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Does the COVID-19 pandemic disproportionately affect the poor? Evidence from a six-country survey

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Abstract

Purpose – The COVID-19 pandemic has wrought havoc on economies around the world. The purpose of this study is to learn about the distributional impacts of the pandemic.

Design/methodology/approach – The authors contribute new theoretical and empirical evidence on the distributional impacts of the pandemic on different income groups in a multicountry setting. The authors analyze rich individual-level survey data covering 6,082 respondents from China, Italy, Japan, South Korea, the United Kingdom and the United States. The results are robust to various econometric models, including ordinary least squares (OLS), Tobit and ordered probit models with country-fixed effects.

Findings – The authors find that while the outbreak has no impact on household income losses, it results in a 63% reduction in the expected own labor income for the second-poorest income quintile. The pandemic impacts are most noticeable for savings, with all the four poorer income quintiles suffering reduced savings ranging between 5 and 7% compared to the richest income quintile. The poor are also less likely to change their behaviors regarding immediate prevention measures against COVID-19 and healthy activities. The authors also found countries to exhibit heterogeneous impacts.

Social implications – Designing tailor-made social protection and health policies to support the poorer income groups in richer and poorer countries can generate multiple positive impacts that help minimize the negative and inequality-enhancing pandemic consequences. These findings are relevant not only for COVID-19 but also for future pandemics.

Originality/value – The authors theoretically and empirically investigate the impacts of the pandemic on poorer income groups, while previous studies mostly offer empirical analyses and focus on other sociodemographic factors. The authors offer a new multicountry analysis of several prevention measures against COVID-19 and specific health activities.

Keywords COVID-19, Poverty, Income quintiles, Behavior changes

Paper type Research paper

JEL Classification — D00, H00, I1, I3, O1

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An imbalance between rich and poor is the oldest and most fatal ailment of all republics.

Plutarch, Greek historian

1. Introduction

Poverty has been steadily declining due to improved global living standards (World Bank, 2018; Ravallion, 2020). Most recently, the international community has set the ambitious goal of eradicating poverty in the next decade with the Sustainable Development Goal number 1 (United Nations, undated). Nevertheless, this undertaking is predicated on a well-functioning economy that yields growth that can be shared among the different population groups. The unexpected arrival of the COVID-19 pandemic has brought most economies worldwide to a grinding halt, which is poised to severely disrupt this agenda. Indeed, a recent study predicts that COVID-19-related negative impacts could drive between 80 and under 400 million people into poverty globally (Sumner *et al.*, 2022). To prevent this scenario from occurring, insights into the harmful effects of the COVID-19 pandemic are essential for effective and efficient policies.

However, despite a rich (and still growing) literature on the impacts of COVID-19, there is relatively little theoretical and empirical evidence on its distributional impacts on different income groups in a multicountry setting. Various policy-relevant questions can be raised regarding these impacts. Were the poor more negatively affected by the pandemic than the rich? Specifically, did the poor lose more income? What were the gradients of the impacts for the different income groups? Are the poor more likely to lose income in the future? Were they able to follow medical guidelines in changing their behaviors to protect their health against the pandemic? Would they be in a position to invest more in healthy activities? A good understanding of these issues provides useful inputs for social protection and public health policies that can help insure the vulnerable against falling into poverty and protect the poor from sliding further into destitution against future pandemics.

To our knowledge, we offer the first study that theoretically and empirically investigates the impacts of COVID-19 on the poor in a multicountry setting. On the theoretical front, following Grossman's (1972) seminal health demand model, we incorporate features from the epidemiology literature (e.g. Kermack and McKendrick (1927)) to build a standard utility-maximizing model with heterogeneous healthcare costs. Under our model, individuals pay for different levels of healthcare quality depending on their income. In particular, richer individuals would choose more expensive and higher levels of quality of care. Our model also addresses the issue of endogenous labor supply under the pandemic, where healthy individuals can provide more labor supply to increase labor income today but face the risk of becoming infected and subsequently reduced future labor income. Our theoretical results suggest that the poor will likely have fewer savings because of the COVID-19 pandemic. They are also less likely to increase investment in their health, as measured by prevention measures against the pandemic and healthy behavior changes.

These theoretical results are supported by our empirical estimates, which we obtain from analyzing a recent survey implemented during the pandemic and covered China, Italy, Japan, South Korea, the United Kingdom and the United States. Specifically, our empirical results indicate that the poor likely expect labor income loss and are less likely to have savings due to the COVID-19 pandemic. They are also less likely to implement newly established prevention measures to protect their health, such as keeping a 4-foot physical distance, not touching their face or covering their mouth when sneezing with a tissue. They are unable to seek medical

care when they exhibit early symptoms of the flu. Worse still, they are less likely to be able to afford to change their daily behavior and adjust to the new COVID-19-induced social regulations. They conduct the following healthy activities less: wash hands, wear a mask, eat sufficient fruit and vegetables, and video chat with relatives and friends, and they rely on public transportation more.

Our paper adds to the growing literature on the impacts of the COVID-19 pandemic on the poor. The two most relevant studies to ours are Papageorge *et al.* (2021) and Belot *et al.* (2021), which analyze the same survey that we use. While some of our results are consistent with the findings in these studies (e.g. the poorer income quintiles are more likely to suffer income losses compared to the wealthier income quintiles), our study differs from these studies in several key aspects. First, we explicitly investigate the impacts of the pandemic on the poorer income groups both theoretically and empirically, while these studies offer empirical analyses with a more general focus on other sociodemographic factors. In particular, these studies do not examine the impacts of the pandemic on some outcomes (including individuals' savings) as we do. Second, we offer a new analysis of a number of prevention measures against COVID-19 and specific healthy activities that are not examined in these studies [1]. Insights into these health measures can lead to policy-relevant advice. Finally, only Belot *et al.* (2021) analyze data from all six countries in the survey, while Papageorge *et al.* (2021) focus on data from the United States alone.

Other studies look at the impacts of poverty in the pandemic, but these studies typically either focus on a single country or use more aggregate data than ours. For example, analyzing US county-level data, Wright *et al.* (2020) find that poverty reduces compliance with the COVID-19 shelter-in-place protocols. Another study by Bargain and Aminjonov (2020) examines data at the regional level for nine countries in Latin America and Africa and finds that poverty reduces work mobility. While these findings are useful, the perspective of individual (or household) decision-making at a disaggregated level is arguably most relevant for reducing poverty and inequality, as exemplified by the pioneering works by Angus Deaton (e.g. Besley, 2016).

Recent studies examine the impacts of the pandemic on vulnerable population groups, such as rural youth in India (Chakravoty *et al.*, 2023) or low-wage workers in Vietnam (Dang *et al.*, 2023) or related topics of labor market inequality or gender inequality (Cajner *et al.*, 2020; Adams-Prassl *et al.*, 2020; Dang and Nguyen, 2021; Alon *et al.*, 2022). Various studies document the negative impacts of COVID-19 on household incomes in various regions around the world, including both richer countries (Coibion *et al.*, 2020) and poorer countries in Asia, Latin America and sub-Saharan Africa (Egger *et al.*, 2021; Josephson *et al.*, 2021; Kansiime *et al.*, 2021; Morgan and Trinh, 2021) [2].

This paper consists of five sections. We offer the theoretical model and estimating equations in the next section before describing the data in Section 3. We present the empirical results in Section 4, provide further discussion and conclude in Section 5.

2. Analytic framework and data

2.1 Theoretical model

We provide a simple theoretical model based on Grossman's (1972) seminal health demand model to guide our empirical analysis. In Grossman's model, an increase in the number of days that individuals are sick would reduce their labor income and consumption. Our model also addresses the issue of endogenous labor supply during the pandemic. While healthy people can work to increase their labor income today, they face a certain risk of becoming infected, which can reduce their future labor income. Our model also incorporates features from the epidemiology literature (Kermack and McKendrick, 1927) to construct a standard utility-maximizing model with heterogeneous healthcare costs.

The cost of healthcare services varies widely depending on the quality of care received and the type of patients.

Following insights from the literature (Arrow, 1963; De Nardi *et al.*, 2010), we assume that individuals pay for different healthcare quality levels depending on their income [3]. In particular, richer individuals would choose more expensive and higher levels of quality of care such that there is a monotone and increasing relationship between the price of healthcare and income. This implies that in our empirical analysis in the next section, there are five different price levels corresponding to the five income quintiles that individuals can be classified into [4]. This assumption is innocuous and consistent with recent empirical findings. For example, Banerjee (1997) uses waiting time as a screening device to discriminate between rich and poor patients. Analyzing survey data on HIV (human immunodeficiency virus) outpatients in Burkina Faso, Kazianga *et al.* (2015) find that more wealth is positively associated with higher up-front costs, which are defined as any fees that the patient paid at the health facility before seeing a health professional.

Consider an economy in which households face a risk of infected disease. Because the dynamics of the epidemic are much faster than the dynamics of the population, the household size is assumed to be constant. Within the household, an individual is either healthy or infected by the disease. Assuming the household lives for two periods. In the time period 0, given an exogenous financial asset y and exogenous wage w, the household makes a choice on consumption (C_0), healthcare expenditures (M), savings (S) and labor supply (L_0). In the time period 1, the household decides on their labor supply (L_1) and consumption (C_1). More generally, M can also represent household investments in health and include healthy activities such as exercising or wearing a mask.

From the law of motions in the epidemiologic Susceptible, Infectious or Recovered (SIR) model (see Appendix, Part A for more details), we have

$$s_1 = s_0 - \alpha i_0 s_0$$

$$i_1 = i_0 + \alpha i_0 s_0 - \Psi i_0$$

$$r_1 = \Psi i_0$$

where s_t is the fraction of healthy individuals, i_t is the fraction of infected individuals, and r_t is the fraction that is recovered from the disease and is no longer infectious. The recovery rate was zero at the beginning. A constant population size implies $i_t + s_t + r_t = 1$, $(t = 0, 1)$. The epidemiology parameters are the contact rate α and the recovery rate from the disease Ψ.

We assume labor is inelastically supplied, and the infected are unable to work such that

$$L_0 = s_0 = 1 - i_0$$

$$L_1 = s_1 + r_1 = s_0 - \alpha i_0 s_0 + \Psi i_0$$

If healthcare quality is high, people are more likely to recover from the disease. To capture this effect, we endogenize the recovery rate as a function of health expenditure $\Psi(M)$ with $\Psi' = \frac{\partial \Psi}{\partial M} \geq 0$, $\Psi'' = \frac{\partial^2 \Psi}{\partial M^2} < 0$ [5].

Let ω be the wage, which is assumed to be the same for two periods; the labor incomes in periods 0 and 1 are given by

$$Y_0 = \omega L_0$$

$$Y_1 = \omega L_1 = \omega(s_0 - i_0 s_0 \alpha + i_0 \Psi(M)) = \omega(L_0 - (1 - L_0)L_0 \alpha + (1 - L_0)\Psi(M))$$

The income loss in period 0 is $D_0 = \omega i_0 = \omega(1 - L_0) = \omega - Y_0$ and the expected income loss in time period 1 is $D_1 = \omega i_1 = \omega(1 - L_1) = \omega - Y_1$.

Let P denote the cost of the healthcare service in terms of the consumption good. Given a nonwage income y, the budget constraint at period 0 is given by

$$y + \omega L_0 = C_0 + PM + S.$$

Then, the consumption in period 1 is

$$C_1 = xS + Y_1.$$

where x is the gross rate of return of savings. Thus, the consumption in period 1 becomes

$$C_1 = x(y + \omega L_0 - C_0 - PM) + \omega(L_0 - (1 - L_0)L_0\alpha + (1 - L_0)\Psi(\mathrm{M})).$$

Given all the relevant constraints, assuming that the utility function is additively separable over time, the household solves the following problem at period 0

$$\max_{C_0, M, L_0} U(C_0) + V(C_1)$$

Assuming U and V are strictly increasing with concave ($U' > 0, V' > 0, U'' < 0, V'' < 0$) and there exist interior solutions, the first-order conditions yield

$$C\text{: } U'(C_0) - xV'(C_1) = 0 \tag{1}$$

$$M\text{: } (\omega(1 - L_0)\Psi_{\mathrm{M}}(M) - xP)V'(C_1) = 0 \tag{2}$$

$$L_0\text{: } (\Psi(\mathrm{M}) - 2\mathrm{L}_0\alpha - x - 1 + \alpha)V'(C_1) = 0 \tag{3}$$

The Hessian of (1)-(3) is required to be negative definite so that the second-order conditions satisfy.

Our model yields the following theoretical results.

P1. The price of healthcare services decreases the demand for healthcare and labor supply.

P2. The poor's labor income is likely unaffected by the pandemic in the current period but may be more affected in the next period.

P3. The poor have fewer savings than the rich during the pandemic.

P4. Given the same risk of infection, the rich are more likely to change their behavior than the poor.

Note that Proposition 1 is not directly related to the empirical results but provides a general result for the other propositions to build on. The proofs for the propositions are presented in Appendix, Part A.

2.2 Empirical model

We estimate the impacts of the COVID-19 pandemic (i.e. the first-order conditions in Equations (1) to 3)) with the following linear regression:

$$E_{ci} = \alpha + \beta' X_{ci} + \gamma' Z_{ci} + \mu_c + \varepsilon_{ci} \tag{4}$$

where E_i includes two sets of outcome variables for individual i, for $i = 1, \ldots, N$ in country c, for $c = 1, \ldots, C$. The first set of outcome variables consists of the (self-reported) changes in one's income and savings due to COVID-19. Three such variables indicate household income losses, the expected losses with one's own labor income and changes in one's savings

(compared to January 2020). To address missing value issues and obtain a better model fit, we add one to these variables before converting them to natural logarithmic form. We further change these variables to negative values (i.e. multiply them with −1) such that a negative sign represents income losses for easier interpretation. The variable changes to one's savings have five values ranging from 1 to 5, which respectively correspond to "*a drop of more than 10%*", "*a drop of less than 10%*", "*no change*," "*an increase of less than 10%*" and "*an increase of more than 10%*".

The second set of outcome variables consists of two subsets of variables. The first subset includes four variables indicating the immediate prevention measures against COVID-19, which include the following actions: "*keep a 4-foot distance*", "*not touch one's face*," "*cover one's mouth with a tissue when sneezing*," and "*seek medical care when developing COVID-19-related symptoms*". These variables have values ranging from 1 to 5, which respectively correspond to "*never*," "*rarely*," "*sometimes*," "*very often*," and "*always*."

The second subset includes a variable indicating whether individuals change their behavior in response to COVID-19. The survey also collects data on specific individual behavior variables before and after the outbreak, which also have the same five values as the first subset of outcomes, with a higher value indicating a stronger level of frequency. Consequently, we create seven additional variables by subtracting the preoutbreak behavior variables from the postoutbreak behavior variables. These variables indicate the changes to such specific activities as "*wash one's hands*," "*wear a mask*," "*eat at least five portions of fruit and vegetables every day*," "*take vitamins*," "*do exercises*," "*video chat with one's relatives and friends*," and "*use public transportation*" and have values ranging from −4 to 4 [6].

Our main explanatory variables (X_{ci}) consist of the different income quintiles, where the richest quintile serves as the reference group. The vector of coefficients of interest is β, which measures the impacts of the pandemic on the different income quintiles.

The other control variables (Z_{ci}) include age, gender and residence areas (i.e. urban, suburban, or rural residence). We also include the country dummy variables to control for the country fixed effects (μ_c), with the United States serving as the reference country. We use the OLS method to estimate Equation (1) for a more straightforward interpretation, but we also offer alternative modeling options such as the Tobit and ordered probit methods for robustness checks [7]. We offer heteroskedasticity-robust variance estimates of the error term (ε_{ci}).

3. Data description

We analyze novel data from a recent international survey on COVID-19 conducted by Belot *et al.* (2020). This survey comprises 6,082 respondents from six countries in different regions ranging from upper-middle income to high-income levels: China, Italy, Japan, South Korea, the United Kingdom and the United States. The sample size of each country is around 1,000, ranging from 963 for South Korea to 1,055 for the United States. In each country, the samples are nationally representative for age groups, gender and household income quintiles. The survey did not collect data on respondents' specific incomes but collected data on which of the five pre-COVID-19 income brackets (quintiles) they belong to [8]. Data were collected after the first phase of the pandemic, between April 15 and April 23, 2020, offering one of the earliest and most relevant multicountry datasets on socioeconomics and behavioral changes in the COVID-19 pandemic. Furthermore, as noted by Belot *et al.* (2020), a major strength of this survey is its better representativeness than other surveys that rely on convenience samples or self-selection into the sample at the time. The median time to complete the questionnaire was around 14 minutes.

We focus on certain variables from this survey for our study and provide the descriptive statistics for these variables in Table B.1 in Appendix. For a better interpretation, we divide the variables into two groups of continuous variables and binary variables, respectively shown in Panel A and Panel B of Table B.1. Table B.1 suggests that individuals, on average, suffer from lost household income and expect to lose income as well as have somewhat less savings because of the pandemic (Panel A, rows 1 to 3). However, most (86%) of individuals changed their behavior because of the pandemic (Panel B, row 6). In particular, they implement prevention measures such as keeping a 4-foot distance, not touching one's face, covering one's mouth when sneezing and seeking medical care more often (with the mean values for these activities being larger than 3; Panel A, rows 4 to 7). They also do more health activities such as washing their hands, wearing a mask, eating fruit, taking vitamins, doing exercises and video-chatting with their relatives and friends (with the mean values for these activities being positive; Panel A, rows 8 to 13), and using the public transportation less (with the mean values for this activity being negative; Panel A, row 14).

Individuals mostly live in urban areas (48%) or suburban areas (37%), with just 13% living in rural areas (Panel B, rows 15 to 17). About half (48%) of the individuals in our sample are female (Panel B, row 18).

4. Empirical estimates

4.1 Impacts on incomes and savings

Table 1 provides estimation results on the impacts of the COVID-19 pandemic on the first set of outcome variables, which include household income losses, the expected losses with one's own labor income and changes to one's savings. While our preferred model for interpretation includes the country-fixed effects, we show estimates without the country fixed effects (Models 1 to 3) and with the country fixed effects (Models 4 to 6) for robustness and comparison. It is reassuring to see that the estimation results are qualitatively similar whether we control for the country dummy variables or not. For subsequent analysis in Tables 2 and 3, we only show estimates that control for the country-fixed effects.

Table 1 shows that the outbreak has no statistically significant impact on household income losses for the different income quintiles (Model 4) (but see more discussion below). However, Table 1 also shows that for other outcomes, the pandemic has statistically significant and negative impacts on some poorer quintiles. In particular, the outbreak results in a 63% reduction in the expected own labor income for the second-poorest income quintile compared with the wealthiest quintile (Model 5). The impacts of the pandemic are most noticeable in terms of savings: all four income quintiles have more reduced savings than the wealthiest quintiles. The savings reduction ranges from 0.13 (the poorest quintile) to 0.18 (the second-poorest quintile) on a 1-to-5 scale. These figures approximately correspond to a 5 to 7% decrease compared to the mean value for savings of 2.49 (Appendix, Table B.1). These results are consistent with the theoretical result discussed earlier (Section 2.1, Propositions 2 and 3) [9]. These estimation results on (expected) income loss are also qualitatively similar to the findings in Papageorge *et al.* (2021) and Belot *et al.* (2021) that individuals in the richest income quintile are less likely to suffer income loss compared to those in the poorest income quintile.

We further show in Appendix, Table B.2 the *t*-tests that compare the differential impacts of the pandemic on the various income quintiles. The estimation results indicate that, compared to the other richer income quintiles, the larger negative impacts for the poorest income quintile are marginally statistically different for income loss at the 10% level but are strongly statistically significant for the expected loss in one's own labor income at the 5% level or less. These results

Variables	(Model 1) Log(LI)	(Model 2) Log (ELI)	(Model 3) Change savings	(Model 4) Log(LI)	(Model 5) Log (ELI)	(Model 6) Change savings
Poorest quintile	0.028	0.141	−0.146***	0.170	0.211	−0.128***
	(0.204)	(0.208)	(0.044)	(0.201)	(0.204)	(0.044)
Second-poorest quintile	−0.223	−0.648***	−0.189***	−0.150	−0.628***	−0.175***
	(0.205)	(0.213)	(0.043)	(0.202)	(0.209)	(0.043)
Middle-income quintile	−0.218	−0.261	−0.160***	−0.161	−0.224	−0.143***
	(0.198)	(0.205)	(0.042)	(0.196)	(0.203)	(0.042)
Second-richest quintile	−0.186	−0.305	−0.042	−0.182	−0.326	−0.03
	(0.2)	(0.204)	(0.042)	(0.197)	(0.202)	(0.042)
Age group (26–35)	0.224	−0.09	−0.104*	0.123	−0.102	−0.117**
	(0.237)	(0.244)	(0.055)	(0.235)	(0.244)	(0.055)
Age group (36–45)	0.141	−0.165	−0.202***	0.08	−0.191	−0.208***
	(0.235)	(0.241)	(0.054)	(0.231)	(0.24)	(0.053)
Age group (46–55)	0.286	−0.141	−0.217***	0.245	−0.077	−0.227***
	(0.238)	(0.246)	(0.053)	(0.234)	(0.243)	(0.053)
Age group (56–65)	1.215***	0.705***	−0.091*	1.052***	0.677***	−0.114**
	(0.244)	(0.251)	(0.055)	(0.239)	(0.249)	(0.055)
Age group (66–75)	2.442***	2.448***	0.126**	2.289***	2.464***	0.110*
	(0.246)	(0.245)	(0.058)	(0.241)	(0.241)	(0.058)
Age group (above 76)	2.623***	2.992***	0.078	2.511***	2.929***	0.061
	(0.321)	(0.299)	(0.072)	(0.318)	(0.302)	(0.072)
Age group (prefer not to say)	−0.347	1.321	−0.642	−0.404	1.997	−0.646
	(2.134)	(1.586)	(0.595)	(2.363)	(1.917)	(0.55)
Female	0.035	−0.454***	0.060**	0.043	−0.426***	0.061**
	(0.126)	(0.13)	(0.027)	(0.125)	(0.128)	(0.027)
Urban	−0.800***	−0.254	−0.112***	−0.381**	−0.364*	−0.047
	(0.19)	(0.198)	(0.041)	(0.192)	(0.2)	(0.043)
Suburban	−0.114	0.156	0.032	−0.032	0.043	0.03
	(0.192)	(0.199)	(0.042)	(0.192)	(0.199)	(0.043)
China				−1.187***	0.268	−0.195***
				(0.197)	(0.194)	(0.05)
Italy				0.196	−0.298*	−0.124**
				(0.172)	(0.176)	(0.052)
Japan				−0.202	−1.574***	0.062
				(0.219)	(0.222)	(0.044)
Korea				−1.799***	−2.197***	−0.067
				(0.258)	(0.263)	(0.047)
United Kingdom				0.933***	0.633***	0.141***
				(0.173)	(0.171)	(0.046)
Constant	−4.507***	−3.959***	2.704***	−4.389***	−3.384***	2.702***
	(0.281)	(0.286)	(0.064)	(0.303)	(0.308)	(0.071)
RMSE	4.878	5.02	1.054	4.801	4.92	1.049
Adjusted R^2	0.038	0.042	0.019	0.068	0.08	0.028
N	6,089	6,088	6,089	6,089	6,088	6,089

Note(s): * < 0.1, ** < 0.05, *** < 0.01. Robust standard errors are in brackets. LI and ELI stand for "lost income" and "expected loss in labor income." The reference groups are the richest quintile for income quintiles, age group 18–25 for age groups, rural residence for residence areas and the United States for countries
Source(s): Authors' own work

Table 1.
Inequality in lost income, expected loss in own labor income and savings

provide further supportive evidence for the differential impacts of the pandemic on different income quintiles, with the poorer quintiles suffering more harmful impacts [10].

For the other control variables, Table 1 also suggests that compared to the age group 18–25, the older age groups (56 years old or older) expect their income to fall less, perhaps

Variables	(Model 1) Keep 4 ft. distance	(Model 2) Not touch face	(Model 3) Cover mouth when sneezing	(Model 4) Seek medical care
Poorest quintile	−0.287***	−0.265***	−0.263***	−0.260***
	(0.051)	(0.050)	(0.049)	(0.068)
Second-poorest quintile	−0.231***	−0.191***	−0.173***	−0.141**
	(0.048)	(0.047)	(0.047)	(0.066)
Middle-income quintile	−0.154***	−0.137***	−0.077*	−0.206***
	(0.045)	(0.044)	(0.043)	(0.063)
Second-richest quintile	−0.037	−0.060	−0.005	0.018
	(0.043)	(0.043)	(0.041)	(0.063)
RMSE	1.157	1.146	1.132	1.616
Adjusted R^2	0.162	0.069	0.061	0.114
N	6,089	6,089	6,089	6,089

Note(s): * < 0.1, ** < 0.05, *** < 0.01. Robust standard errors are in brackets. The reference group is the richest quintile. All regression models include the same control variables as in Table 1, which are age groups, gender, residence areas and country fixed effects. The full regression results are shown in Appendix, Table B.4
Source(s): Authors' own work

Table 2.
Inequality with changes in prevention measures against COVID-19

Variables	(Model 1) Change behavior	(Model 2) Wash hand	(Model 3) Wear mask	(Model 4) Eat fruit	(Model 5) Take vitamin	(Model 6) Do exercises	(Model 7) Video chat	(Model 8) Public trans
Poorest quintile	−0.107***	−0.188***	−0.473***	−0.068**	−0.041	0.011	−0.147***	0.187***
	(0.015)	(0.042)	(0.064)	(0.031)	(0.029)	(0.041)	(0.050)	(0.049)
Second-poorest quintile	−0.055***	−0.089**	−0.186***	−0.026	−0.031	0.026	−0.096*	0.226***
	(0.014)	(0.042)	(0.063)	(0.032)	(0.030)	(0.041)	(0.051)	(0.049)
Middle-income quintile	−0.035***	−0.083**	−0.217***	−0.047	−0.113***	−0.001	−0.073	0.229***
	(0.013)	(0.041)	(0.061)	(0.031)	(0.027)	(0.040)	(0.050)	(0.047)
Second-richest quintile	0.006	−0.020	−0.085	−0.012	0.006	−0.013	0.046	0.088*
	(0.012)	(0.040)	(0.059)	(0.031)	(0.028)	(0.040)	(0.050)	(0.048)
RMSE	0.337	1.007	1.542	0.752	0.699	0.985	1.221	1.155
Adjusted R^2	0.044	0.039	0.171	0.070	0.039	0.040	0.017	0.047
N	6,089	6,089	6,089	6,089	6,089	6,089	6,089	6,089

Note(s): * < 0.1, ** < 0.05, *** < 0.01. Robust standard errors are in brackets. "Public trans." stands for "taking public transportation." The reference group is the richest quintile. All regression models include the same control variables as in Table 1, which are age groups, gender, residence areas and country fixed effects. The full regression results are shown in Appendix, Table B.5
Source(s): Authors' own work

Table 3.
Inequality with changes in daily behavior

because of better experience with managing their finances. The age groups 26–65, however, save less. Women expect their labor income to fall more than men, but they save more than men. The negative impacts on women are consistent with recent empirical evidence indicating that women might be more affected than men in the United Kingdom and the United States (Alon *et al.*, 2022; Hupkau and Petrongolo, 2020). However, while these existing studies focus on one specific country, our estimates offer more general results in a multicountry setting [11].

4.2 Impacts on behavior changes

Our theory suggests that the poor are less likely to change their behaviors to protect themselves against COVID-19, given the same risk of infection (Section 2.1, Propositions 1 and 4). Indeed, Table 2 shows the empirical results that support this finding [12]. All the three poorer income quintiles implement the immediate prevention measures against COVID-19 less often than the richest quintile, and Table B.2 further indicates that the differences are generally strongly statistically significant. Only the second-richest income quintile's actions are not statistically significant from those of the richest quintile. Furthermore, it is generally the case that the poorer the individuals are, the less likely they are to implement these prevention measures.

In particular, individuals in the poorest quintile are 0.29 less likely to keep a 4-foot distance from another person, while the corresponding figures for the second-poorest and middle-income quintiles are lower at 0.23 and 0.15, respectively (on a 1-to-5 scale). Qualitatively similar results hold for the other prevention measures, such as not touching one's face and covering one's mouth with a tissue when sneezing, with a reduction in the frequency of around −0.26 for the poorest income quintile, −0.17 to −0.19 for the second-poorest and middle-income quintiles, and −0.08 to −0.14 for the second-richest income quintile. The exception is seeking medical care when developing COVID-19-related symptoms, where the middle-income quintile shows slightly less action than the second-poorest income quintile. However, this difference is not statistically significant (*t*-test shown in Appendix, Table B.2).

Table 3 provides the estimation results on the impacts of the COVID-19 pandemic on changes in healthy behaviors, which further support the results shown in Table 2. Several main results stand out for this Table. First, individuals in the poorer income quintiles are generally less likely to change their behavior to better adjust to the pandemic. More specifically, those in the poorer income quintiles are less likely to adopt new COVID-19-induced practices such as washing their hands, wearing a mask or video chatting with their relatives and friends. They are also less likely to eat sufficient fruit and vegetables. Second, the poorer the individuals are, the less frequently they change their general behaviors for the better. Poorer individuals are also less likely to wash their hands or wear a mask than richer individuals.

Finally, Table 3 also shows that individuals in poorer income quintiles use public transportation more often than those in the richest quintile (Model 8). In particular, those in the three poorer income quintiles are 0.19–0.23 more likely to use public transportation than those in the richest quintile (on a 1-to-5 scale). This increase in frequency is more than twice higher than the corresponding difference of 0.9 between the second-richest income quintile and the richest quintile (but also note that the difference between the second-richest income quintile and the richest quintile is only marginally statistically significant at the 10% level). This empirical result is consistent with our theoretical result that the rich are more likely than the poor to change their behaviors, given a higher risk of infection when using public transportation (as shown by $\frac{\partial M}{\partial P} \geq 0$ for $P \geq \frac{\omega}{2x}$ in the proof for Proposition 4 in Appendix, Part B).

We provide several different robustness checks for the results in Table 2 and Table 3. First, we re-run the estimates in these two tables and control for the industry fixed effects (for those that work). The estimation results, shown in Appendix, Table B.3 and Panel B, are qualitatively similar. Second, instead of employing the OLS method, we use the Tobit and ordered probit models to re-estimate the impacts of the pandemic on behavior changes. However, the estimation results, shown in Appendix, Tables B.6 and B.7, are qualitatively similar. Finally, we also offer an alternative, simpler measure of behavior changes that indicate whether the post-outbreak behaviors have less frequency, the same frequency or more frequency than the preoutbreak behaviors. Put differently, these alternative behavior change variables have only three values. The estimation results, shown in Appendix, Table B.8, are also qualitatively similar. Furthermore, the *t*-tests that compare the estimated

impacts on the various income quintiles, shown in Appendix, Table B.2, confirm that the more negative impacts that the poorest income quintile suffers compared to the richer income quintiles are strongly statistically significant.

4.3 Country heterogeneity

In Figure 1, we plot the heterogeneous impacts of COVID-19 on countries that are shown in Tables 1–3. Figure 1 shows that the impacts of the pandemic vary from country to country, and countries exhibit heterogeneity for all the two sets of outcome variables. Furthermore, several specific remarks are in order. First, for the first set of outcome variables, compared with all the six countries, the United Kingdom consistently comes out as the country with the least household income loss and expected labor income loss and the most savings. Interestingly, the opposite of the United Kingdom is South Korea, which has the most household income loss and expected labor income loss. The remaining countries display more complex patterns; for example, compared to the United States, China has more income loss but less expected labor income loss and fewer savings.

Second, Japan is the country that is least likely to adopt behavioral changes. This country scores the least in terms of a number of activities ranging from keeping a 4-foot distance and not touching one's face to eating sufficient fruit and vegetables and video chatting. Italy, however, is the opposite and most likely to have behavioral changes. Finally, some countries stand out in certain activities. For example, Chinese, Italians and South Koreans wash their hands and wear masks more often than the remaining countries.

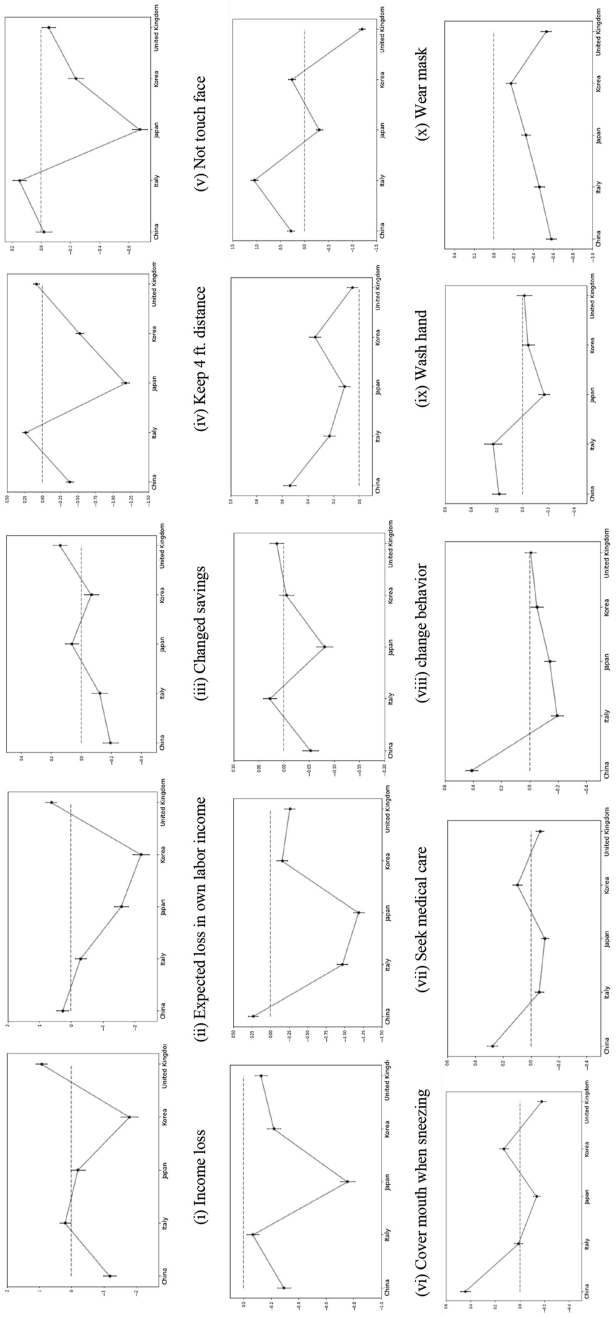
5. Further discussion and conclusion

We contribute new evidence on the distributional impacts of the COVID-19 pandemic on the different income groups using rich micro-survey data from six countries in different geographical locations and at different income levels. We offer a new theoretical model built on the economics and epidemiology literatures to guide our empirical analysis. We offer the first study that combines both theoretical and empirical analysis of the pandemic impacts in a multicountry setting.

We find that while the outbreak has no statistically significant impacts on household income losses for the different income quintiles, it results in a 63% reduction in the expected own labor income for the second-poorest income quintile compared to the richest quintile. The impacts of the pandemic are most noticeable in terms of savings, with all four poorer income quintiles having reduced savings ranging between 5 and 7% compared to the mean. We also find that the poor are less likely to change their behaviors to protect themselves against COVID-19 in terms of immediate preventative measures such as keeping a 4-foot physical distance and healthy activities such as washing one's hands or wearing a mask. The poorer individuals are, the less likely they are to adopt healthy behavior changes.

Our findings suggest that even if the pandemic does not immediately impact the poor, it may decrease their incomes and health in the future. Furthermore, economic and epidemiological conditions may combine and result in poverty traps that determine the long-term trajectory of a society's health and economic development (Bonds *et al.*, 2010; Barrett and Carter, 2013; Kraay and McKenzie, 2014). As such, designing tailor-made social protection and health policies to support the poorer income groups in richer and poorer countries can generate multiple positive impacts that help minimize the negative and inequality-enhancing consequences of the COVID-19 pandemic.

Our findings also suggest that countries exhibit heterogeneous impacts and behavior changes due to the pandemic. While the United Kingdom has the least household income loss and expected labor income loss and the most savings, South Korea has the most household



Note(s): These graphs show the estimated coefficients obtained from the regression results in Tables 1 to 3. The reference country is the United States

Source(s): Authors' own work

Figure 1.
Heterogeneity of country impact

income loss and expected labor income loss. Japan is the country that is least likely to adopt behavioral changes, but Chinese, Italians and South Koreans tend to wash their hands and wear masks more often than the remaining countries.

This latter result indicates that cultural factors may take an important role in common hygiene practices and are consistent with recent findings in the public health literature (e.g. West *et al.* (2020)). In particular, Feng *et al.* (2020) observe that wearing a face mask is considered hygienic practice in many Asian countries but something only unwell people do in European and North American countries. Applying the precautionary principle, Greenhalgh *et al.* (2020) also encourage using face masks because we have little to lose and potentially something to gain from this measure. Most recently, Mitze *et al.* (2020) find that face masks to reduce the daily growth rate of reported infections by around 40% in Germany. As such, public education campaigns may be useful to reduce the stigma and discrimination that is associated with wearing a mask in certain countries. Our findings thus add to this policy discussion on public health measures against the pandemic.

These concerns have practical relevance not only for COVID-19 but also for future pandemics. Government responses to the pandemic have varied widely across countries and have been successful to varying degrees, at least during the initial reactions (Cheng *et al.*, 2020; Hale *et al.*, 2021). These responses require strong support from all population groups to be effective. However, some evidence suggests that poorer individuals are less supportive of government responses, and poorer individuals residing in more economically unequal countries offer even less government support during the pandemic (Dang *et al.*, 2022). These findings are consistent with earlier findings in the United States that poorer individuals face financial resource constraints during the pandemic that limit their behavior changes or mobility patterns (Weill *et al.*, 2020; Kim and Kwan, 2021). Consequently, governments may be able to gather more support from the poorer population groups by offering special social protection programs that target these groups during a crisis. More importantly, our policy recommendation remains relevant to the role of the government to take immediate action to support poorer groups in potential scenarios of future pandemics.

Our study has some limitations. First, we look at inequality among population groups across countries during the first wave of the pandemic, when vaccines were not available. Second, we analyze cross-section data, which might not be able to control for individual time-invariant characteristics that could have affected the outcomes.

A promising direction of future research is thus to evaluate inequality within and between countries in the next stage of fighting the pandemic, where vaccines become available to the public and inequality in access to vaccines might have existed. Another fruitful area is to apply more rigorous econometric models to longitudinal data (including household surveys or administrative data) that span the pandemic periods to better analyze the longer-term impacts of the pandemic on the poor.

Notes

1. Specifically, the prevention measures include keeping 4 ft. distance, not touching one's face, covering one's mouth with a tissue when sneezing and seeking medical care when developing COVID-19-related symptoms. The healthy activities include eating sufficient fruit and vegetables, taking vitamin, doing exercises, video chat with one's relatives and friends and use public transportation.
2. In the absence of appropriate household survey data spanning the pandemic, some studies also employ simulation methods (e.g. Cantó *et al.*, 2022) or present descriptive statistics on before-and-after household incomes (Egger *et al.*, 2021). See Brodeur *et al.* (2021), Miguel and Mobarak (2022) and Bloom *et al.* (2022) for recent review studies on the impacts of the pandemic. See also Aubert *et al.* (2022) for further review of the interactions between wealth and health inequalities and the

COVID-19 epidemic that could further reinforce existing inequalities along income and health dimensions.

3. As indicated in Arrow (1963) "*The unusual pricing practices and attitudes of the medical profession are well known: extensive price discrimination by income (with an extreme of zero prices for sufficiently indigent patients*".
4. Specifically, we can present the price variable P_j for each income quintile qt_j, for $j = 1, \ldots, 5$. But we suppress the subscript j in the subsequent derivations for less cluttered notation.
5. In a different approach, Goenka *et al.* (2014, 2021) model Ψ as a function of health capital which is produced by health expenditure.
6. For robustness check, we also offer an alternative but simpler measure of behavior changes. We return to more discussion in the next section.
7. See, e.g. Wooldridge (2010) for a textbook treatment of these discrete choice models.
8. These income brackets are obtained by calculating quintiles of the gross household income distribution from the last available wave of nationally representative household surveys or census data, which capture the income distributions before the COVID-19 pandemic (Belot *et al.*, 2020). Further comparisons of the distributions of respondents by gender and age groups in the survey and the distributions of these characteristics obtained from the official figures suggest that the differences are not large and the proportions of respondents in each income quintile in the six countries are roughly close to 20% (Dang and Nguyen, 2021). However, these shares for the poorest two quintiles are statistically less than 20% for four countries, Italy, South Korea, the U.K. and the U.S., suggesting that the data may not allow us to clearly delineate differential impacts between these two quintiles (Dang *et al.*, 2022).
9. The survey also collects data on the employment industries for those in the survey that work, but the sample size for these individuals is around two-thirds of the whole sample. Nevertheless, we rerun the estimates in Table 1 controlling for industry fixed effects. The estimation results, shown in Appendix, Table B.3, Panel A are qualitatively similar.
10. We would like to thank one anonymous reviewer's observation that the affluent derive a significant portion of their income from stock markets and capital gains, whereas the less privileged primarily rely on wages from labor. Consequently, the richer might have suffered more losses on the stock market than the poorer, due to the negative impacts of the pandemic on the stock market. Yet, various studies on the same countries that we analyze here find that COVID-19 had a negative but limited short-term impact on stock markets (He *et al.*, 2020; Topcu and Gulal, 2020).
11. We return to discuss the country heterogeneity impacts in Section 4.3.
12. We leave out the control variables to save space in Tables 2 and 3 We show the full regression results in Appendix, Tables B.4 and B.5.

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Appendix

The supplementary material for this article can be found online.

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