish influenza, mortality rates in Norway were higher among working class districts, while in Chicago they were highest among the unemployed (Bambra et al., 2020). Research on influenza shows that inequality exacerbates rates of transmission and mortality. In the case of H1N1, mortality rates in England were three times higher in more deprived areas than in those less deprived (Rutter et al., 2012).

4 For the purpose of analyzing the correlation with COVID-9 cases and related deaths, the Palma ratio is our preferred proxy for income inequality. The comparison of the extremes of the income distribution connects more directly with some channels of how inequality can affect the spread of the virus, namely different working conditions and social distancing possibilities. As a robustness check, we also use the income share of the highest 10% earners as a proxy for income inequality. See annex 1 for the histograms of the Palma ratio and the Gini coefficient.

5 The variable total population is included to measure the size of the country. Some factors associated to this dimension could be related to transmission rates, especially at early stages of the pandemic, like number of international flights and the capacity for federal and local governments to implement social distancing measures.

6 See annex 2 and 3 for basic statistics and the correlation matrix of the estimation variables, respectively.

us to disentangle and identify the effects of being at the bottom of the income distribution (relative poverty) from being poor (absolute poverty). We also include regional fixed effects (Africa, Latin America and Asia) and a dummy controlling whether countries are located in the Northern hemisphere[7]. Because of the count nature of the data on cases and deaths, we estimate equations (1) and (2) by random effects Poisson regressions in Stata[8]. The random effects α_i, δ_t and $\varepsilon_{i,t}$ are Gaussian distributed with mean zero. [1]Annex 3 shows the correlations between the variables. As none of the correlations are extremely high, problems of collinearity are not expected and all variables are kept in the model.

Equations (1) and (2) provide the basis for analysing the correlation between COVID-19 cases and deaths and inequality. However, it is important to consider that the pandemic has also been shaped by the policy measures implemented to curb the infection rates within countries. To take into account country efforts to limit the spread of the virus, we specify the following equations:

$$\log(\Delta \text{Cases}_{i,t}) = \alpha_i + \delta_t + \gamma \text{Active cases}_{i,t-1} + \rho \text{Stringency}_{i,t-1} + \theta \text{Inequality}_i + \beta \text{Stringency}_{i,t-1} * \text{Inequality}_i + \pi X_i + \varepsilon_{it} \quad (3)$$

$$\log(\Delta \text{Deaths}_{i,t}) = \alpha_i + \delta_t + \gamma \text{Active cases}_{i,t-1} + \rho \text{Stringency}_{i,t-1} + \theta \text{Inequality}_i + \beta \text{Stringency}_{i,t-1} * \text{Inequality}_i + \pi X_i + \varepsilon_{it} \quad (4)$$

with

$$\Delta \text{Cases}_{i,t} = \text{Cases}_{i,t} - \text{Cases}_{i,t-1} \text{ and}$$

$$\Delta \text{Deaths}_{i,t} = \text{Deaths}_{i,t} - \text{Deaths}_{i,t-1}$$

The dependent variables, $Cases_{i,t}$ and $Deaths_{i,t}$, represent the number of COVID-19 cases and related deaths per 100,000 people in country i, t months since the first case in the country. The *Active cases*$_{i,t-1}$ variable corresponds to the lagged number of active cases[9] for each country. The *Stringency*$_{i,t-1}$ variable is a proxy for the (cumulative) degree of intensity of lockdowns and other social distancing measures taken to control the pandemic in country i by time t-1, including school or workplace closings, cancellations or restrictions of public events and social gatherings, public transport closures, stay-at-home orders and restrictions on national and international movement.[10] Though this variable does not capture how well measures are enforced or how the population complies to them, it is expected to have a negative effect in the number of cases and deaths. Stringency varies between 0 and 100 with 100 being the most severe/intense measures. We also use the Gini coefficient and the Palma ratio as proxies for national income inequality.

7 Several other variables were considered in the regressions, including GDP per capita, Human Development Index, an index of the quality of healthcare systems, and the share of population over 65 years. Given the high correlation of these variables with poverty (above 0.5), we introduced them in separate regressions. The results on inequality remain robust to the inclusion of these variables.

8 We use robust standard errors to control for overdispersion in the data. While the negative binomial regression is designed to tackle the overdispersion problem in count data, Poisson panel estimators rely on weaker distributional assumptions and, with cluster-robust standard errors, can lead to more consistent estimates (Cameron and Trivedi, 2010).

9 Active cases represent the number of confirmed cases minus the number of recovered cases and deaths (number of cases still considered to be infectious).

10 The *Stringency* variable comes from the *Oxford COVID-19 Government Response Tracker* (see https://www.bsg.ox.ac.uk/sites/default/files/2020-10/BSG-WP-2020-032-v8.pdf).

In addition, we include a multiplicative variable of *Stringency* and *Inequality*. This multiplicative variable indicates whether the effect of the policy measures to curb the pandemic depends on the level of inequality. The lack of social cohesion,[11] social capital and confidence in health authorities could make public behaviour less responsive to compulsory social distancing measures. Finally, the vector X includes regional dummies (Africa, Latin America and Asia) and a dummy for countries in the Northern hemisphere. Again, we estimate equations (3) and (4) by random effects Poisson regression in Stata.

4 Does inequality matter?

Table 2 displays the results for the estimations of equation (1) of COVID-19 cases. Column (1) shows the regressions after 4 months since the first case in each country and using the Palma ratio as a measure for inequality. The coefficient associated with the Palma ratio is not significant, showing that the different spread of the virus across countries is not related to differences in inequality. A similar result applies when using the Gini coefficient, in column (2). The following columns from (3) to (6) display the estimations after 7 months since the first case. Columns (3) and (5) present the baseline regressions, and columns (4) and (6) include the lagged value of cases as explanatory variable. The results indicate that the Palma ratio is positively correlated to the number of cases across countries in the two specifications. The correlation is also positive and significant when using the Gini coefficient. Thus, this indicates that the correlation between inequality and cases appears only once the virus has spread sufficiently within countries[12]. Beyond the inequality variables, the results also show that a country's share of urban population has a positive and significant correlation with COVID-19 cases and related deaths, as expected. The share of the population living below the poverty line is not correlated with the number of cases across countries.

Table 3 display the results for equation (2). In the regressions after 4 months since the first case in column (1), the result shows that the coefficient associated with the Palma ratio is not significant, with a similar result when using the Gini coefficient. After 7 months, the coefficients are positive, but remain not significant. This indicates that the differences in income inequality across countries are not related to the differences in the numbers of deaths. Interestingly, the share of people living below the national poverty line is positively and significantly correlated to the number of deaths, which could reflect a higher share of population with deficient healthcare services[13].

Table 4 presents the regression results for equations (3) and (4). Column (1) displays the regression for the change in cases, when using the Palma ratio as a proxy for inequality. As expected, the coefficient associated with the variable Stringency is negative and significant, illustrating that the national efforts to curb the spread of the virus are important. The coefficient associated with the Palma ratio is not statistically different than 0, while the multiplicative variable of Palma ratio and Stringency is positive and significant. Notably, the marginal effect of the Palma ratio remains positive and significant at a 5%, consistent with the previous results in table 1. Interestingly, the positive coefficient of the multiplicative variable suggests that the effect of

11 Social cohesion refers to the extent of connectedness and solidarity among groups in society. It is composed of two main dimensions: the sense of belonging of a community and the relationships among members within the community itself (Manca, 2014).

12 The data on cases can be underestimated, as countries greatly differ in their testing capacity. To tackle this issue, we estimate equation (1) including the number of tests per thousand people as explanatory variable (see annex 4). In addition, there might be measurement problems regarding the number of deaths from COVID-19 across countries. In fact, some countries used different guidelines on the certification and coding of COVID-19 as a cause of death. At the same time, the official death toll in many countries seem to undercount the total number of fatalities.

13 As a robustness check, we also implement the regressions of table 1 and 2 using the share of the 10% of highest earners as a proxy for inequality (see annex 5).

Table 2
Poisson panel regressions – Cases

	4 months		7 months			
	Cases (1)	Cases (2)	Cases (3)	Cases (4)	Cases (5)	Cases (6)
$Cases_{t-1}$	0.00	0.00		0.00		0.00
	(3.24)**	(3.24)**		(6.50)***		(6.46)***
Palma ratio	0.13		0.31	0.24		
	(1.09)		(3.00)**	(2.98)**		
Gini		0.02			0.03	0.02
		(1.25)			(2.04)**	(1.79)*
Poverty	-0.00	-0.00	-0.00	0.00	-0.01	-0.00
	(0.35)	(0.64)	(0.69)	(0.05)	(0.92)	(0.10)
Population	-0.27	-0.26	-0.22	-0.15	-0.19	-0.13
	(4.08)***	(4.00)***	(3.80)***	(2.91)**	(3.29)***	(2.53)**
Urban share	2.68	2.53	2.15	1.85	2.09	1.83
	(4.43)***	(4.37)***	(4.09)***	(4.09)***	(3.94)***	(4.08)***
Northern Hemisphere	-0.17	-0.27	-0.14	-0.01	-0.37	-0.18
	(0.61)	(0.97)	(0.54)	(0.06)	(1.35)	(0.80)
Regional dummies	Yes	Yes	Yes	Yes	Yes	Yes
Observations	393	405	914	783	942	807
Countries	131	135	131	131	135	135
Wald Chi2	2,431	2,552	4,460	8,915	4,218	8,356
Prob>Chi2	0.000	0.000	0.000	0.000	0.000	0.000

Source: Authors' own elaboration.

Note: *$Cases_{t-1}$* is the lagged value of the numbers of cases per 100,000 people. *Palma ratio* corresponds to the share of national income of the 10% highest earners over the share of the bottom 40%. *Gini* corresponds to the Gini coefficient. *Poverty* is the share of the population living below the national poverty line. *Population* is the log of total population size. *Urban share* is the percentage share of population living in urban areas. *Northern Hemisphere* is a dummy variable that takes the value 1 for countries situated in the northern hemisphere. *Regional dummies* are for Africa, Asia and Latin America. t statistics (shown in parentheses) with robust standard errors.
* Significant at 10%; ** Significant at 5%; *** Significant at 1%.

the social distancing measures to curb the virus depends on the level of inequality in each country. In fact, the positive effect of compulsory social distancing measures is lower in countries with a higher Palma ratio. The same results are observed when using the Gini coefficient as a proxy for inequality in column (2).

In the case of equation (4) of monthly changes in deaths, the results go in the same direction, as shown in columns (3) and (4). The marginal effects of the Palma ratio and the Gini coefficient are positively correlated with the number of deaths, and higher levels of inequality make social distancing measures to be less effective in the comparison across countries. Then, we investigate whether the positive correlation of income inequality and the change in deaths illustrated in columns (3) and (4) remains robust once we control for the change in the number of cases. The regressions are presented in columns (5) and (6). The results show

Table 3
Poisson panel regressions - Deaths

	4 months		7 months			
	Deaths (1)	Deaths (2)	Deaths (3)	Deaths (4)	Deaths (5)	Deaths (6)
$Cases_{t-1}$	0.00	0.00		0.00		0.00
	(4.44)***	(4.41)***		(7.54)***		(7.55)***
Palma ratio	-0.08		0.13	0.05		
	(0.72)		(1.32)	(0.57)		
Gini		0.01			0.01	0.00
		(0.41)			(0.70)	(0.15)
Poverty	0.01	0.01	0.01	0.02	0.01	0.01
	(1.37)	(1.13)	(1.65)*	(2.65)**	(1.61)*	(2.70)**
Population	0.12	0.11	0.03	0.11	0.04	0.11
	(1.64)*	(1.45)	(0.48)	(2.05)**	(0.66)	(2.17)**
Urban share	2.98	2.95	3.12	2.63	3.17	2.71
	(4.66)***	(4.71)***	(5.21)***	(5.19)***	(5.13)***	(5.17)***
Northern Hemisphere	-0.17	-0.20	-0.28	-0.17	-0.42	-0.58
	(0.63)	(0.64)	(0.97)	(0.63)	(1.49)	(1.04)
Regional dummies	Yes	Yes	Yes	Yes	Yes	Yes
Observations	393	405	914	783	942	807
Countries	131	135	131	131	135	135
Wald Chi2	261.0	259.5	400.0	606.7	377.6	558.5
Prob>Chi2	0.000	0.000	0.000	0.000	0.000	0.000

Source: Authors' own elaboration.

Note: *$Cases_{t-1}$* is the lagged value of the numbers of cases per 100,000 people. *Palma ratio* corresponds to the share of national income of the 10% highest earners over the share of the bottom 40%. *Gini* corresponds to the Gini coefficient. *Poverty* is the share of the population living below the national poverty line. *Population* is the log of total population size. *Urban share* is the percentage share of population living in urban areas. *Northern Hemisphere* is a dummy variable that takes the value 1 for countries located in the northern hemisphere. *Regional dummies* are for Africa, Asia and Latin America. t statistics (shown in parentheses) with robust standard errors.
* Significant at 10%; ** Significant at 5%; *** Significant at 1%.

Table 4
Poisson panel regressions - Change in cases and deaths

	ΔCases (1)	ΔCases (2)	ΔDeaths (3)	ΔDeaths (4)	ΔDeaths (5)	ΔDeaths (6)
Active cases$_{t-1}$	-0.01	-0.01	-0.00	-0.00		
	(6.97)***	(7.09)***	(3.75)***	(3.59)***		
ΔCases					0.39	0.39
					(10.40)***	(11.46)***
Stringency	-0.44	-0.52	-0.68	-1.11	-0.36	-1.02
	(7.98)***	(5.52)***	(6.63)***	(5.68)***	(3.12)**	(5.10)***
Palma ratio	-0.17		-1.22		-1.35	
	(1.15)		(2.52)**		(2.60)**	
Palma * Stringency	0.04		0.16		0.17	
	(2.06)**		(2.91)**		(2.79)**	
Gini		-0.02		-0.13		-0.20
		(1.16)		(3.35)**		(4.75)***
Gini * Stringency		0.00		0.02		0.03
		(2.04)**		(3.79)***		(4.85)***
Marginal effects						
Palma ratio	0.13		0.17		0.06	
	(4.49)***		(3.15)**		(1.10)	
Gini		0.01		0.02		0.01
		(2.86)**		(2.89)**		(0.84)
Regional dummies	Yes	Yes	Yes	Yes	Yes	Yes
Observations	784	844	563	605	563	605
Countries	135	144	129	139	129	139
Wald Chi2	1,249	1,276	121.0	119.2	438.8	452.6
Prob>Chi2	0.000	0.000	0.000	0.000	0.000	0.000

Source: Authors' own elaboration.

Note: Regressions after 7 months since the first case in each country. *Active cases*$_{t-1}$ corresponds to the lagged value of the number of active COVID-19 cases. *Stringency* corresponds to the lagged value of the log of the stringency index of lockdowns and restrictive measures implemented by countries to control the pandemic. *Palma ratio* corresponds to the share of national income of the 10% highest earners over the share of the bottom 40%. *Gini* corresponds to the Gini coefficient. Δ*Cases* corresponds to the monthly variation in the number of cases. Regressions include a *Northern Hemisphere* dummy that takes the value 1 for countries situated in the northern hemisphere and regional dummies for Africa, Asia and Latin America. t statistics (shown in parentheses) with robust standard errors.
* Significant at 10%; ** Significant at 5%; *** Significant at 1%.

that the marginal effects of the Palma ratio and the Gini coefficient are not significant[14]. They also show that the change in the number of deaths is positively and significantly correlated with the change in the number of cases. Thus, similar to the regression results of tables 1 and 2, income inequality is shown to be strongly correlated with COVID-19 cases and, through its impact on cases, it seems to affect mortality rates. As a robustness check, we use the income share of the highest 10% earners as a proxy for income inequality and obtain similar results (see annex 6).

Hence, the analysis uncovers the role of income inequality on the spread of COVID-19. The results point towards two specific mechanisms. On the one hand, there is an impact of inequality levels on the spread of COVID-19 On the other hand, the results show that the effect of social distancing measures on the number of cases is contingent on the levels of inequality. This could likely be related to lack of social cohesion and social capital in more unequal countries, which can undermine population compliance with mandatory social distancing measures, as seen in previous pandemics (Chuang *et al.*, 2015). For deaths, there a positive effect of poverty on the COVID-19 mortality.

5 Concluding remarks

This study shows that income inequality may be an important factor in explaining cross-country differences in the spread and mortality of the novel coronavirus. The empirical evidence shows that inequalities are positively correlated with the transmission of the virus, which can indirectly contribute to higher mortality rates. These findings are robust to the use of several inequality measures. The underlying mechanisms behind the correlation of income inequality and the spread of the virus could relate to between-country differences in lack of trust in institutions, working conditions and unequal ability to social distance. This points to the importance in more unequal countries of targeting virus mitigation measures and support to individuals in more contact-intense situations (e.g. labour-intensive industries and services, urban settings). The underlying mechanisms at play could also relate to lack of social cohesion and confidence in government, as higher national levels of income inequality are associated with reduced effectiveness of social distancing measures, which will undermine national efforts to curb the pandemic. As a result, more unequal countries will likely need more robust and targeted public responses to contain the spread of the virus. More generally, elevated socioeconomic inequalities place societies in a more vulnerable position to confront the COVID-19 pandemic, which underscores the importance of tackling high levels of inequality in order to build more resilient societies in the medium-term.

14 This is surprising considering that the coefficients associated with the inequality measures and the multiplicative variables are significant. This is explained because of the relatively high correlation between both these variables, which inflates each other's variance and reduces t-test statistics. While this is somewhat problematic, removing the multiplicative variable would generate a significant bias in the estimations. Thus, this is a trade-off between unbiasedness and precision in the estimation. But, if the estimates are biased, the issue of precision becomes, to some extent, irrelevant.

References

Alvaredo, Facundo, Lucas Chancel, Thomas Piketty, Emmanuel Saez and Gabriel Zucman (2018). *World Inequality Report 2018*, World Inequality Lab.

Atkinson, Anthony B. (2015). *Inequality: What Can Be Done*, Harvard University Press, Cambridge Massachusetts.

Bambra, Clare, Ryan Riordan, John Ford, and Fiona Matthews (2020). The COVID-19 pandemic and health inequalities. *Journal of Epidemiology & Community Health*, vol. 74, issue 11, pp.964–968.

Blanchard, Olivier and Dani Rodrik (2021). *Combating Inequality: Rethinking Government's Role*. Massachusetts Institute of Technology and Peterson Institute for International Economics. The MIT Press, Cambridge Massachusetts.

Brown, Caitlin S. and Martin Ravallion (2020). "Inequality and the coronavirus: socioeconomic covariates of behavioral responses and viral outcomes across US counties", NBER Working Paper 27549 July.

Cameron, Colin A. and Pravin K. Trivedi (2010). *Microeconometrics using STATA*, Stata Press.

Chancel, Lucas (2021). "Ten Facts about Inequality in Advanced Economies" in *Combating Inequality, Rethinking Government's Role*, Olivier Blanchard and Dani Rodrik (Eds.) The MIT Press, Cambridge, Massachusetts.

Chuang, Ying-Chih, Huang, Ya-Li, Tseng, Kuo-Chien, Yen, Chia-Hsin and Lin-Hui Yang (2015). "Social capital and health-protective behavior intentions in an influenza pandemic". PloS One 10, e0122970.

d'Hombres, Beatrice, Anke Weber and Leandro Elia (2012). "Literature review on income inequality and the effects on social outcomes", Joint Research Centre (JRC) Scientific and Policy Reports, Luxembourg: Publications Office of the European Union.

Elgar, Frank J., Anna Stefaniak, and Michael J. A. Wohl (2020). "The trouble with trust: Time-series analysis of social capital, income inequality, and COVID-19 deaths in 84 countries", *Social Science & Medicine*, vol. 263, 113365.

Gould, Eric D. and Alexander Hijzen (2016). "Growing Apart, Losing Trust? The Impact of Inequality on Social Capital", IMF Working Paper, WP/16/176.

Irwin, Carlos A., Oronce Christopher A. Scannell, Ichiro Kawachi and Yusuke Tsugawa (2020) "Association Between State-Level Income Inequality and COVID-19 Cases and Mortality in the USA", *Journal of General Internal Medicine*, vol. 35(9), pp.2791–2793.

Islam, S. Nazrul, Hoi Wai Jackie Cheng, Kristinn Sv. Helgason, Nicole Hunt, Hiroshi Kawamura, and Marcelo LaFleur (2020). "Variations in COVID strategies: Determinants and lessons". DESA Working Paper No. 172.

Keisler-Starkey, Katherine, and Lisa N. Bunch (2020). "Health Insurance Coverage in the United States: 2019", Report Number P60-271, United States Census Bureau, September 15.

Kim, Daniel, Subramanian, S.V., Ichiro, Kawachi (2006). “Bonding versus bridging social capital and their associations with self-rated health: a multilevel analysis of 40 US communities”, *Journal of Epidemiology & Community Health*, vol. 60, pp.116–133.

Lingam, Lakshmi, and Rahul Suresh Sapkal (2020). “COVID-19, Physical Distancing and Social Inequalities: Are We All Really in This Together?”, *The International Journal of Community and Social Development*, vol. 2, issue 2, pp. 173–190.

Manca, Anna Rita (2014). Social Cohesion. In: Michalos A.C. (eds), Encyclopedia of Quality of Life and Well-Being Research. Springer, Dordrecht.

Milanovic, Branco (2016). *Global Inequality: A New Approach for the Age of Globalization*. Harvard University Press, Cambridge Massachusetts.

Nassif-Pires, Luiza, Laura Carvalho, and Eduardo Rawet (2020). “Multidimensional Inequality and COVID-19 in Brazil”, Public Policy Brief No. 153, Levy Economics Institute of Bard College, September.

Pickett, Kate and Richard Wilkinson (2015). “Income inequality and health: A causal review”, *Social Science & Medicine,* vol. 128, pp. 316-326.

Piketty, Thomas (2014). *Capital in the Twenty-First Century*, Harvard University Press, April.

Rutter, Paul D., Oliver Mytton, Matthew Mak, and Liam J. Donaldson (2012). “Socio-economic disparities in mortality due to pandemic influenza in England”, *International Journal of Public Health*, vol. 57, pp.745–750.

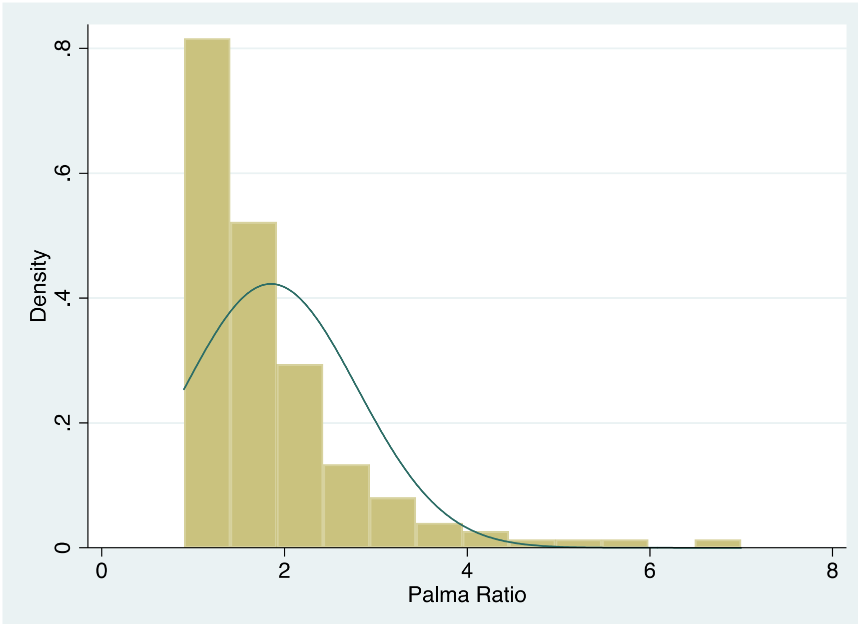
Savoia, Antonio, Joshy Easaw, and Andrew McKay (2010). “Inequality, Democracy, and Institutions: A Critical Review of Recent Research”, *World Development*, vol. 38, issue 2, pp. 142-154.

United Nations (2020). World Social Report 2020: Inequality in a rapidly changing world. Department of Economic and Social Affairs, ST/ESA/372. Sales No. E.20.IV.1

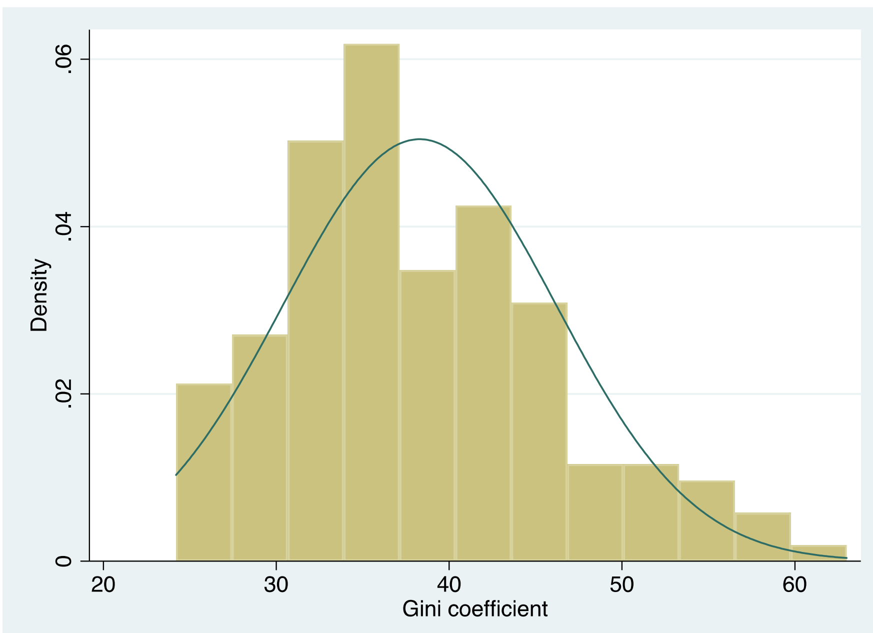
Annex 1

Histograms of inequality measures

Palma ratio



Gini coefficient



Source: Authors' own elaboration based on data for the latest available year for each country from World Development Indicators (World Bank) accessed on 30 October 2020.

Annex 2

Basic statistics

Variables	Mean	Std. Dev.	Min.	Max.
Cases (4 months)	188.6	340.2	0.21	3,301.1
Cases (7 months)	641.0	793.0	1.04	4,357.1
Deaths (4 months)	6.0	12.1	0	82.4
Deaths (7 months)	16.2	21.5	0	99.6
Palma ratio	1.85	0.94	0.9	7.0
Gini coefficient	38.29	7.88	24.2	63.0
Income share of highest 10%	29.9	6.14	19.9	50.5
Poverty (percentage)	27.1	16.79	0.6	82.3
Stringency (logs)	8.37	1.42	1.0	9.9
Population (logs)	2.27	1.72	-2.12	7.3
Urban population (percentage)	59.6	22.6	12.9	100

Source: Authors' own elaboration based on data for the latest available year for each country from World Development Indicators (World Bank) accessed on 30 October 2020.

Annex 3

Simple correlations

Variables	1	2	3	4	5	6	7
1 Palma ratio	1.0						
2 Gini	0.90	1.0					
3 Income of highest 10%	0.90	0.97	1.0				
4 Poverty	0.44	0.48	0.46	1.0			
5 Stringency	0.04	0.04	0.03	-0.05	1.0		
6 Population	0.03	0.08	0.12	-0.03	-0.02	1.0	
7 Urban population	-0.14	-0.18	-0.22	-0.45	-0.03	-0.16	1.0

Source: Authors' own elaboration.

Annex 4

Poisson panel regressions – Robustness checks

	Cases (1)	Cases (2)
$Cases_{t-1}$		0.02 (6.42)***
Testing	0.00 (1.29)	0.00 (0.73)
Palma ratio	0.30 (2.78)**	0.23 (2.63)**
Poverty	-0.00 (0.45)	0.00 (0.03)
Population	-0.06 (0.85)	-0.05 (0.87)
Urban share	1.13 (1.44)	1.34 (2.19)**
Northern Hemisphere	-0.24 (0.79)	-0.15 (0.61)
Regional dummies	Yes	Yes
Observations	577	510
Countries	88	88
Wald Chi2	4,132	10,049
Prob>Chi2	0.000	0.000

Source: Authors' own elaboration.

Note: Regressions after 7 months since first case in each country. $Cases_{t-1}$ is the lagged value of the numbers of cases per 100,000 people. Palma ratio corresponds to the share of national income of the 10% highest earners over the share of the bottom 40%. Poverty is the share of the population living below the national poverty line. Population is the log of total population size. Urban share is the percentage share of population living in urban areas. Northern Hemisphere is a dummy variable that takes the value 1 for countries situated in the northern hemisphere. Regional dummies are for Africa, Asia and Latin America. t statistics (shown in parentheses) with robust standard errors. * Significant at 10%; ** Significant at 5%; *** Significant at 1%.

Annex 5

Poisson panel regressions – Robustness checks

	Cases (1)	Cases (2)	Deaths (3)	Deaths (4)
$Cases_{t-1}$		0.00		0.00
		(6.46)***		(7.55)***
Income share of highest 10%	0.05	0.03	0.02	0.00
	(2.57)**	(2.11)**	(0.99)	(0.25)
Poverty	-0.01	-0.00	0.01	0.01
	(1.11)	(0.13)	(1.53)	(2.68)**
Population	-0.20	-0.13	0.04	0.11
	(3.42)**	(2.62)**	(0.66)	(2.17)**
Urban share	2.11	1.86	3.15	2.70
	(3.96)***	(4.11)***	(5.07)***	(5.17)***
Northern Hemisphere	-0.36	-0.18	-0.41	-0.25
	(1.35)	(0.84)	(1.41)	(1.05)
Regional dummies	Yes	Yes	Yes	Yes
Observations	942	807	942	807
Countries	135	135	135	135
Wald Chi2	4,404	8,421	376.6	558.4
Prob>Chi2	0.000	0.000	0.000	0.000

Source: Authors' own elaboration.

Note: Regressions after 7 months since first case in each country. $Cases_{t-1}$ is the lagged value of the numbers of cases per 100,000 people. *Income share of highest 10%* corresponds to the share of national income of 10% highest earners. *Poverty* is the share of the population living below the national poverty level. *Population* is the log of total population size. *Urban share* is the percentage share of population living in urban areas. *Northern Hemisphere* is a dummy variable that takes the value 1 for countries located in the northern hemisphere. Regional dummies are for Africa, Asia and Latin America. *t* statistics (shown in parentheses) with robust standard errors.
* Significant at 10%; ** Significant at 5%; *** Significant at 1%.

Annex 6

Poisson panel regressions – Robustness checks

	ΔCases	ΔDeaths	ΔDeaths
Active cases$_{t-1}$	-0.01 (7.07)***	-0.00 (2.99)**	
ΔCases			0.83 (18.23)***
Stringency	-0.54 (5.43)***	-1.82 (4.62)***	-1.22 (4.55)***
Income share of highest 10%	-0.03 (1.35)	-0.29 (2.64)**	-0.29 (3.76)***
Income share of highest 10% * Stringency	0.01 (2.11)**	0.04 (2.90)**	0.03 (3.94)***
Marginal effects Income share of highest 10%	0.02 (2.72)**	0.01 (2.30)**	0.00 (0.65)
Regional dummies	Yes	Yes	Yes
Observations	844	652	652
Countries	145	140	140
Wald Chi2	1,267	159.4	483.9
Prob>Chi2	0.000	0.000	0.000

Source: Authors' own elaboration.

Note: Regressions after 7 months since first case in each country. *Active cases*$_{t-1}$ corresponds to the lagged value of the number of active COVID-19 cases. *Stringency* corresponds to the lagged value of the log of the stringency index of lockdowns and restrictive measures implemented by countries to control the pandemic. *Income share of highest 10%* corresponds to the share of national income of 10% highest earners. Regressions include a *Northern Hemisphere* dummy that takes the value 1 for countries situated in the northern hemisphere and regional dummies for Africa, Asia and Latin America. *t* statistics (shown in parentheses) with robust standard errors.
* Significant at 10%; ** Significant at 5%; *** Significant at 1%.