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Economic Development and COVID-19 Cases *

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Abstract/Résumé

This note provides preliminary evidence on the determinants of the COVID-19 infection and death cases using a sample of 217 countries and territories. We control for a number of country characteristics. These include GDP per capita, and demographic, openness, institutional and geographic variables. We find positive effects of the level of economic development and the size of pediatric population on infection cases. In terms of death cases, the number of infections, the share of geriatric population and the lack of systematic BCG vaccination all play a positive and significant role.

Keywords/Mots-clés: COVID-19, GDP Per Capita, BCG Vaccine, China

JEL Codes/Codes JEL: C31, I15, I38

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1. Introduction

The COVID-19 pandemic has generated widespread interest from academic and non-academic circles to pursue research and gain a better understanding of the pandemic and its consequences.[1] The pandemic has also generated controversy in the mass media[2] about the economic impact of COVID-19 cases. Preliminary evidence from economic research (McKibbin and Fernando, 2020) suggests that the economic costs of the pandemic are substantial. While macroeconomic effects dominate the economic narrative of the pandemic, some researchers have paid attention to the determinants of the infection cases. Reports based on simple correlation between Gross Domestic Product (GDP) per capita and COVID-19 cases[3] have been widely shared in the mass media, which brings about a question regarding the relation between the spread of the pandemic and the level of economic development. While preliminary epidemiological research is focusing on individual determinants (Wang et al., 2020), an examination of country characteristics is still missing or insufficient. This note aims at filling this gap, by providing preliminary evidence on country-level determinants of COVID-19 infection and death cases by controlling for the level of economic development and demographic, openness, institutional and geographic characteristics, using a worldwide sample of countries and territories. We also test for the BCG vaccine hypothesis, which claims that systemic BCH anti-tuberculosis vaccination might slow down the infection rate and mortality rate of COVID-19.[4] The next section presents the data, the econometric model and the results. The last section concludes.

2. Data and Results

2.1 Data and Model

We collect data on COVID-19 infection and deaths cases by country from the American Library Association (ALA)[5] and transform them into cases per million inhabitants. The data is collected on April 3, 2020 at midnight. Descriptive statistics reported in Table 1 show, on average, 319.35 infections and 12.14 deaths per million inhabitants.

We divide our independent variables into five groups. The first includes GDP per capital (PPP, current international $) collected from the World Development Indicators (WDI) database of the World Bank, for the year 2018, which is the latest available full set of data. The second group consists of demographic variables. Specifically, we use the percentage of the population aged 0-14 years old, the percentage of the population aged above 64 years old, the sex ratio (males per 100 females) and life expectancy, which are also collected from the WDI for the year 2018. The third group consists of openness variables. These include data for the year 2018 for the trade value (percent of GDP) collected from the WDI, and bilateral trade with China (percent of GDP)

[1] https://www.economist.com/graphic-detail/2020/03/20/coronavirus-research-is-being-published-at-a-furious-pace?fsrc=scn/fb/te/bl/ed/dailychartcoronavirusresearchisbeingpublishedatafuriouspacegraphicdetail
[2] https://www.bbc.com/news/business-51706225
[3] https://ourworldindata.org/grapher/total-confirmed-cases-of-covid-19-per-million-people-vs-gdp-per-capita
[4] https://clinicaltrials.gov/ct2/show/NCT04328441?term=vaccine%2C+bcg&cond=COVID-19&draw=2&rank=1
[5] https://www.worldometers.info/coronavirus/

collected from United Nations COMTRADE database on international trade. The last variable in this group is the total number of airport passengers by country, collected from the 2017 CIA World Factbook. The fourth group consists of three institutional variables. The 2019 Global Health Security Index developed by The Economist Intelligence Unit (EIU), which is used as a measure of each country's public health security. The second variable is a dummy variable, which is equal to 1 if the country's BCG national vaccination policy is not recommended for everyone, and to 0 otherwise.[6] The last is a dummy variable on 'whether the country is democratic', collected from the Democracy Index 2019 report.[7] Finally, we control for two relevant geographic features: the distance from China in Kilometers (km) collected from GeoDatos, and the average temperature in degrees Celsius for the months of January, February and March 2020, for the largest city in each country or territory.[8] The latter is used to control for potential seasonality in viral transmission.

Table 1: Descriptive Statistics

	(1) Obs.	(2) Mean	(3) Std. Dev.	(4) Min	(5) Max
Dependent Variables					
infected cases (per million inhabitants)	216	319.35	865.36	0	7251.74
death cases (per million inhabitants)	216	12.14	66.94	0	887.97
Gross Domestic Product					
GDP per capita (PPP, current Intl' $)	186	21736	23298	744	126898
Demographic Variables					
pop 0-14 (% of population)	193	27.41	10.44	11.90	49.98
pop 65+ (% of population)	193	8.91	6.30	1.09	27.58
sex ratio (males per 100 females)	192	101.59	21.44	84.58	301.18
life expectancy (years)	199	72.53	7.65	52.24	84.68
Openness Variables					
trade value (% of GDP)	184	92.87	57.26	21.50	400.08
bilateral trade (% of GDP)	188	0.001	0.007	0	0.1
passenger volume	166	2.09E+07	7.41E+07	0	7.98E+08
Institutional Variables					
GHS index	192	40.35	14.59	13.20	83.50
BCG vaccine not required	217	0.02	0.15	0	1
democracy dummy	170	0.45	0.50	0	1
Geographic Variables					
distance from China (km)	214	8658.10	3987.20	1222	19604
average temperature (°C)	192	15.81	11.09	-15.90	29.13

[6] http://www.bcgatlas.org/
[7] "Democracy Index 2019: A Year of Democratic Setbacks and Popular Protest"
[8] https://en.climate-data.org/

We run the following Ordinary Least Squares regressions:

$$Infections_i = \alpha_0 + \alpha_1 GDP_i + \alpha_2 Dem_i + \alpha_3 Openness_i + \alpha_4 Inst_i + \alpha_5 Geo_i + \alpha_6 time_i + u_i \quad (1)$$

$$Deaths_i = \beta_0 + \beta_1 Infections_i + \beta_2 GDP_i + \beta_3 Dem_i + \beta_4 Openness_i + \beta_5 Inst_i + \beta_6 Geo_i + \beta_7 time_i + v_i \quad (2)$$

Where *i* is country *i*. $Infections_i$ and $Deaths_i$ are the number of COVID-19 infections and deaths cases per million inhabitants in country *i*. GDP_i is GDP per capita, Dem_i is the vector of the demographic variables, $Openness_i$ the openness variables, $Inst_i$ the institutional variables and Geo_i the geographical variables. In all the regressions, we control for the time elapsed since the first registered case. u_i and v_i are error terms.

2.2 Results

Table 2 reports the results of the OLS regression for the number of COVID-19 infection cases per million cases. In column 1, we control for GDP per capita and the time elapsed since the first reported infection. We consecutively add demographic, openness, institutional and geographic variables in columns 2 to 5, respectively. We find that GDP per capita is positively and significantly related to COVID-19 infection cases in all specifications. This result might be related to the level of economic development, which positively correlates with a higher density of economic relationships inside the economy. In addition, we find a positive and significant effect for the share of the population aged between 0 to 14. Interestingly, the share of the population aged 65 and above is only significant in specifications 2 and 3 but becomes insignificant when we add institutional and geographic variables. The results suggest that the pediatric population could be a vector of transmission of COVID-19 cases across the world. The insignificance of the geriatric population effect in the last two specifications suggests that, this segment of the population that is disproportionately affected, is not the main vector of transmission. This segment might not be as mobile as the rest of the population or in need of the same level of dependent care as the pediatric segment. All openness variables, i.e. trade, bilateral trade with China and the number of airport passengers, do not seem to affect the number of infections. Similarly, the institutional variables, including the GHS index that is used as a proxy of the quality of the health care system, are also insignificant. Lastly, we find no relationship between the number of infections and the distance from China or the average temperature.

Table 3 reports the results for the number of COVID-19 death cases per million inhabitants. The regressions are similar to the ones used in Table 2, with the exception that we also control for the number of COVID-19 infection cases in all specifications. As expected, the latter variable is always positive and significant. However, GDP per capita, although negative, is neither economically nor statistically significant.

Table 2: OLS number of infection cases

variables	(1) Infections	(2) infections	(3) infections	(4) infections	(5) infections
GDP per capita	0.013***	0.014**	0.013**	0.0201**	0.020**
	(0.005)	(0.007)	(0.005)	(0.008)	(0.008)
pop 0-14		20.01***	24.68***	17.06*	19.28*
		(6.613)	(8.522)	(8.905)	(10.01)
pop 65+		41.34**	44.93***	22.05	21.73
		(16.33)	(16.57)	(18.80)	(17.02)
sex ratio		-1.569	-1.614	-6.440	-5.699
		(3.569)	(3.108)	(4.423)	(4.196)
life expectancy		0.257	2.868	3.515	3.393
		(7.742)	(10.68)	(12.04)	(12.58)
trade value			2.349	1.058	1.457
			(2.358)	(2.212)	(2.311)
bilateral trade			-2.265e+05*	-1.842e+05	-1.428e+05
			(1.210e+05)	(2.092e+05)	(1.832e+05)
passengers			1.60e-07	-4.88e-07	-6.79e-07
			(4.25e-07)	(4.86e-07)	(5.74e-07)
GHS index				-4.758	-5.917
				(5.938)	(6.358)
BCG not required				367.2	362.7
				(319.7)	(343.9)
democracy				51.25	67.09
				(67.67)	(87.80)
distance from China					0.011
					(0.010)
average temperature					-5.034
					(6.284)
time	0.120	-1.394	-0.769	0.001	0.974
	(2.490)	(2.280)	(2.272)	(2.538)	(2.854)
constant	-71.33*	-829.8	-1,303	-320.6	-472.5
	(42.67)	(759.7)	(998.6)	(1,217)	(1,269)
Observations	186	170	138	129	123
R-squared	0.294	0.377	0.421	0.486	0.496

Robust standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

Table 3: OLS number of death cases

variables	(1) Deaths	(2) deaths	(3) deaths	(4) deaths	(5) deaths
infection cases	0.034**	0.032**	0.034**	0.032*	0.033*
	(0.015)	(0.015)	(0.017)	(0.016)	(0.017)
GDP per capita	-0.0002	-0.0002	-0.0001	-0.0004	-0.0003
	(0.0002)	(0.0002)	(0.0001)	(0.0003)	(0.0003)
pop 0-14		0.435	0.230	-0.118	-0.219
		(0.432)	(0.561)	(0.521)	(0.574)
pop 65+		1.572**	1.507*	1.081*	1.276*
		(0.776)	(0.828)	(0.606)	(0.769)
sex ratio		0.169*	0.145*	0.219*	0.191
		(0.101)	(0.0800)	(0.129)	(0.120)
life expectancy		-0.209	-0.400	-0.741	-0.743
		(0.483)	(0.604)	(0.657)	(0.702)
trade			-0.128	-0.102	-0.115
			(0.092)	(0.083)	(0.092)
bilateral trade			4,916.18	1,006.27	872.79
			(4,682.25)	(6,229.10)	(6,309.57)
passengers			-3.04e-08	-8.11e-08**	-9.22e-08**
			(2.30e-08)	(4.00e-08)	(4.37e-08)
GHS index				0.128	0.173
				(0.265)	(0.270)
BCG not required				66.87**	69.64**
				(32.67)	(33.19)
democracy				0.415	-0.796
				(2.274)	(3.112)
distance from China					-0.0001
					(0.0004)
avg temperature					0.349
					(0.285)
time	0.288**	0.258**	0.283**	0.287**	0.226
	(0.127)	(0.116)	(0.135)	(0.138)	(0.159)
constant	-4.034**	-29.30	-0.642	25.35	26.31
	(1.810)	(48.05)	(61.37)	(53.98)	(59.54)
Observations	186	170	138	129	123
R-squared	0.416	0.447	0.472	0.590	0.597

Robust standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

Similarly, the share of population aged 0 to 14, which significantly affects the number of infection cases, is not a significant determinant of the number of death cases. However, we find a positive and significant effect of the share of the population aged 65 and above. This is in line with the statistics showing that the geriatric population has a significantly higher mortality rate related to the COVID-19 disease than the rest of the population. Moreover, we find a positive and mostly significant effect (in 3 out of 4 specifications) of the sex ratio. Specifically, we find that countries with a higher sex ratio, i.e. a higher number of males per 100 females, have higher death cases, which provides supporting evidence to the statistics showing that more men are dying from COVID-19 than women. In terms of openness variables, we find that the number of airlines passengers is negative and significant, which is a surprising result given that COVID-19 is a highly transmissible disease (Liu et al., 2020). As for the institutional variables, even though the GHS index is still insignificant, we now find a large and significant effect of the BCG vaccine on the number of deaths. Specifically, the countries in which the BCG vaccination is not required for all the population have 69 additional deaths per million inhabitants. This supports the new studies claiming that the BCG vaccine might play a role in fighting the COVID-19 pandemic. Lastly, we find no effect of the distance from China and the average temperature on the number of deaths.

3. Conclusion

This note provides preliminary evidence on the determinants of COVID-19 infections and death cases across the world. We find the level of economic development to be the most salient variable in terms of the number of infections, in addition to the share of the population aged 0 to 14. This last result shows that the pediatric population is a significant vector of transmission of the disease, which provides support to 'school closures' that was one of the first government responses around the world in the fight against the pandemic. In terms of the number of deaths, countries with a higher share of population aged 65 and above and countries where the BCG vaccination is not required for the whole population, experience more deaths from the COVID-19 pandemic.

These results are preliminary given that our data on the numbers of COVID-19 infection and death cases are changing tremendously every day. Definite conclusions on the determinants will only be known several months or maybe years from now. Moreover, as more medical evidence is provided, more precise testable hypotheses would be readily available, one of which is the relevance of GDP per capita.

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