Document généré le 22 mars 2025 09:30

Review of Economic Analysis

Everything that Rises Must Converge: How the Policy and Public Responses to Covid-19 in the Education Sphere Impact on Virus Transmission

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Volume 16, numéro 3, 2024

URI : https://id.erudit.org/iderudit/1115528ar
DOI : https://doi.org/10.15353/rea.v16i3.5397

Aller au sommaire du numéro

Éditeur(s)

International Centre for Economic Analysis

ISSN

1973-3909 (numérique)

Découvrir la revue

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Eleftheriou, K., Ioakimidis, M. & Johnes, G. (2024). Everything that Rises Must Converge: How the Policy and Public Responses to Covid-19 in the Education Sphere Impact on Virus Transmission. *Review of Economic Analysis*, *16*(3), 393–408. https://doi.org/10.15353/rea.v16i3.5397

Résumé de l'article

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Review of Economic Analysis 16 (2024) 393-408 1973-3909/2024393

Everything that Rises Must Converge: How the Policy and Public Responses to Covid-19 in the Education Sphere Impact on Virus Transmission

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This paper studies the variation across countries in mortality rates due to COVID-19. A two-stage approach is used to model international data on the spread of COVID-19. The first stage applies a convergence club framework to identify clusters of countries within which the development of the epidemic is similar. The second stage models the membership of these clusters as a function of policy responses and public responses to the pandemic, with a particular focus on education as a determinant of the public response. Data include COVID-19 mortality per million, tertiary education completed, age structure, and voice and accountability and government effectiveness measures for each country in the dataset. We find evidence of two convergence clubs, one with a higher and one with a lower COVID-19 death rate. We also find evidence to support the hypothesis that relatively high levels of educational attainment in a population predicts a lower COVID-19 death rate among individuals 65 or more years of age. We speculate that this is attributable to more informed prosocial behaviors directed toward elderly people in the form of adherence to guidelines intended to reduce spread of the virus.

Keywords: COVID-19; convergence; education; world data

JEL Classifications: C23; I18; I23

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Acknowledgement: We are thankful to the Editor and two anonymous referees of this journal for their helpful comments and suggestions. Competing interests: None declared

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1 Introduction

The COVID-19 pandemic has had devastating effects on the lives and livelihoods of people across the world. Its spread has been accelerated by the extent of modern day connectedness, and so while pandemics have happened before, the degree of preparedness for such an occurrence has been limited. Despite (or perhaps because of) this, the policy response and the public response have varied considerably across countries in terms of both their characteristics and speed of implementation.

In this paper, we focus on the public response, and in particular consider the following research question: to what extent has education shaped the public response within each country and so served to mitigate the impact of the pandemic? In doing so, we employ a modelling framework grounded in the theory of convergence (Barro and Sala-i-Martin, 1991, 1992). We hypothesise that, while countries' experiences of COVID-19 are not synchronised, the properties of the virus will lead this experience to converge, albeit possibly on more than one equilibrium. Hence some countries converge on an equilibrium that is more benign than that approached by others. Our primary interest is in the role played by education in determining which countries cluster together in these convergence clubs.

The paper is structured as follows. This introduction is the first section. Section 2 provides a brief literature review, covering both relevant parts of the emergent COVID-19 literature and methodological contributions. The methodology is discussed in greater detail in Section 3. Section 4 presents the data used in the study. The main analytical section, alongside a discussion of the results, is Section 5, and Section 6 concludes the paper and draws policy implications from the analysis.

2 Literature review

The COVID-19 pandemic has presented economies around the world with a shock that is unprecedented in recent history. The authorities were, in effect, faced by a choice between closing down transmission of the virus (or at least slowing it down enough to allow vaccines to be developed) by drastically reducing social contact or allowing the virus to infect entire populations. Either option was hugely costly. The first involved minimising close contact between people, where much of this contact occurs in places of work as a necessary input into economically productive activity. Hence lockdown sacrifices economic output, creating job loss and economic hardship for many individuals, especially young adults, minority ethnic groups, and those with unstable employment (Crossley et al., 2021). Lockdown may also adversely affect mental health by creating undue isolation (Brodeur et al., 2021). The second option likewise involves sacrificing the output of those who are infected while they are infected and in recovery. It also entails accepting a high rate of fatality, which is costly because lives have value. In any calculation of the relative merits of each option, weight needs to be assigned to the deaths that occur, in effect assigning an economic value to life. Most countries opted for some form of lockdown, hoping to minimise the number of fatalities by, in effect, closing down their economies for a period of (at least) several weeks, and then relaxing the lockdown restrictions gradually as the evolution of the epidemic permits. Both the policy response – the severity of the lockdown – and the public response – the degree to which the public have adhered to government guidelines and the extent to which they have behaved in a manner that either anticipated or enhanced these guidelines (for example keeping their children away from school) – are likely to be relevant in determining the effectiveness of the approach.

The workhorse model of the development of a pandemic is the Susceptible-Infected-Removed (SIR) model (Kermack and McKendrick, 1927). In this model, an epidemic begins when some members of a large population of susceptible people become infected by a small number of virus carriers. Eventually these people are removed (either by recovery or death), so that, over time, the numbers of susceptible people decline and the numbers removed increase. The numbers infected start small, increase as infected people pass the virus on to (other) susceptible people, and then eventually decline as the numbers of susceptible people (who are not already infected or removed) falls. The SIR model implies that the steady state of the infection rate is zero, but that the infection rate is above this during the epidemic period. Where the infection spreads rapidly in the initial stages, the infection rate will peak at a relatively high level before falling.

The rate of spread of the infection has been a key consideration during the COVID-19 pandemic. The reproduction number, R0, is defined as the expected number of further cases that are directly generated by a typical case that has the infection. Early estimates of R0 for COVID-19 were between 2 and 3 (Li et al., 2020; Zhang et al., 2020). These caused concern because any number above unity implies that the virus will spread to the entire susceptible population and cannot be contained. But, since the virus, in order to spread, needs to come into contact with uninfected people, putting social distancing measures in place can serve to reduce R0. This has been the aim of lockdown measures. Indeed, Gans (2020) has suggested that, once these behavioural considerations are accommodated in the modelling, the steady state value of R0 must be one. The malleability of R0 challenges the SIR model which, in its basic form at least, assumes a constant infection rate. Consequently, infections may not decline to a steady state of zero; indeed, there may be no steady state; and in the case considered by Gans, the steady state may be path dependent.

In this last context, it is appropriate to consider the processes that determine outcomes in different countries. We see here a parallel to the extensive literature on the cross-country convergence of output (Barro and Sala-i-Martin, 1991, 1992; Quah, 1996). Early papers introduced the notions of β-convergence (based on a regression coefficient) and σ-convergence (based on the spread of growth rates across countries). Simple models of convergence in output receive mixed support from the empirical literature; on the one hand convergence does seem to happen, but on the other it is excruciatingly slow. The latter observation has led to the idea that more rapid convergence may be observed within convergence clubs – aggregations of countries within which economies are converging, but between which economies may either be not converging at all or converging at a slower pace (Ben David, 1998; Canova, 2004). Econometric methods developed by Phillips and Sul (2007, 2009) are designed to accommodate the opportunity that panel data provide to accommodate heterogeneity across countries, while still identifying clusters of countries that demonstrate panel convergence (analogous to σ-convergence).[1] Christopoulos and Eleftheriou (2020) have recently applied analytical tools drawn from this literature to the context of medicine, and we build on that work in the following sections by applying these methods to the spread of COVID-19.

Any clustering of countries into convergence clubs that exhibit similar pandemic outcomes is likely to be a function of government policy responses and public responses to the challenge. These reactions may, in turn, be affected by various factors, including government effectiveness (Liang et al., 2020; Tatar et al., 2021) as well as voice and accountability (Tatar et al., 2021). Pandemic results may also be related to the degree of education among a country's citizenry. This is suggested by findings showing education to be positively correlated with diverse improved health outcomes (Clark and Royer, 2013; Kuhlánová et al., 2014). It is possible that this correlation is partly due to more education leading to more health-friendly thinking and decision-making (Cutler and Lleras-Muney, 2006), which may result in a nation's citizens taking increased precautions to avoid contracting the COVID-19 virus. Furthermore, evidence that increased education reduces mortality due to preventable causes (Grytten et al., 2020) suggests the possibility that more education may lead to more COVID-19-preventive behavior.

It is widely known that the pandemic has affected higher education by necessitating measures to reduce student-student and student-teacher contact, with particular measures varying from country to country (Crawford et al., 2020; see also, e.g., Agasisti & Soncin, 2021 and Jung et al., 2021). But is the converse also true – that is, does higher education have an effect on the pandemic? Of particular interest in this research is whether the public response to the pandemic is related to the percentage of a population that has completed tertiary education. One effect of higher education may be to increase the number of jobs that can be done at home, thereby reducing workers' virus exposure. Indeed, research suggests that tertiary education may be correlated with an increase in the availability of home-based work (Dingel and Neiman, 2020). Another pandemic-relevant factor positively related to higher education is prosocial

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[1] Phillips and Sul methodology has a number of advantages compared with other club convergence techniques, such as: independence from theoretical underpinnings based on growth theory, robustness against small-sample problems, endogenous identification of convergence clubs, appropriateness in the case of temporal transitional heterogeneity (for more details on the advantages of the Phillips and Sul approach, see Apergis et al. (2013)).

orientation, which consists of attitudes of behaving in socially responsible ways toward others (Brandenberger and Bowman, 2015). Having a prosocial attitude has been found to be positively related to the adoption of health measures, such as wearing face masks and practicing physical distancing, designed to prevent the spread of the COVID-19 virus (Campos-Mercade et al., 2021). However, in contrast, a study in Switzerland found that higher-educated youth were less compliant with health measures meant to mitigate infection by the COVID-19 virus (Nivette et al., 2021), a result suggesting that an increased percentage of higher education within a population may actually worsen the public response. Furthermore, despite the correlation between education and health measures, recent studies have found little evidence that there is a causal relationship between degree of education and health outcomes (Albarrána, Hidalgo-Hidalgo, & Iturbe-Ormaetxe, 2020; Lynch & von Hippel, 2016; Xue, Cheng, & Zhang, 2021). Given these varying findings, there is an evident need better to understand what the relationship may be between a citizenry's education, including tertiary education, and their country's pandemic outcomes.

3 Methodology

The first step in our analysis involves applying the method of Phillips and Sul (2007, 2009) to the data on COVID-19. The data allow us to model, as dependent variable, the rate of deaths from infection, X, in each jurisdiction, i, at each point in time, t. The essence of the Phillips and Sul method is to decompose the dependent variable, X_{it}, into a common component, μ_t, and an idiosyncratic component, δ_{it}, such that

$$X_{it} = \delta_{it}\,\mu_t \tag{1}$$

The idiosyncratic component is itself modelled as the sum of a time-invariant component, δ_i, and a term that combines scale effects, σ_i, random effects, ξ_{it}, and a slowly varying structure, $L(t)^{-1}t^{-\alpha}$. Convergence, which implies $\delta_i = \delta$ and $\alpha \geq 0$ can then be formally tested as a null hypothesis against the alternative hypothesis by estimating the following equation and obtaining a robust t statistic for the $\hat{b}$ coefficient,

$$\log\left(\frac{H_1}{H_t}\right) - 2\log L(t) = \hat{c} + \hat{b}\log t + \hat{u}_t, \tag{2}$$

where (H_1/H_t) denotes the cross sectional variance ratio. If the null hypothesis is rejected, then all geographies do not converge, and Phillips and Sul recommend a procedure for identifying convergence clusters. This involves starting with all possible core clubs, and repeatedly adding states to these clubs and testing for convergence within (but not across) the clusters.

A series of Stata commands in the PSECTA package (Du, 2017) allows this procedure to be conducted relatively easily. Unless otherwise noted in the text, we use default values of parameters.

Given the widely different experiences of different countries affected by the COVID-19 pandemic, our prior expectation is that there is more than one convergence club. Indeed, if it were to transpire that there were only one, our approach would add little to the existing literature. Assuming therefore, for the time being, that more than one cluster is identified, our analysis proceeds to a second stage in which a logit/probit model (a multinomial logit/probit in the case of more than two clusters) is used to explain how countries are allocated across convergence clubs.

4 Data

The data we use in this study come from a variety of sources. The data for new COVID-19 deaths per million inhabitants (*ndpm*) were extracted from https://ourworldindata.org/coronavirus and cover the period from May 4 through August 31, 2020. These data allow us to conduct the first stage of the analysis.

For the second stage, however, the latest available data on a wider range of variables are needed. Data on educational attainment in each country are drawn from the updated Barro and Lee (2015) data set from which we obtained projections for 2020 of tertiary education completed in each country. Data on population age structure were retrieved from https://ourworldindata.org/coronavirus. Data on government effectiveness and voice and accountability come from the World Bank’s governance data set (available at www.govindicators.org). From these data we used estimates ranging from approximately -2.5 (weak) to 2.5 (strong). The World Government Indicators (WGI) methodology paper (Kaufmann et al., 2010) provides details on data sources, aggregation method, and indicator interpretation.

Descriptive statistics for all variables are reported in Table 1. For most variables we only have one observation per country – and the value of this observation does not vary across the short period under consideration. For the COVID-19 deaths variable, however, we have day-specific observations within each country. These data cover 54 countries over the period from May 04, 2020 through August 31, 2020, and so there are 6,480 daily observations forming a balanced panel.

The countries in the sample are varied in character, including some from all continents and all levels of development. Since some countries suffered their first experience of COVID-19 earlier than others, at the stage at which these data were collected the countries represented here are at various points in the cycle of the epidemic.

Table 1: Descriptive statistics

	N	Mean	S.D.	Min	Max
ndpm	6,480	0.824	2.523	0	119.34
ndpm_w	6,480	3.724	2.523	2.900	122.24
ndpm_m	6,480	1.120	2.523	0.296	119.64
aged 65 older	54	12.04	6.686	1.144	27.05
voic_acc	54	0.330	1.007	-1.450	1.730
gov_eff	54	0.622	0.946	-1.460	2.230
tertiary	54	14.55	9.585	0.400	43.60
days_100	54	20.70	36.646	0	116

Notes: *ndpm* = new COVID-19 deaths per million inhabitants; *ndpm_w* = weekly-corrected new COVID-19 deaths per million inhabitants; *ndpm_m* = monthly-corrected new COVID-19 deaths per million inhabitants; *gov_eff* = government effectiveness index; *voic_acc* = voice and accountability index; *tertiary* = percentage of population aged 25-64 who have completed tertiary education; *aged 65 older* = percentage of population aged 65 and above; *days_100* = number of days since 100 total COVID-19 deaths.

To account for this effect, we time-correct the *ndpm* variable as follows: First, we regress *ndpm* on weekly (or monthly) dummies and save the estimated coefficient for each dummy. Second, we subtract the above estimated coefficients from *ndpm* to create the time-corrected variable.

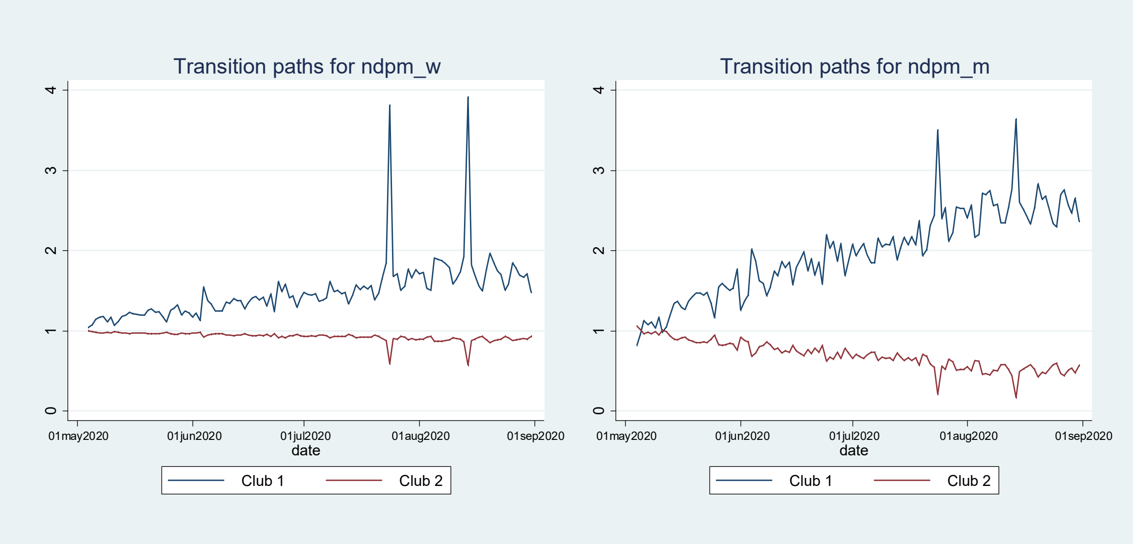
We chose to analyze data from 04 May to 31 August 2020 because this was the interval during which early pandemic-inspired lockdowns had passed for most, if not all, of the countries in our sample. Note that, owing to lack of data availability and the need to obtain a balanced panel, some countries have been excluded. We wanted to learn how policy and public factors affected COVID-19 outcomes during the period when restrictions were somewhat loosened. During this interval, citizens had greater freedom in their behavioural responses to the pandemic. We especially wanted to learn how individuals with a tertiary education responded to the pandemic when they had greater latitude in choosing to exercise or not exercise preventive measures such as wearing masks, social distancing, and not attending large gatherings. Beginning in September 2020, the emergence of the so-called second wave of the pandemic resulted in governments again enforcing stricter guidelines and in some cases instituting a lockdown. Citizens no longer had the degree of latitude they had enjoyed during the previous four months in deciding the extent to which they would engage in behaviours to prevent the spread of the virus. The undertaking of preventive actions became more a function of governmental decrees than it had been previously. Thus, the period from May through August offers a unique window through which to view whether having a higher education was related to pandemic outcomes that might be attributed to relatively self-determined preventive behaviours.

5 Results

Applying the Phillips and Sul (2007, 2009) methods to the time-corrected new COVID-19 deaths per million inhabitants (*ndpm*) data allows identification of two distinct convergence clubs in each case. The membership of these clubs is reported in Table 2. There is a sharp distinction between the two groups in that the mean number of weekly-corrected (monthly-corrected) new deaths per million is 5.6515 (2.2582) in convergence club 1, but is 3.4369 (0.7594) in convergence club 2. That said, the composition of the two clubs warrants some comment. Some countries with high incidence of COVID-19 death, such as Belgium and the United Kingdom, appear in convergence club 2 alongside other countries, such as New Zealand, that have been more successful in restricting the death count. Meanwhile, convergence club 1 likewise comprises both high incidence countries such as the United States and Brazil, and low incidence countries such as Australia. In interpreting our results, it is important therefore to note that membership of one club rather than the other concerns the *process of convergence* to an equilibrium, not the mean value of *ndpm* itself. All in all, while the countries of each convergence club may exhibit high variability in terms of COVID-19 mortality, they will eventually converge in the long-run.

Figure 1 illustrates the transition paths in each case. These confirm that the divergence between the two clubs rises with the passage of time.

Figure 1. Transition Paths



Notes: ndpm_w = weekly-corrected new COVID-19 deaths per million inhabitants; *ndpm_m* = monthly-corrected new COVID-19 deaths per million inhabitants.

Table 2: Club convergence of time-corrected new COVID-19 deaths per million inhabitants (*ndpm*) [May 04, 2020 – August 31, 2020]

Countries	***Panel A: Phillips and Sul (2007)***			***Panel B: Phillips and Sul (2009)***		
	log t	*t-stat*	*New club*	*Final club*	*log t*	*t-stat*
Weekly-corrected ndpm (ndpm_w)						
Full sample	-0.7217 (-0.2813)	-2.5658^{**}				
Club 1 [Argentina, Israel, Mexico, Peru, Romania, South Africa, United	0.591 (-0.2228)	2.651				
Club 2 [Afghanistan, Algeria, Armenia, Australia, Austria, Bahrain, Belgium, Brazil, Cambodia, Canada, China, Croatia, Denmark, Dominican Republic, Estonia, Fiji, Finland, Germany, Greece, Iceland, India, Indonesia, Iraq, Ireland, Japan, Kuwait, Latvia, Malaysia, Malta, Morocco, Nepal, Netherlands, New Zealand, Norway, Pakistan, Philippines, Qatar, Russia, Serbia, Singapore, Sri Lanka, Sweden, Switzerland, Thailand, United Arab Emirates, United Kingdom, Vietnam] (Mean ndpm_w = 3.4369)	0.081 (0.1337)	0.602				
Monthly-corrected ndpm (ndpm_m)						
Full sample	-0.5601 (0.1646)	-3.4020^{**}				
Club 1 [Argentina, Dominican Republic, Israel, Mexico, Peru, Romania, South Africa, United States]	0.980 (0.1889)	5.19	*Club 1+2*	***Club 1*** [Argentina, Australia, Brazil, Dominican Republic, Israel, Malta, Mexico, Morocco, Peru, Philippines, Romania, South Africa, United States] (Mean ndpm_m =	0.543 (0.1561)	3.481
Club 2 [Australia, Brazil, Malta, Morocco, Philippines]	0.529 (0.1568)	3.376				
Club 3 [Afghanistan, Algeria, Armenia, Austria, Bahrain, Belgium, Cambodia, Canada, China, Croatia, Denmark, Estonia, Fiji, Finland, Germany, Greece , Iceland, India, Indonesia, Iraq, Ireland, Japan, Kuwait, Latvia, Malaysia, Nepal, Netherlands, New Zealand, Norway, Pakistan, Qatar, Russia, Serbia, Singapore, Sri Lanka, Sweden, Switzerland, Thailand, United Arab Emirates, United Kingdom, Vietnam]	0.331 (0.1691)	1.958	*Club 2+3*	***Club 2*** [Afghanistan, Algeria, Armenia, Austria, Bahrain, Belgium, Cambodia, Canada, China, Croatia, Denmark, Estonia, Fiji, Finland, Germany, Greece , Iceland, India, Indonesia, Iraq, Ireland, Japan, Kuwait, Latvia, Malaysia, Nepal, Netherlands, New Zealand, Norway, Pakistan, Qatar, Russia, Serbia, Singapore, Sri Lanka, Sweden, Switzerland, Thailand, United Arab Emirates, United Kingdom, Vietnam] (Mean ndpm_m = 0.7594)	0.331 (0.1691)	1.958

Notes: The term log t (t-stat) denotes the convergence coefficient (convergence test statistic). The t-stat is distributed as a simple one-sided t-test with a critical value of −1.65. Standard errors are reported in parentheses. ** denotes the rejection of the null hypothesis (convergence) at 5% level of statistical significance. The estimations were performed using the Stata codes provided by Du (2017).

There are two blips in the series – around the end of July (July 24) and the mid of August (August 14). These appear to be due to extreme values for the case of Peru. Specifically, the corresponding values of *ndpm* for Peru are 117.89 (July 24, 2020) and 119.34 (August 14, 2020).

Since there are two (and only two) convergence clubs identified by the model, the second stage of our approach involves running logit/probit models to explain the membership of each cluster. In Tables 3 and 4, we report the results of several such models.

The results in Tables 3 and 4 confirm that education has a small but significant impact on the process of convergence of time-corrected COVID-19 deaths. Specifically, an increase in the percentage of the population aged 25-64 who have completed tertiary education of one standard deviation (9.585) decreases, on average, the probability of being in the convergence club 2 by 0.01×9.585 = 0.096 percentage points. Recall that this is the convergence club experiencing the lower average death rate; but recall also that membership of the two convergence clubs reflects the dynamic processes rather than the average value of *ndpm*. A high rate of infection during the first wave of the pandemic in some countries may allow these countries to converge on a relatively low equilibrium fatality rate despite having experienced a high death rate up to this point.

Further insight may be obtained by considering, as a further explanatory variable, the interaction of the population age (*aged 65 older*) with the education variable (*aged 65 older* × *tertiary*). In particular, the size of the positive marginal effect of the interaction term implies that an increase in university graduates ultimately decreases COVID-19 deaths for countries with more aged population; for a country having a percentage of individuals aged 65 and above one standard deviation above the average (6.686), the probability of belonging to the low-COVID-19-deaths group is higher by approximately 0.002×6.686×9.585 = 0.128,[2] that is, an overall positive effect of 0.128 - 0.096 = 0.032. This finding implies that while the death rate due to COVID-19 is heavily concentrated amongst very old people, it appears that having an educated population mitigates this to some extent. A possible explanation for the finding is that a more highly educated population is one that is more aware of the well-known fact that advanced age and COVID-19 mortality are highly correlated. This greater awareness may then lead to increased behaviours, when around older, more susceptible people, that reduce the

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[2] The marginal effect of the interaction term was computed following Ai and Norton (2003).

Table 3: Determinants of *COVID-19* deaths – Probit estimates

Dependent variable	*weekly-corrected ndpm*		*weekly-corrected ndpm*		*monthly-corrected ndpm*		*monthly-corrected ndpm*	
	Estimates	Marg. eff.	Estimates	Marg. eff.	Estimates	Marg. eff.	Estimates	Marg. eff.
aged 65 older	-0.0584	0.0251**	0.00735	0.0254**	-0.0623	0.0335**	-0.0237	0.0342***
	(0.139)	(0.0127)	(0.136)	(0.0101)	(0.0983)	(0.0139)	(0.0929)	(0.0121)
tertiary	-0.220*	-0.00768	-0.261*	-0.0103*	-0.225**	-0.00947	-0.198**	-0.00912
	(0.113)	(0.00595)	(0.147)	(0.00567)	(0.0950)	(0.00732)	(0.0857)	(0.00690)
aged 65 older× tertiary	0.0150	0.0019707***	0.0143	0.0021277**	0.0158**	0.0026552***	0.0133*	0.0023275***
	(0.00922)	(0.0007598)	(0.0117)	(0.0009984)	(0.00790)	(0.0007428)	(0.00733)	(0.0006898)
country membership	-0.0880	-0.0143	-0.120	-0.0134	0.825	0.186	0.908	0.196
	(0.740)	(0.120)	(1.206)	(0.133)	(0.752)	(0.165)	(0.804)	(0.170)
gov_eff	0.968*	0.157*	1.123*	0.127	0.873**	0.196**	0.750*	0.159**
	(0.514)	(0.0863)	(0.670)	(0.0772)	(0.395)	(0.0820)	(0.385)	(0.0738)
voic_acc	-1.584**	-0.257**	-2.619***	-0.295***	-1.810***	-0.407***	-1.905***	-0.403***
	(0.678)	(0.124)	(0.918)	(0.0899)	(0.599)	(0.114)	(0.674)	(0.108)
days_100			-0.0312***	-0.00352***			-0.0110*	-0.00234**
			(0.00832)	(0.000914)			(0.00593)	(0.00102)
constant	2.302		3.960**		1.501		1.498*	
	(1.475)		(1.618)		(0.974)		(0.850)	
Observations	54		54		54		54	
Pseudo *R*-squared	0.238		0.476		0.273		0.323	

Notes: ***, **, * indicate significance at the 1%, 5% and 10% level, respectively. We report the average marginal effects and, in parentheses, robust standard errors. The marginal effect of the interaction term was computed following Ai and Norton (2003). Dependent variable = dichotomous variable which takes the value of 1 if the country belongs to Club 2 (see Table 2); *country membership* = dummy variable indicating whether the country is an OECD member (1) or not (0); *gov_eff* = government effectiveness index; *voic_acc* = voice and accountability index; *tertiary* = percentage of population aged 25-64 who have completed tertiary education; *aged 65 older* = percentage of population aged 65 and above; *days_100* = number of days since 100 total COVID-19 deaths per million inhabitants.

Table 4: Determinants of *COVID-19* deaths – Logit estimates

Dependent variable	*weekly-corrected ndpm*		*weekly-corrected ndpm*		*monthly-corrected ndpm*		*monthly-corrected ndpm*	
	Estimates	Marg. eff.	Estimates	Marg. eff.	Estimates	Marg. eff.	Estimates	Marg. eff.
aged 65 older	-0.155	0.0235*	-0.0635	0.0266**	-0.126	0.0316**	-0.0546	0.0333***
	(0.320)	(0.0143)	(0.325)	(0.0111)	(0.171)	(0.0145)	(0.162)	(0.0117)
tertiary	-0.414	-0.00630	-0.542	-0.00989*	-0.383**	-0.00802	-0.347**	-0.00765
	(0.257)	(0.00625)	(0.431)	(0.00529)	(0.170)	(0.00776)	(0.154)	(0.00734)
aged 65 older× tertiary	0.0300	0.0018206**	0.0335	0.0022239*	0.0280*	0.0025119***	0.0243*	0.0021284***
	(0.0215)	(0.0008571)	(0.0370)	(0.0012443)	(0.0148)	(0.0007935)	(0.0143)	(0.0007302)
country membership	-0.271	-0.0243	-0.168	-0.0104	1.365	0.180	1.535	0.188
	(1.235)	(0.110)	(2.055)	(0.126)	(1.370)	(0.177)	(1.579)	(0.195)
gov_eff	1.740	0.156	1.978	0.124	1.505**	0.197**	1.321*	0.156**
	(1.069)	(0.0952)	(1.392)	(0.0889)	(0.737)	(0.0858)	(0.736)	(0.0751)
voic_acc	-2.832*	-0.253*	-5.041*	-0.315***	-3.167***	-0.414***	-3.474**	-0.409***
	(1.520)	(0.146)	(2.623)	(0.103)	(1.171)	(0.122)	(1.414)	(0.118)
days_100			-0.0569***	-0.00356***			-0.0203*	-0.00239***
			(0.0197)	(0.000829)			(0.0106)	(0.000918)
constant	4.422		7.837*		2.651		2.753*	
	(3.510)		(4.679)		(1.689)		(1.498)	
Observations	54		54		54		54	
Pseudo *R*-squared	0.239		0.480		0.273		0.330	

Notes: ***, **, * indicate significance at the 1%, 5% and 10% level, respectively. We report the average marginal effects and, in parentheses, robust standard errors. The marginal effect of the interaction term was computed following Ai and Norton (2003). Dependent variable = dichotomous variable which takes the value of 1 if the country belongs to Club 2 (see Table 2); *country membership* = dummy variable indicating whether the country is an OECD member (1) or not (0); *gov_eff* = government effectiveness index; *voic_acc* = voice and accountability index; *tertiary* = percentage of population aged 25-64 who have completed tertiary education; *aged 65 older* = percentage of population aged 65 and above; *days_100* = number of days since 100 total COVID-19 deaths per million inhabitants.

spread of the virus. The likely result of these prosocial behaviours directed toward protecting the health of the elderly during the pandemic would be decreased mortality due to COVID-19 among elderly citizens. Regarding the impact of the rest of the variables, having more effective government improves the probability of being in the low-COVID-19-deaths club, while voice and accountability and the number of days since 100 total COVID-19 deaths per million inhabitants have an opposite effect. Good governance clearly, and for obvious reasons, has a beneficial effect on outcomes, but the role played by voice - often associated with democratic institutions - is interesting. In more politically open settings, voice may be associated with a toleration of dissent, and while this may generally be regarded as a favourable characteristic it can lead to negative outcomes in the context of a pandemic where public discipline is critical. Moreover, the number of days since 100 total COVID-19 deaths per million inhabitants can be considered as a measure of the spread of the infection; the fewer the days, the higher the spread of the disease. While a small value of this variable may indicate more COVID-19 deaths in the short-run, could eventually result to lower deaths in the long-run due to the higher degree of immunization (the spread of the disease is positively related to the degree of immunization). Finally, the impact of the percentage of population aged 65 and above and of the country membership appears to be statistically insignificant.

We also conducted a robustness check without time-correcting *ndpm* and found that the regression results are qualitatively identical. Moreover, we performed our estimations after controlling for income (proxied by the log of GDP per capita, PPP - constant 2017 international $). However, the effect of income was statistically insignificant.

At this point, it is important to note that the Maximum Likelihood Estimation (MLE) of our specifications may suffer from sparse-data bias due to the small sample size and the existence of rare events. To this end, we checked the robustness of our results by using the Stata command -penlogit- (Discacciati et al., 2015) to estimate an approximate Bayesian logistic regression model using penalized likelihood estimation via data augmentation. Our estimation is performed by imposing informative normal priors, and the produced estimates, which are available upon request, corroborate the validity of our findings.

6 Conclusion

The COVID-19 pandemic has had differing impacts on countries. This paper has shown how a sample of 54 countries form two distinct convergence clusters, one with higher and one with lower COVID-19 deaths. Our second stage modelling shows how different characteristics of the countries in the sample might explain these countries' experience of COVID-19. We distinguish between factors that affect the policy response and those that influence the public response. The former characteristics include government effectiveness and voice and accountability. The latter include the percentage of the populace with experience of tertiary education. We find that government effectiveness is related to a country's being in the lower mortality convergence club, while the voice and accountability variable is related to being in the higher mortality club. Though we found tertiary education on its own to be associated with membership in a higher COVID-19 mortality country, tertiary education combined with percent age 65 or more predicts being in the lower mortality club.

The finding that government effectiveness is associated with being in the lower mortality convergence club may be due to effective governments more capably dealing with the pandemic through establishing directives and publicizing information that help reduce spread of the virus.

The result that level of voice and accountability predicts being in the higher mortality convergence club is possibly due to a greater acceptance of dissent in countries high in voice and accountability, which may weaken adherence to government guidelines.

The finding that higher education combined with percent 65 or older is related to being in the lower mortality convergence club suggests that when near elderly people, more highly educated individuals are more likely to practice behaviours intended to reduce spread of the virus. This is possibly due to their having greater awareness of the serious potential consequences of the virus and the elderly’s increased susceptibility, which may foster prosocial behaviors around the elderly. Insofar as these individuals do have greater awareness, this implies that they are more informed about the virus, how it is spread, and who is most susceptible. In general, those with higher education do seem to be better informed about health issues and in a position to make use of the information (Cutler and Lleras-Muney, 2006). Given that the COVID-19 pandemic has been the subject of many media reports, including those about government advisories and decrees, being better informed would suggest that highly educated individuals are more likely than others to have understood and paid attention to reports about the virus. Some of less educated may not have understood the reports due to reading or language problems; education may also affect the degree or nature of engagement with current affairs. These considerations indicate the importance of governments recognizing that innovative ways may need to be devised to inform some less educated citizens on matters critical to public health.

A limitation of the study is that data about COVID-19 deaths were restricted to the period from early May to August 31, 2020. It may still be a number of months before the pandemic is finally over. However, increasing numbers of people are now being inoculated against the COVID-19 virus and governments are moving toward fewer mandatory restrictions to halt virus spread. Therefore, we may be entering a period in which this study can be repeated. If so, we recommend doing so to determine if the combination of percent tertiary education and percent of population aged 65 or more continues to predict a country’s membership in the lower COVID-19 mortality club.

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