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Epidemics, Gender, and Human Capital in Developing Countries

by Stefania Fabrizio, Diego B. P. Gomes, Carine Meyimdjui, and Marina M. Tavares

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Epidemics, Gender, and Human Capital in Developing Countries

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Abstract

Epidemics have disrupted lives for centuries with deleterious human capital and economic repercussions. In this paper, we investigate how epidemics episodes have impacted school dropouts in developing countries, considering 623 epidemics episodes across countries from 1970 to 2019. Our estimates show that, on average, epidemics reduce completion rates by about 2.6 and 2.1 percentage points in primary and lower secondary education respectively, with girls more severely affected than boys. Using detailed micro data for Senegal, we also estimate the potential loss of lifelong earnings and find that the potential labor earnings loss from dropping out of primary and secondary school is almost double for girls than for boys.

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Table of Contents

I. INTRODUCTION

Epidemics have disrupted societies' wellbeing for centuries, causing loss of lives and abrupt economic disruptions. Additionally, epidemics may reduce human capital formation by forcing many kids out of school due to teachers' and students' illness, school closures, and loss of family income. The COVID-19 pandemic is a vivid example of how such events can be harmful on a global scale. However, the negative human capital effects may be particularly severe in developing countries, where children already face significant barriers to education, leading to absenteeism and early dropouts.[2] In these countries, girls are extremely vulnerable to school dropout during epidemics, as they are forced to early marriage and suffer a higher risk of unplanned pregnancy (Bandiera and others, 2019; Denney and others, 2015; Elston and others, 2017; Menzel, 2019).

To understand the likely impacts of epidemics on human capital formation in developing countries, this paper empirically investigates the impact of historical epidemics events on primary and lower secondary school completion rates[3] in developing countries.[4] We restrict our analysis to developing countries because in these countries where educational attainment is on average lower and gender education gaps larger than in richer countries. In addition, they are more vulnerable to epidemics due to poor health and sanitation conditions, and also less likely *a priori* to be able to maintain schooling practices in the face of serious disruptions such as epidemics. We use data on epidemics episodes from the Emergency Event Database (EM-DAT) and on school completion rates from the World Bank. We consider all the events of viral, bacterial, parasitic, fungal, or prion diseases declared by the World Health Organization (WHO) as an epidemic. This yields 623 epidemic episodes from 1970 to 2019 in 57 developing countries.

We find that epidemics reduce completion rates significantly on average, by 2.6 p.p. in primary education and 2.1 p.p. in lower secondary education using a fixed-effects panel regression specification.[5] Furthermore, we find that girls are more severely affected than boys. In primary education, for instance, completion rates decrease by 2.1 p.p. for boys and 3 p.p. for girls. In lower secondary education, the drop is about 2 p.p. for boys and 2.5 p.p. for girls. These results are robust to a vast array of robustness checks.

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[2] Children in developing countries are at high risk of dropping out of school. School dropout risk is associated with socioeconomic status, parental education, family size, sibling order, urban/rural location, disability, and gender (Bhattarai and others, 2020; Park and others, 2020; Wils and others, 2019). School dropout may also be associated to significant infrastructure barriers, such as water, sanitation, and hygiene concerns (e.g., Dreibelbis and others, 2013; Kazeem and others, 2010; Kim & Rhee, 2019).

[3] Lower secondary education is equivalent to the first four or five years in secondary school. In some countries, it is equivalent to intermediate or middle school and generally ends with an examination that gives the right to the first diploma in secondary education.

[4] Our definition of developing countries follows IMF (2019). We included the countries in which income per capita in 2016 was $2,700 or lower.

[5] These figures are the average epidemic's impact calculated as the simple average of the current epidemics estimates in Table 1, columns 1, 3, 4, and 6 for primary education, and columns 7, 9, 10, and 12 for lower secondary education.

To assess the potential earnings impact of boys and girls dropping out of school, we quantify the labor earnings impact of completing primary and secondary education in Senegal, a low-income country for which available detailed micro-data allow us to estimate a returns-to-education regression controlling for age, marital status, industry, and location. We find that children who not complete primary education could experience as adults a monthly earnings loss of 32 percent if they are girls and 18 percent if they are boys relative to children who complete primary education. Not completing secondary education induces a subsequent earnings loss of 85 percent for women and 41 percent for men relative to completing middle school.

Our paper contributes to a growing literature that studies the impact of epidemics on children outcomes by looking at country-specific episodes (Elston and others, 2016; Korkoyah and Wreh, 2015; Risso-Gil and Finnegan, 2015; Rothe 2015). While the literature in this area before COVID-19 mostly focused on HIV/AIDS crisis (Guo and others, 2012 summarized the HIV crisis) and Ebola crisis (Bandiera and others, 2019; O'Brien and Tolosa 2016; UNICEF, 2016), our paper analyzes the impacts of a large variety of epidemics, which can provide useful insights on the possible outcomes of the current COVID-19 crisis.[6] Our paper also contributes to a large literature that estimate the returns of education in developing countries (see Patrinos and Pasacharopoulos, 2020 for a recent survey). Consistent with this literature, we find that the returns of education for girls are larger than for boys in a typical low-income country such as Senegal.

The rest of the paper is organized as follows. Section II presents the macro-econometric panel analysis that estimates epidemics' effects on school completion rates of girls and boys in developing countries. Section III presents the micro-econometric analysis that estimates the potential earnings losses from dropping out of school in Senegal. Section IV concludes.

II. EPIDEMICS AND SCHOOL DROPOUTS

To assess the impact of epidemics events on school completion rates in developing countries, we use a panel regression approach. The following subsections detail the data and empirical strategy and present the main results and a number of robustness checks.

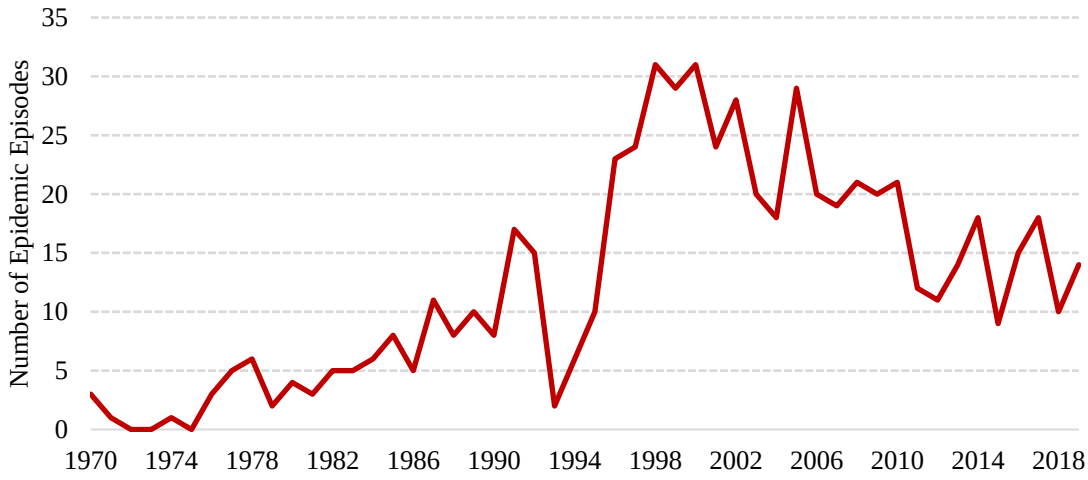
A. Data and Empirical Strategy

We consider all the events of viral, bacterial, parasitic, fungal, or prion diseases declared by the WHO as an epidemic (Emergency Event Database, EM-DAT). In the data, there are 623

[6] See Cirenia and others (2021) for a survey about health-related school closures and their impact on children.

unique country-year epidemics events in developing countries from 1970 to 2019 (Figure 1).[7,8] Epidemics picked at around 30 episodes per year by the end of the 1990s. Since then, the number of episodes has dropped, stabilizing between 10 to 20 episodes per year. The increasing trend until the end of the 1990s can be attributed to the discovery of new microorganisms, the proliferation of slums resulting from urbanization, and trade openness (Lindahl and Grace, 2015; Oliveira and others, 2020). We combine the epidemics data with data on primary and lower secondary school completion rates and other social and macro-data from the World Bank's World Development Indicators (WDI).

Figure 1. Epidemic Episodes in Developing Countries by Year, 1970–2019



Source: EM-DAT

To estimate the impact of epidemics on school completion rates, we use a fixed-effects panel regression model. We index countries by i and years by t. Let $y_{i,t}$ be the school completion rate of interest, $E_{i,t}$ the epidemic indicator, $\mathbf{X}_{i,t}$ a vector of possible controls, δ_i country fixed effects, and θ_t year fixed effects. Then, our regression equation can be stated as

$$y_{i,t} = \alpha + \beta E_{i,t} + \boldsymbol{\gamma}'\mathbf{X}_{i,t} + \delta_i + \theta_t + \varepsilon_{i,t}, \quad (1)$$

where $\varepsilon_{i,t}$ is the error term and β measures the average impact of epidemics on school completion rates. A negative and significant estimate of β implies that epidemics reduce school completion.

[7] In fact, the data includes 643 epidemic episodes in developing countries from 1970 to 2019. However, since some countries experienced more than one event in the same year, the number of unique country-year episodes reduces to 623. For example, in 2001, Benin experienced both cholera and meningococcal disease episodes, and both were considered as epidemic events by the WHO. The same happened with The Democratic Republic of Congo in 1998. Chad experienced meningitis, measles, and cholera episodes in 2010.

[8] Table A.1 in the Appendix presents the list of countries and their respective number of epidemic events.

We control for possible confounding factors through: country fixed effects to capture unobservable factors that vary across countries but that are fixed over time; year fixed effects to account for possible global trends that may affect our dependent variable; a set of controls $\mathbf{X}_{i,t}$ that includes one lag of the epidemic indicator, and the log of real GDP per capita. In our robustness check, we also control for government expenditures on education per pupil as a percentage of GDP per capita.[9] To address the potential biases that could arise if the residuals are auto-correlated and heteroscedastic, standard errors in all our regressions have been clustered at the country level.

B. Main Results

Table 1 shows the results for school completion rates both in primary and lower secondary education. Current and lagged epidemic episodes are associated with reductions in school completion rates of children–the coefficients of current and lagged epidemic indicators are negative and significant. For primary education, the drop in completion rates due to epidemic shocks (current and/or lagged) is significantly greater than two percentage points. For lower secondary education, the fall varies between 1.3 and 2.4 percentage points, depending on the specification.

Table 1. Effects of Epidemics on Primary and Secondary School Completion Rates

	Primary Education					
	(1)	(2)	(3)	(4)	(5)	(6)
$E_{i,t}$	-2.741***		-2.606***	-2.621***		-2.495***
	(0.952)		(0.903)	(0.857)		(0.825)
$E_{i,t-1}$		-2.199**	-2.026**		-2.204***	-2.048***
		(0.940)	(0.888)		(0.709)	(0.670)
N	1,467	1,468	1,467	1,375	1,375	1,375
R^2	0.625	0.625	0.627	0.662	0.661	0.665
Log RGDPpc	NO	NO	NO	YES	YES	YES
	Lower Secondary Education					
	(7)	(8)	(9)	(10)	(11)	(12)
$E_{i,t}$	-2.437***		-2.257***	-1.886**		-1.756**
	(0.872)		(0.786)	(0.840)		(0.768)
$E_{i,t-1}$		-1.965**	-1.727**		-1.476*	-1.299
		(0.915)	(0.828)		(0.868)	(0.794)
N	1,137	1,138	1,137	1,076	1,076	1,076
R^2	0.697	0.696	0.699	0.683	0.682	0.684
Log RGDPpc	NO	NO	NO	YES	YES	YES

Notes: Standard errors in parentheses are robust and clustered at the country level. All specifications include country and year fixed-effects.
*** p<0.01, ** p<0.05, * p<0.1

[9] Due to the data restrictions, we can't run a full ARDL specification.

Table 2 shows the results for primary school completion rates separately by gender (boys and girls). The estimates confirm the previous findings─boys and girls are both negatively affected by epidemic events, with drops in primary school completion rates generally higher than 2 p.p. In addition, girls are more severely affected than boys. For example, we start by comparing the results of columns (13) and (14), in which we evaluate the effects of a current epidemic event without further controls other than country and year fixed-effects. These results show that, on average, an epidemic shock reduces the school completion rate of boys and girls by 2.4 p.p. and 3.2 p.p., respectively. As we can see from columns (13) to (24), this pattern is pervasive across all other estimated specifications, being robust to controlling for lagged epidemic shocks and the aggregate income level captured by the log of real GDP per capita.

Table 2. Effects of Epidemics on Primary School Completion Rates by Gender

Not controlling for log of real GDP per capita						
	(13)	(14)	(15)	(16)	(17)	(18)
	Boys	Girls	Boys	Girls	Boys	Girls
$E_{i,t}$	-2.380**	-3.227***			-2.243**	-3.083***
	(1.039)	(0.944)			(0.995)	(0.896)
$E_{i,t-1}$			-2.157**	-2.317**	-2.003**	-2.104**
			(0.941)	(0.914)	(0.896)	(0.863)
N	1,326	1,326	1,326	1,326	1,326	1,326
R^2	0.514	0.705	0.513	0.703	0.516	0.707
Controlling for log of real GDP per capita						
	(19)	(20)	(21)	(22)	(23)	(24)
	Boys	Girls	Boys	Girls	Boys	Girls
$E_{i,t}$	-1.910*	-2.939***			-1.769*	-2.789***
	(1.017)	(0.915)			(0.981)	(0.875)
$E_{i,t-1}$			-2.163***	-2.352***	-2.039***	-2.156***
			(0.774)	(0.786)	(0.731)	(0.739)
N	1,271	1,271	1,271	1,271	1,271	1,271
R^2	0.551	0.720	0.552	0.718	0.554	0.722

Notes: Standard errors in parentheses are robust and clustered at the country level. All specifications include country and year fixed-effects.
*** p<0.01, ** p<0.05, * p<0.1

Table 3 presents similar results for lower secondary school completion rates separately for boys and girls. Epidemic events are again significantly associated with a drop in completion rates, with girls more adversely affected than boys. Comparing the results of columns (25) and (26), which are analogous to columns (13) and (14) of Table 2, we see that on average, an epidemic shock reduces the lower secondary school completion rate of boys and girls by 2.3 p.p. and 2.8 p.p., respectively. This pattern is still observed when we control the regressions for lagged epidemic shocks and log of real GDP per capita (columns (27) to (36)).

Table 3. Effects of Epidemics on Lower Secondary School Completion Rates by Gender

	Not controlling for log of real GDP per capita					
	(25)	(26)	(27)	(28)	(29)	(30)
	Boys	Girls	Boys	Girls	Boys	Girls
$E_{i,t}$	-2.281**	-2.832***			-2.103**	-2.605***
	(0.960)	(0.942)			(0.892)	(0.849)
$E_{i,t-1}$			-1.963**	-2.491**	-1.744**	-2.220**
			(0.866)	(0.981)	(0.795)	(0.891)
N	994	994	994	994	994	994
R^2	0.629	0.713	0.628	0.712	0.631	0.716
	Controlling for log of real GDP per capita					
	(31)	(32)	(33)	(34)	(35)	(36)
	Boys	Girls	Boys	Girls	Boys	Girls
$E_{i,t}$	-1.898**	-2.424***			-1.767**	-2.232***
	(0.936)	(0.906)			(0.876)	(0.819)
$E_{i,t-1}$			-1.477*	-2.118**	-1.295	-1.887**
			(0.851)	(0.986)	(0.786)	(0.901)
N	948	948	948	948	948	948
R^2	0.605	0.699	0.604	0.698	0.607	0.702

Notes: Standard errors in parentheses are robust and clustered at the country level. All specifications include country and year fixed-effects.
*** p<0.01, ** p<0.05, * p<0.1

As an additional robustness check, we include as a control in the regressions the government expenditures on education per pupil as a percentage of GDP. Adding this control significantly reduces sample size by over three fourths, making comparisons with the previous estimates difficult. Even so, the results presented in Table A.2 in the Appendix still display negative estimates on the lagged epidemic shock, with girls more severely affected than boys, these estimates are statistically significant only for primary school completion rates likely due to the important reduction of the sample.

III. Earnings Consequences of School Dropouts

To assess the potential earnings consequences of dropping out of school, we quantify the earnings gains of completing primary and secondary education using a returns-to-education framework inspired by the standard Mincerian approach (Mincer, 1974). We consider Senegal as a case study.

A. Data and Empirical Strategy

We use microdata from the 2011-12 Senegal Household Survey from the World Bank. The data covers 168,201 individuals from the 14 regions. We selected those individuals aged 15-64 with a paid job, bringing our sample to 41,364 observations (Table 4). Our final sample comprises 57.6 percent of men and 42.4 percent of women, reflecting lower female labor force participation relative to men. More than half of the individuals in our sample do not have a school education, and only 6 percent have finished secondary education. Moreover, among

those that have finished secondary education, more than 70 percent are men, reflecting the gender education gap, which is still large in many developing countries.

In addition to the gender education gap, the data also reveals a pervasive gender earnings gap across levels of education. Overall, men earn double than women. However, the earnings gap decreases with levels of education. For example, men with no education diploma earn 2.3 times more than their female counterparts. Among those with tertiary education, the earnings gap shrinks to 1.2 times, which means that men earn 20 percent more than women. There are many possible reasons for the decline in the gender wage gap with education, including that workers with a higher level of education are more likely to work in the formal sector, and women working in the formal sector are better protected against discrimination than women in the informal sector (Malta and others 2019a and b).

Table 4. Sample Description, Senegal 2011–2012

	Number of Observations			Average Monthly Labor Earnings (in CFA)			
	Total	% Women	% Men	Women	Men	Overall	Gap, M/W
No Schooling	26,501	48.33	51.67	33,831	79,585	57,474	2.352
Primary	8,629	34.80	65.20	57,104	86,590	76,329	1.516
Middle	3,597	30.16	69.84	75,344	103,594	95,072	1.375
Secondary	1,731	27.15	72.85	218,602	194,979	201,393	0.892
Tertiary	906	20.97	79.03	286,807	345,968	333,561	1.206
Total	41,364	42.44	57.56	48,063	97,896		2.037

Note: The data is from the 2011-12 Senegal Household Survey from the World Bank. The Senegalese education system is divided into four levels: pre-primary (at least 1 year between ages 5 and 6), primary (6 years between ages 6 and 11), lower secondary (4 years between ages 12 and 15), and upper secondary (3 years between ages 16 and 18). In this table, secondary corresponds to finishing upper secondary education, which corresponds to finishing high-school in many countries.

To estimate the earnings impact of completing primary and secondary education, we estimate generalized linear models (GLM) with a log-link function and a Gamma error distribution.[10] We estimate two models separately by gender. To formalize our regression specification, we index individuals by i and its respective gender by g. Let $y_{i,g}$ be the individual monthly labor earnings, $E_{i,g}$ the individual education level, and $\mathbf{X}_{i,g}$ a vector of controls (age groups, marital status, geographic regions, and industry categories). Then, our regression equation can be stated as

$$y_{i,g} = f\left(\alpha_g + \beta_g E_{i,g} + \boldsymbol{\gamma}'\mathbf{X}_{i,g} + \varepsilon_{i,g}\right), \tag{2}$$

[10] See Section 18.4 of Wooldridge (2010) on why it's becoming more popular to directly model the expected value of nonnegative, continuous response variables (e.g. income) rather than using a transformation (usually the natural log) and specifying a model linear in parameters with an additive error. See also Blackburn (2007) on estimating wage differentials without logarithms.

where $\varepsilon_{i,g}$ is the error term. We are interested in the average marginal effect (AME) of each education level, which measures men's and women's average earnings impact of completing each education level relative to having no schooling.

B. Empirical Results

Table 5 shows the AME of each level of education for both men and women. All estimates are positive and significant at the one percent level. By combining the AMEs from Table 5 with the average monthly labor earnings for those with no schooling from Table 4, we can calculate the percentage increase in earnings that comes from reaching a subsequent education level. Figure 2 shows that, on average, completing primary education increases women's monthly earnings by 33 percent relative to not completing it, while men's earnings increase only by 18 percent. The completion of secondary education increases women's earnings by 85 percent relative to only completing middle school, while men's earnings grow by only 41 percent. These results show that women forgo larger earnings from dropping out of primary and secondary education than men.

Table 5. Average Marginal Effects of Each Education Level by Gender

Men

	Avg. Marginal Effect	Standard Error	95% Confidence Interval	
No schooling	*(base)*			
Primary	14,412.93***	4,324.92	5,936.24	22,889.63
Middle	22,988.81***	6,044.73	11,141.35	34,836.27
Secondary	64,718.71***	10,939.03	43,278.60	86,158.81
Tertiary	105,130.90***	15,157.95	75,421.92	134,840.00

Women

	Avg. Marginal Effect	Standard Error	95% Confidence Interval	
No schooling	*(base)*			
Primary	11,140.45***	2,568.08	6,107.11	16,173.78
Middle	18,870.29***	3,887.98	11,249.99	26,490.59
Secondary	63,930.13***	11,587.46	41,219.13	86,641.14
Tertiary	111,291.90***	16,685.25	78,589.39	143,994.40

Notes: Standard errors are clustered at the geographic region level. All estimates are weighted using the sample weights provided by the survey. The estimates are in monthly CFA units.
*** p<0.01, ** p<0.05, * p<0.1

Figure 2: Percentage Increase in Labor Earnings from Reaching a Subsequent Education Level

IV. CONCLUSION

In this paper, we analyze the impact of past epidemics on school completion rates and the associated lifetime earnings losses. Our results suggest that past epidemics reduced completion rates by an average of 2.6 p.p. in primary education and 2.1 p.p. in lower secondary education. Furthermore, we find that girls are more severely affected than boys. In primary education, for instance, completion rates decrease by 2.1 p.p. for boys and 3 p.p. for girls. In lower secondary education, rates fall by about 2 p.p. for boys and 2.5 p.p. for girls.

School dropouts have severe adverse implications for future human capital formation and, in turn, for productivity and lifetime earnings. To document this, we investigate the potential earnings losses from not completing primary and secondary education degrees in Senegal, a typical low-income country. We find that not completing primary education can potentially reduce women's monthly earnings by 32 percent and men's earnings by 18 percent, while not completing secondary education could imply a loss of earnings of 85 percent for women and 41 percent for men. Women's losses are more significant than men's possibly because girls who attain a higher level of education are more likely to work in the formal sector instead of working in the informal sector or on family enterprises, where they work for little or no pay. Formal jobs are also covered by labor legislations that reduce discrimination against women (Malta and others 2019b). This same protection is absent in the informal sector, where women face higher levels of discrimination.

The COVID-19 pandemic is having a severe disruptive effect on schooling, particularly in developing countries, as kids have been dropping out due to containment measures (e.g., school closures), and education attendance in these countries was already limited and fragile due to poor conditions and immediate need for survival. This is even more the case for girls, which in many countries are lagging behind boys in terms of educational outcomes.

This potential deleterious effect on human capital, overall productivity, and lifetime earnings that current generations of kids, in particular girls, may suffer due to pandemic-induced school disruptions further strengthen the case for making vaccination more widely and quickly accessible to developing countries. Enhanced global collaboration is required to make this happen. Furthermore, governments in developing countries should prioritize safe school reopening and incentives to encourage re-enrollment of students at higher risk of dropping out, particularly girls.

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APPENDIX I: SAMPLE CHARACTERISTICS

Table A.1. Number of Unique Epidemic Episodes by Country

Country	N	Country	N	Country	N
Afghanistan	7	Haiti	6	Papua New Guinea	4
Bangladesh	21	Honduras	7	Rwanda	9
Benin	17	Kenya	16	Sao Tome and Principe	3
Bhutan	2	Kiribati	1	Senegal	10
Burkina Faso	18	Kyrgyzstan	3	Sierra Leone	12
Burundi	9	Lao People's Democr..	8	Solomon Islands	2
Cambodia	7	Lesotho	3	Somalia	17
Cameroon	21	Liberia	9	South Sudan	5
Central African Rep.	11	Madagascar	7	Sudan	19
Chad	18	Malawi	11	Tajikistan	6
Comoros	4	Mali	14	Tanzania	20
Dem. Rep of Congo	26	Mauritania	6	Timor-Leste	2
Congo	14	Moldova	1	Togo	10
Cote d'Ivoire	10	Mozambique	20	Uganda	23
Djibouti	5	Myanmar	3	Uzbekistan	1
Ethiopia	16	Nepal	13	Viet Nam	9
Gambia	4	Nicaragua	7	Yemen	6
Ghana	16	Niger	25	Zambia	15
Guinea	15	Nigeria	26	Zimbabwe	15
Guinea-Bissau	8				

APPENDIX II: ROBUSTNESS EXERCISES

Table A.2. Including Government Expenditures on Education per Pupil as a Control Variable

	Primary school completion rates			
	(37)	(38)	(39)	(40)
	Boys	Girls	Boys	Girls
$E_{i,t}$	1.081	-0.558	1.781	0.177
	(1.204)	(1.091)	(1.095)	(1.004)
$E_{i,t-1}$	-2.354**	-2.736**	-2.131**	-2.529**
	(1.012)	(1.238)	(0.940)	(1.091)
N	293	293	290	290
R^2	0.557	0.727	0.610	0.761
Log RGDPpc	NO	NO	YES	YES
Gov. exp. on educ.	YES	YES	YES	YES
	Lower secondary school completion rates			
	(41)	(42)	(43)	(44)
	Boys	Girls	Boys	Girls
$E_{i,t}$	0.467	-0.032	0.404	-0.024
	(0.928)	(0.992)	(0.917)	(0.933)
$E_{i,t-1}$	-1.540	-1.696*	-1.296	-1.588
	(0.950)	(1.003)	(1.111)	(1.207)
N	203	203	200	200
R^2	0.595	0.626	0.587	0.619
Log RGDPpc	NO	NO	YES	YES
Gov. exp. on educ.	YES	YES	YES	YES

Notes: For primary school completion rates, we include government expenditures per pupil on primary education only. For lower secondary school completion rates, we include government expenditures per pupil on secondary school only. Standard errors in parentheses are robust and clustered at the country level. All specifications include country and year fixed-effects.

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