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School Performance and GDP in Africa: Estimating the Impact of COVID-19 Using Harmonized Learning Outcomes

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Abstract

The economic difficulties faced by African countries may have been significantly exacerbated by the outbreak of the COVID-19 pandemic, which caused significant disruptions to student learning across the world. In this study, we estimate the relationship between human capital, measured through Harmonized Learning Outcomes, and GDP per capita in African countries based on available historical data. Our estimations indicate that a one-standard deviation increase in human capital is associated with roughly a 400 point increase in GDP per capita, with statistical significance found both for primary and secondary school achievements in the educational domains of mathematics and reading. Given the evidence from the literature on the significant economic and educational impacts of the COVID-19 pandemic, this could translate into an economic loss, estimated as being between 70 and 330 US dollars per capita in African countries. We highlight the need for reliable and consistent estimations of school performance in the continent.

Keywords: **COVID-19, learning loss, African countries.**

Osiągnięcia szkolne i PKB w Afryce: Oszacowanie wpływu COVID-19 z wykorzystaniem Zharmonizowanych Wyników Uczenia się

Streszczenie

Trudności gospodarcze, z jakimi borykają się kraje afrykańskie, mogły zostać znacznie pogłębione przez wybuch pandemii COVID-19, która spowodowała istotne zakłócenia w edukacji uczniów na całym świecie. W niniejszym badaniu szacujemy związek między kapitałem ludzkim, mierzonym za pomocą Zharmonizowanych Wyników Uczenia się (Harmonized Learning Outcomes) a PKB per capita w krajach afrykańskich w oparciu o dostępne dane historyczne. Nasze szacunki wskazują, że wzrost kapitału ludzkiego o jedno odchylenie standardowe wiąże się ze wzrostem PKB per capita o około 400 punktów, przy czym istotność statystyczna została stwierdzona zarówno w przypadku osiągnięć w szkołach podstawowych i średnich, jak i w dyscyplinach matematyki i umiejętności czytania. Biorąc pod uwagę dane z literatury na temat znaczącego wpływu pandemii COVID-19 na gospodarkę i edukację, może to przełożyć się na stratę ekonomiczną szacowaną na poziomie od 70 do 330 dolarów amerykańskich per capita w krajach afrykańskich. Zwracamy uwagę na potrzebę wiarygodnych i spójnych szacunków wyników edukacyjnych na tym kontynencie.

Słowa kluczowe: **COVID-19, spadek wyników w nauce, kraje afrykańskie.**

1. INTRODUCTION

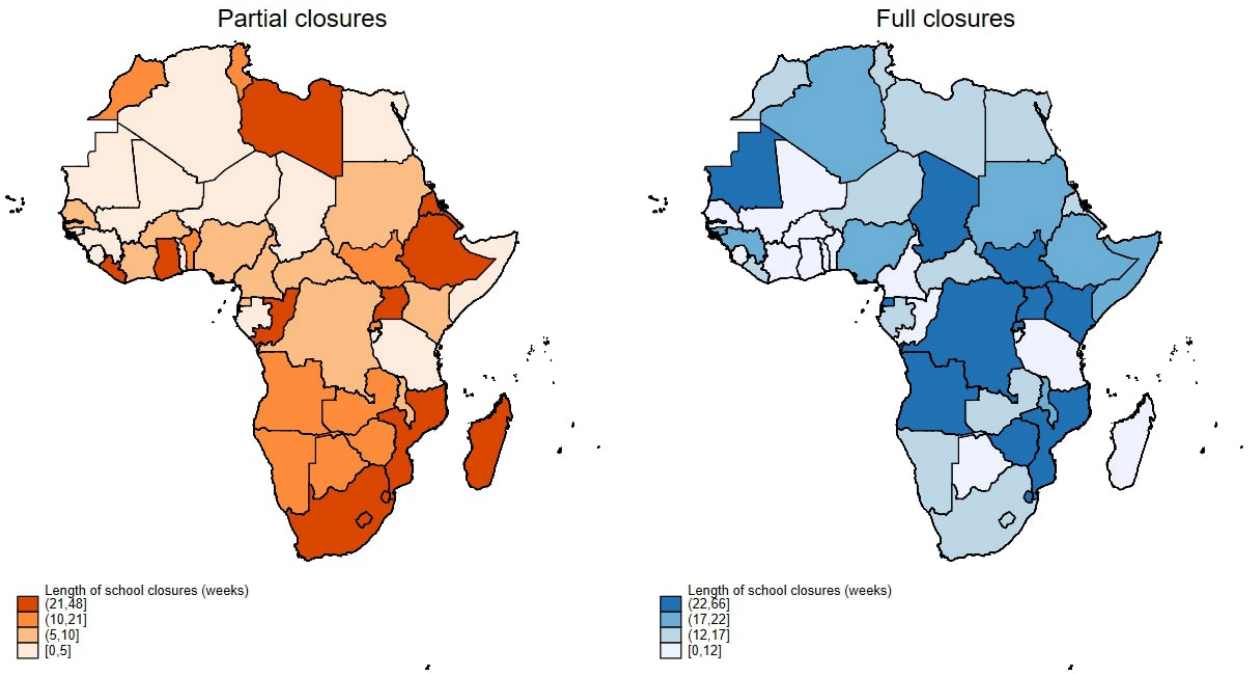
Africa has struggled with economic growth in recent decades (Collier & Gunning, 1999). Researchers point to environmental challenges and ineffective policies that have failed to remove key obstacles (Sachs & Warner, 1997; Akyüz & Gore, 2001). In the continent, difficulties remain despite recent institutional developments that have improved economic conditions (Fosu, 2013). However, it has also been found how human capital in the continent can be a driver of increased economic development and productivity (Oketch, 2006). Yet, the continent lacks clear assessments of its human capital, also as a result of the low participation rate of its countries in large-scale studies. In this paper, we aim to contribute to filling this gap by providing evidence from the continent using Harmonized Learning Outcomes, which measure student achievement in a consistent and reliable way across different international assessments.

Recent evidence on educational policy in Africa confirms the existence of significant challenges for the development of quality schooling. One major issue is access to education. Notably, Bashir et al. (2018) presented evidence on how one-fifth of the children in the continent do not attend school, with dropout also being a relevant issue. Furthermore, Yeboah et al. (2023) showed how low training for educators may reduce inclusivity. Yet, as noted by Evans et al. (2021), there is still a lack of large-scale evidence due to the scarce implementation of policy interventions in the continent. The aim of the current study is to contribute to the evidence from African countries using large-scale data, which allows for reliable estimations across countries and cycles.

The evidence on the impact of the COVID-19 pandemic in Africa has been mixed. The pandemic created major economic and health challenges in Africa (Lone & Ahmad, 2020). However, some evidence suggests that the health impact was lower than in other regions of the world (Bamgboye et al., 2021). Despite this, the huge economic difficulties experienced by the populations in the continent may have been increased by the outbreak of the pandemic (Ataguba, 2020). However, this mixed evidence has not been widely investigated with respect to the long-term economic consequences of educational disruptions, thus leaving open the question of the impact of school closures in African countries.

The evidence indicates how the pandemic has caused learning losses corresponding to more than one year of education for primary school students, leading to significant economic repercussions (Jakubowski et al., 2023). These could be particularly negative for Africa, where educational systems still struggle and lacked the preparation for the implementation of remote learning during the pandemic (Matete et al., 2023). Significant learning losses have also been predicted for the region, due to the challenges in education and high dropout rates (Angrist et al., 2021a; Sabates et al., 2021; Moscoviz & Evans, 2022). The lack of investments in technology for remote learning, especially in the Sub-Saharan region, may also be a driver of such losses, given the frequent disruptions to education in the region (Ayega, 2020). Furthermore, schools in Africa have remained closed for longer than in the developed world, and this is not based on the trends in COVID-19 cases (Buonsenso et al., 2021). Figure 1 shows the length of school closures in African countries, comparing partial and full closures as measured by UNESCO.

Figure 1 ***School closures in African countries***



Source: Author's elaboration based on UNESCO (2022) data

In this study, we address the issue of how learning losses may be associated with economic development in African countries, using pre-pandemic data to simulate and estimate the effect of the pandemic. While the nature of our analysis is speculative, we aim at contributing to the evidence on education in the continent using large-scale harmonized data and economic indicators. In particular, we investigate the relationship between academic achievements and GDP per capita in the continent, relying on multiple observations of Harmonized Learning Outcomes (Angrist et al., 2021b). Our aim is to quantify the relationship between the change in human capital and in economic affluence, and thereby provide a tentative estimation of the economic impact of the COVID-19 pandemic caused by learning disruptions, given the lack of pre- and post-pandemic data for the majority of African countries. While the availability of data does not allow for a more rigorous measurement of the impact of the pandemic itself, our estimations allow us to obtain a tentative and preliminary measurement based on historical data and on the impact of the pandemic as computed by previous studies in the literature.

2. DATA AND METHODOLOGY

The investigation of the relationship between school performance and GDP is implemented using data on Harmonized Learning Outcomes computed by Angrist et al. (2021b). These estimations span several international assessments and provide comparable measures across domains and grades. In our analysis, we restrict the dataset to the 45 African countries for which observations are available for the time period between 2000 and 2017, and including observations from the EGRA, PASEC, PIRLS, PISA, SACMEQ, and TIMSS assessments. While the data on educational achievements has not been regularly collected, since countries did not take part in all the editions of all the assessments, the initial size of the dataset of 229 individual observations allows general estimations to be obtained that can provide information on the general trends in Africa.

Harmonized Learning Outcomes have the significant advantage of providing reliable and consistent estimations across different assessments and domains for all the countries in the dataset. However, it is important to acknowledge their limitations as well. In particular, the harmonization of the estimations across different assessments can reduce the explanatory power given by the specific features of each of them. Moreover, the irregular frequency and quality of Harmonized Learning Outcomes measurement across countries can also present a limitation, given that it may reduce the generalizability of the findings, especially given that we are focusing on the entire continent, thus overlooking possible significant differences among countries. Nonetheless, the use of Harmonized Learning Outcomes enables many observations to be used across different domains and school levels, thus enriching the analysis and allowing for a more robust estimation.

To estimate the relationship between human capital and economic affluence in African countries, we implement unbalanced panel data regressions using GDP per capita as the dependent variable, and standardized Harmonized Learning Outcomes as the main independent variable (we use a z-score of the variable, with the mean equal to 0 and the standard deviation equal to 1). The choice of unbalanced panel data stems from the fact that countries have different numbers of observations, as well as some repeated observations in the years when more than one assessment took place in the same country. For this reason, the data was set based only on the panel variable (i.e., country), and not on the time variable. The relationship between educational outcomes and economic development has been investigated with regressions in the past, using GDP growth or income per capita (Hanushek & Woessmann, 2008; OECD, 2010).

In our model, the use of GDP per capita allows a direct and meaningful measure to be obtained of the individual losses experienced as a result of school closures during the COVID-19 pandemic. A possible issue in this approach is that the results should be interpreted as showing correlation and not causality, given that higher economic development may result in improved education instead. Yet, the data suggest that there is no evidence to dismiss the claim that education may cause economic development (Hanushek & Kimko, 2000; Hanushek & Woessman, 2007), also given that education usually takes place before entering the labor market, thus being one of the determinants of later income (Hanushek & Woessman, 2008).

Our analysis shows correlation between HLOs and GDP per capita, not causation. On the one hand, it can be argued that the accumulation of human capital driven by increased student achievement may lead to improved economic capital as well (Becker, 1975). On the other hand, as noted above, economic development may lead to increased educational quality through increased expenditures in education itself. For this reason, the results should be interpreted with caution, and mainly as descriptive evidence relating the two indicators of interest (human capital, proxied by Harmonized Learning Outcomes, and economic development, proxied by GDP per capita). In this respect, causality may only be hypothesized.

To determine the appropriate panel data estimation method, we conducted a Hausman test to compare the fixed effects (FE) and random effects (RE) models. The test assesses whether the unique errors are correlated with the regressors, which would violate the assumptions of the RE model. A significant test result favors the use of the FE model. In our analysis, the Hausman test yielded a p-value of less than 0.001, indicating robust evidence against the null hypothesis that the RE estimator is consistent. Consequently, we adopted the fixed effects specification for our panel regression to control for time-invariant heterogeneity across entities. In all the models, we further compute robust standard errors, adjusting them to be heteroskedasticity- and autocorrelation-consistent, making inferences more reliable.

In Model 1, we simply regress GDP per capita against standardized Harmonized Learning Outcomes (HLOs). In Model 2 and 3 we further include Gross Capital Formation, Expense, and Trade, all as a share of GDP, gathered from the World Bank datasets, as control variables (equation 1):

$$Y = \beta_0 + \beta_1 HLO + \beta_2 GCF + \beta_3 Expense + \beta_4 Trade + \varepsilon \quad (1)$$

In equation 1, Y indicates GDP per capita, HLOs the standardized Harmonized Learning Outcomes, GCF the Gross Capital Formation, while Expense and Trade the corresponding shares of GDP.

The choice of the control variables stems from their relevance for the determination of GDP per capita, the dependent variable. Gross capital formation has been found to positively impact economic development and growth (Topcu et al., 2020; Kesar et al., 2023); however, this link is usually not significant in African countries (Kanu & Ozurumba, 2014; Maune & Matanda, 2022), possibly also due to the low overall indicator in the region (Akobeng, 2017). In addition to this, the other control variables allow measurements of economic management on the side of the government (expense) and openness (trade) to be included, both of which can influence economic development and human capital accumulation. Their inclusion as control variables allows for a more robust estimation that accounts for economic dynamics that are not specifically related to education.

Due to the possible cross-country dependency, as well as the fact that in some cases there are multiple observations for a single year in a country (i.e., when HLOs cover more than one domain within the same assessment), we ran panel data models with the aim of obtaining a measurement of β1 in particular, which represents the magnitude of the change in GDP per capita observed as a result of a change of one standard deviation in HLOs. We use GDP per capita in absolute terms to be able to interpret the regression coefficients and the relationship between HLOs and GDP per capita itself. All the variables, except for Harmonized Learning Outcomes (HLOs), are taken from the World Bank datasets. We implemented our analyses on the pooled data of African countries available in the HLO dataset, on school levels (primary and secondary) separately, as well as by educational domain (mathematics, reading, and science).

3. RESULTS

This section presents the results of the panel models of GDP per capita and standardized Harmonized Learning Outcomes (HLOs). In Table 1, which shows the results of the pooled data, considering all school levels and domains, it can be seen how HLOs are positively associated to GDP per capita, both when considered as a single independent regressor and when adding the control variables. The coefficients indicate that an increase of one standard deviation in HLOs corresponds to a positive change of around 400 points in GDP per capita in current US dollars. When comparing the estimations for educational achievements in primary and secondary school (Table 2a and Table 2b), it can be noted how HLOs retain statistical significance in both, with a magnitude of around 570 points of change in current US dollars when control variables are included for primary school achievements; and with a stronger magnitude of around 1000 points of change in current US dollars when control variables are included for secondary school achievements. Figure 2 compares the correlation coefficients.

The gaps in coefficients between primary and secondary school achievements can be explained by different factors. A straightforward explanation is that secondary education, being more advanced, generates more human capital and thus greater income gains. However, findings from the literature on African countries suggest that secondary school achievements may have more impact in reducing economic inequalities than primary school ones (Abdullah et al., 2015), suggesting that overall secondary school achievements could have a stronger explanatory power on economic factors. Furthermore, it has also been argued that students from low socioeconomic backgrounds may struggle more in secondary school than their more affluent peers (Shaw et al., 2017), which could suggest that secondary school achievements are more dependent on income than primary school ones. While this can suggest reverse causality, it can also support the argument that secondary school achievements are more strongly related to economic capital than primary school achievements.

Table 1 ***Panel data analysis of GDP per capita and HLOs, pooled data***

	Model 1	Model 2	Model 3
Harmonized Learning Outcomes	366.98** (148.83)	428.08*** (131.72)	402.85*** (123.76)
Gross fixed capital formation (% of GDP)		114.09** (43.93)	109.62*** (36.34)
Expense (% of GDP)		60.61 (79.72)	47.54 (81.16)
Trade (% of GDP)			20.94 (22.05)
Constant	3068.34*** (0.63)	-409.01 (1696.03)	-1739.21 (2027.91)
r-squared	0.06	0.25	0.28
No. of observations	203	124	123

Source: World Bank and Angrist et al. (2021b) data. *p<0.1, **p<0.05, ***p<0.01. Robust standard errors in parentheses

Table 2a ***Panel data analysis of GDP per capita and HLOs, by school level (primary)***

	Model 1	Model 2	Model 3
Harmonized Learning Outcomes	377.93** (175.27)	613.95*** (177.56)	574.06*** (177.08)
Gross fixed capital formation (% of GDP)		129.98** (59.93)	125.02** (50.06)
Expense (% of GDP)		13.52 (108.34)	14.35 (86.26)
Trade (% of GDP)			41.28* (21.14)
Constant	2734.76*** (17.96)	352.06 (2154.36)	-3035.47 (2275.76)
r-squared	0.05	0.25	0.33
No. of observations	148	79	78

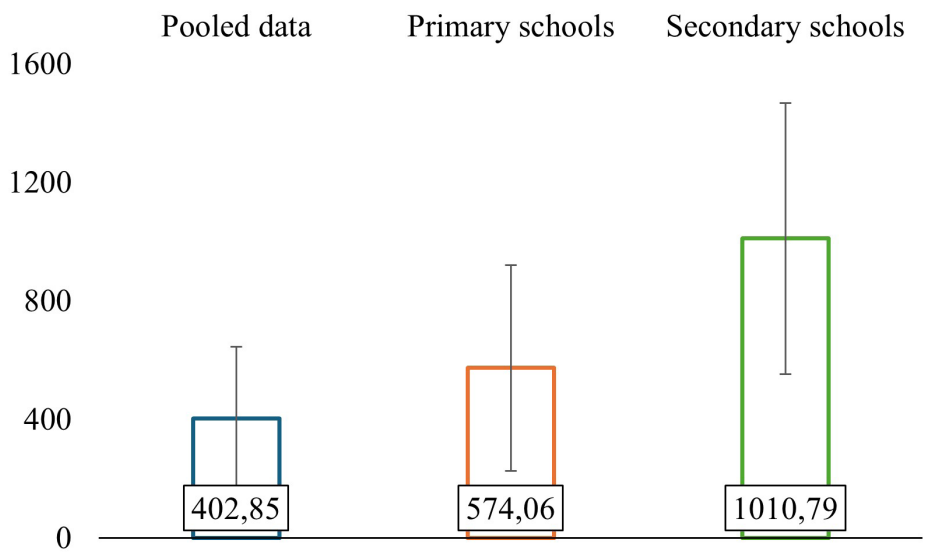
Source: World Bank and Angrist et al. (2021b) data. *p<0.1, **p<0.05, ***p<0.01. Robust standard errors in parentheses

Table 2b ***Panel data analysis of GDP per capita and HLOs, by school level (secondary)***

	Model 1	Model 2	Model 3
Harmonized Learning Outcomes	1166.00** (350.55)	1020.13** (262.61)	1010.79*** (233.19)
Gross fixed capital formation (% of GDP)		66.31 (33.59)	68.39* (30.06)
Expense (% of GDP)		90.51*** (20.52)	98.29*** (19.18)
Trade (% of GDP)			-4.10 (12.35)
Constant	3736.14*** (102.15)	-201.19 (1089.50)	-109.17 (1279.57)
r-squared	0.30	0.54	0.54
No. of observations	55	45	45

Source: World Bank and Angrist et al. (2021b) data. *p<0.1, **p<0.05, ***p<0.01. Robust standard errors in parentheses.

Figure 2 ***Correlation coefficients of HLOs and GDP per capita by school level (Model 3)***



Source: Author's elaboration. 95% confidence intervals are shown

Table 3a, Table 3b, and Table 3c show the estimations of panel data regressions across the different educational domains surveyed by international assessments (mathematics, reading, and science, respectively). The results indicate that standardized HLOs in mathematics and reading are positively and significantly associated with an increase in GDP per capita, with a magnitude of around 600 points in current US dollars for the former and a magnitude of around 900 points in current US dollars for the latter, respectively. Conversely, science achievements are not significantly associated with increases in GDP per capita, possibly due to the small number of observations. In the models, it is worth noting how standardized HLOs alone manage to explain a significant share of the results – indicated by the r-squared values – especially for secondary school and mathematics achievements. Figure 3 compares the correlation coefficients by domain.

The observed gaps between the estimations for mathematics and reading, which show significant coefficients, and science, which does not, are worth of additional consideration. One possible underlying reason is the lower number of observations for science, which may lead to not reaching significant coefficients despite the magnitude being positive. In this respect,

the strongest estimations appear to be those for reading, which has overall a stronger coefficient magnitude than mathematics, while achieving similar significance levels. Previous research has highlighted how reading skills precede those of mathematics (Grimm, 2008; Vukovic et al., 2010), which may suggest that especially science achievements may need further improvements before being more consistently associated with GDP per capita. This could also be due to the difficulties with science and technology education in the continent (Ogunniyi, 1996).

Table 3a ***Panel data analysis of GDP per capita and HLOs, by domain (mathematics)***

	Model 1	Model 2	Model 3
Harmonized Learning Outcomes	927.70*** (190.77)	660.71** (220.55)	600.24** (241.69)
Gross fixed capital formation (% of GDP)		107.58* (54.77)	97.44* (45.71)
Expense (% of GDP)		47.54 (93.98)	37.46 (89.25)
Trade (% of GDP)			26.77 (23.96)
Constant	3094.88*** (101.82)	186.11 (2117.71)	-1698.98 (2541.95)
r-squared	0.17	0.27	0.31
No. of observations	70	45	45

Source: World Bank and Angrist et al. (2021b) data. *p<0.1, **p<0.05, ***p<0.01. Robust standard errors in parentheses

Table 3b ***Panel data analysis of GDP per capita and HLOs, by domain (reading)***

	Model 1	Model 2	Model 3
Harmonized Learning Outcomes	514.31* (296.22)	1022.19** (391.23)	942.35** (424.87)
Gross fixed capital formation (% of GDP)		109.26 (67.40)	108.33 (64.42)
Expense (% of GDP)		2.28 (107.51)	8.07 (91.17)
Trade (% of GDP)			26.66 (29.85)
Constant	2616.94*** (114.91)	1096.71 (2216.21)	-1143.33 (3320.59)
r-squared	0.06	0.28	0.31
No. of observations	100	51	50

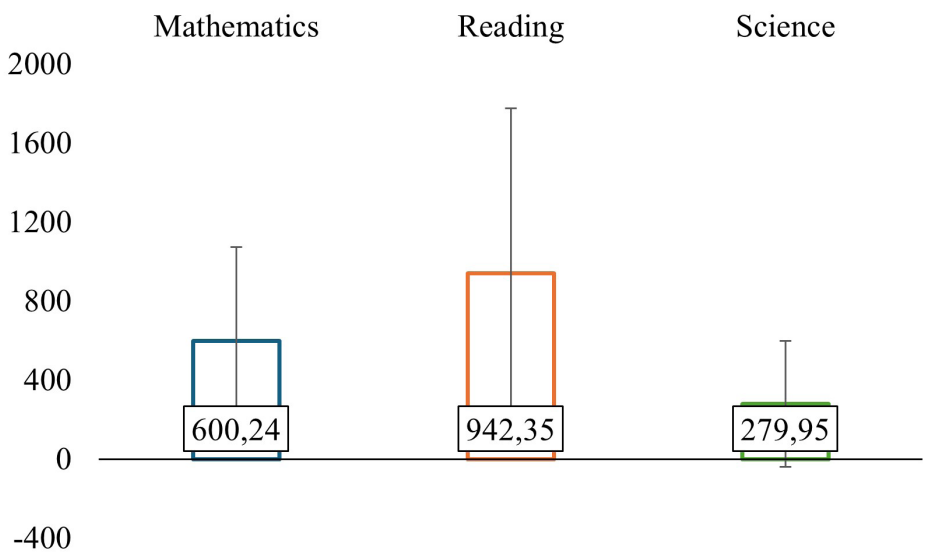
Source: World Bank and Angrist et al. (2021b) data. *p<0.1, **p<0.05, ***p<0.01. Robust standard errors in parentheses

Table 3c ***Panel data analysis of GDP per capita and HLOs, by domain (science)***

	Model 1	Model 2	Model 3
Harmonized Learning Outcomes	405.51 (266.41)	281.73 (175.81)	279.95 (162.26)
Gross fixed capital formation (% of GDP)		81.78 (48.21)	82.67 (46.43)
Expense (% of GDP)		131.13*** (25.62)	134.89** (49.88)
Trade (% of GDP)			-1.98 (22.63)
Constant	3915.61*** (18.54)	-1619.90 (1379.14)	-1577.72 (1598.44)
r-squared	0.10	0.46	0.47
No. of observations	33	28	28

Source: World Bank and Angrist et al. (2021b) data. *p<0.1, **p<0.05, ***p<0.01. Robust standard errors in parentheses

Figure 3 ***Correlation coefficients of HLOs and GDP per capita by domain (Model 3)***



Source: Author's elaboration. 95% confidence intervals are shown

Our results indicate that improving educational performance (measured by HLOs) by one standard deviation could lead to an increase in GDP per capita between 400 and 1000 current US dollars in African countries on average, with the magnitude varying depending on the school level or educational domain considered. This association is statistically significant for primary and secondary school achievements, and for scores in mathematics and reading.

The estimations by Jakubowski et al. (2023) indicate that the pandemic has caused the loss of more than one year of education for primary school students, with declines in achievements between 18% and 33% of a standard deviation in scores. Using these estimations with the results of the analysis based on standardized HLOs and GDP per capita in African countries, this could translate into a loss ranging between 73 and 133 US dollars per capita overall. Moreover, the economic losses could range between 103 and 189 US dollars per capita for primary school students, and between 182 and 334 US dollars per capita for secondary school students.

It should be noted that these estimations are tentative and based on pre-pandemic HLO data for African countries, and also that the PIRLS scale (on which the estimations by Jakubowski et al., 2023 are based) and HLOs differ in terms of overall measurement. However, these preliminary results show a large economic loss in African countries due to the COVID-19

pandemic and the associated school closures, and highlight the need for a precise computation of the learning loss in African countries specifically in order to reach a more robust estimation of the corresponding economic consequences.

4. CONCLUSIONS

We provided preliminary evidence on the economic impact of school closures and educational disruptions caused by the COVID-19 pandemic in Africa. To this aim, we implemented panel data regressions of Harmonized Learning Outcomes and GDP per capita, using historical data from the continent, covering 45 countries over multiple years. Our estimations highlight the significance of HLOs in determining a higher GDP per capita in African countries over time, with the particular importance of secondary schools and the educational domains of mathematics and reading. A preliminary computation indicates that between 70 and up to 330 US dollars per capita may have been lost due to disruptions to education in Africa. Given the economic struggles faced by many countries in the continent, it is crucial to mitigate such an impact with all the available policymaking tools.

The existing evidence points to significant challenges in the educational sector in Africa. These not only refer to low achievements, but also to difficulties in developing appropriate educational programs in such crucial sectors as science and technology (Ogunniyi, 1996). Our results support these claims. In particular, we observed that human capital is—as predicted—significantly associated with economic capital. The low overall student achievements and school performance in the continent may lead to significant economic struggles, which prevent the development of advanced and effective educational systems. In the case of reverse causality, is to be assumed that low economic capital would still be significantly associated with human capital, supporting the argument that widespread poverty may hinder the development of local educational systems.

The results of the analysis are speculative and simulative in nature. In particular, we used pre-pandemic data to estimate the effect of the pandemic itself. This means that the interpretation of the results should be cautious, and consider the general trends observed in the data. The estimations indicate that secondary school achievements are more strongly associated to GDP per capita than those of primary school: this could be due to the higher skills that must be learned in secondary school, which lead to higher human capital accumulation. We found significant links between mathematics and reading achievements and GDP per capita, but not for science. This may reflect the small sample size or more complex learning dynamics. In any case, even just the low number of observations can be seen as a warning sign that science education is underdeveloped in Africa.

Another contribution of the study is the provision of large-scale evidence from Africa regarding the association between human and economic capital, with a particular focus on the pandemic. The literature suggests that despite the economic and educational struggles in the continent, the impact of the pandemic may have been more mixed than in other areas. In this respect, the evidence provided here can be seen as a starting point for more advanced analyses that take into account regional differences or delve deeper into the dynamics of human and economic capital in the continent. The use of data from large-scale assessments, when available, can represent an important tool for policymakers and researchers focusing on African countries.

Our study has some limitations. First, by using pooled data at the continental level, our estimations miss the regional or country-level features that may affect the relationship between human capital and GDP per capita. This issue could potentially be solved by implementing smaller-scale studies with local data, though at the possible expense of reliability in the measurement. Second, we implemented panel data regressions without considering the impact of time due to cross-country dependency and multiple observations per year, but this could also be an important factor in estimating the relationship between human capital and GDP per capita. Lastly, we have drawn our conclusions on the impact of the COVID-19 pandemic using data gathered before the pandemic itself. While this stemmed from the fact that very few estimations are available for African countries after the pandemic (except for Morocco and South Africa in PIRLS 2021, Morocco in PISA 2022, and Morocco, Côte d'Ivoire, and South Africa in TIMSS 2023), it is important that up-to-date measurements are nonetheless implemented.

As noted previously, the results should be interpreted with caution. In particular, our estimations provide evidence of correlation between human capital, as measured by Harmonized Learning Outcomes, and economic development, measured by GDP per capita. Therefore, causal claims cannot be definitively made, especially due to the possibility of reverse causality between the two indicators. However, the results can still be interpreted in a descriptive way, showing that there is a positive association between human and economic capital in the continent, and therefore that the COVID-19 pandemic may have significantly impacted both, especially through its disruptions to the educational system.

Our results also emphasize the need for reliable and consistent data on the school performance of students in African countries, given the high explanatory value of human capital on GDP per capita in the continent. In fact, we assessed the economic losses caused by disruptions to education based on historical data due to the lack of consistent pre- and post-pandemic estimations for most African countries. Regular estimations of human capital through educational performance in the continent could provide significant benefits for policymakers, students, and for the economic development of the area.

Data availability statement: The data is publicly available in the Harmonized Learning Outcomes repository and in the World Bank database. The dataset for the present research can be made available upon request.

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