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Children Who Have Never Gone to School: How Regional Heterogeneity Shapes Access to Primary Education in Uganda

Christian Kakuba* and Valérie Golaz**

Abstract

Although Uganda was among the first sub-Saharan countries to introduce universal primary education in 1997, about 6% of children aged 9–11 had never been to school in 2014. An analysis of a 10% sample of the latest Uganda Population and Housing Census (2014) data set highlights striking spatial inequalities. We compare results from separate logistic regression analyses for the Karamoja subregion, the rest of the country, and the country as a whole. Our multilevel analyses show that the role played by household heads' education and wealth in school enrolment emerges as a common factor. But while girls were significantly more likely to have never been enrolled in Karamoja and boys in the rest of Uganda, sex was not significant in the national model. Gendered expectations and constraints differ, which policies must consider. Our analysis questions the relevance of national models and therefore many national-level results in a context of high subnational heterogeneity.

Keywords

education, school enrolment, spatial inequalities, poverty, gender, multilevel model, sub-Saharan Africa

Following the international conferences in Jomtien in 1990 and in Dakar in 2000, access to primary education became a policy priority for many countries worldwide (Lange, 2001, 2018). In the 1990s, a large proportion of school-age children in numerous sub-Saharan African countries were out of school, particularly girls (Lange, 1998). Policies at the national and international levels have supported the development of education in recent decades, with many specifically targeting girls. Equity in access to school then became a Millennium Development Goal, and is now a target in the Sustainable Development Goals. Globally, gender equity in accessing primary and secondary education was

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achieved by 2014 (UNESCO, 2016). In sub-Saharan Africa, according to UNESCO data, 20% of primary-school-age children were not in school in 2019 versus 47% in 1990.⁽¹⁾ Similarly, the subcontinent's gender parity index rose from 0.83 in 1990 to 0.95 in 2019 (Lange, 2018). Today, many African countries like Senegal (Delaunay et al., 2021) and several other countries with high enrolment rates (Psaki et al., 2018) have achieved parity, if not better schooling rates for girls than boys at the primary level.

Uganda was among the first countries in sub-Saharan Africa to introduce universal primary education in 1997 and universal secondary education in 2007. In a single year, from 1996 to 1997, primary-school enrolments increased from slightly over 3 million to close to 5.3 million (Kakuba, 2014). The reports of the 2002 and 2014 population censuses both stated that gender parity had been achieved at the primary level (Uganda Bureau of Statistics [UBOS], 2016). Research based on Demographic and Health Survey data confirms parity in enrolment from 2011, with higher dropout rates for boys in Uganda (Psaki et al., 2018).

This notwithstanding—and despite the Global Out-of-School Children Initiative launched in 2010 by UNICEF and the UNESCO Institute of Statistics (2011)—in 2014, close to 20 years after the introduction of universal primary education, 12.5% of children aged 6–12 years were still not in school, 10% had never enrolled, and 2.5% had dropped out (UBOS, 2016).

Most studies on the topic usually focus on out-of-school children overall, including both children who have never enrolled (non-enrolment⁽²⁾) and children who have dropped out of the education system. However, Lewin (2007) considered these two situations as falling within different zones of exclusion from the education system and therefore requiring specific studies. Indeed, the issues at stake in understanding why some children have never enrolled might be different from those affecting school dropouts. To our knowledge, no nationally representative study about the predictors of non-enrolment in Uganda exists. We aim to provide a better understanding as to why 1 in 10 children had never attended school in Uganda by census time.

In Uganda, some studies have examined performance in school (Ssewamala et al., 2011; Acham et al., 2012). Others have documented aspects related to access and equity regarding primary (Deininger, 2003; Wells, 2009; Kakuba, 2015; Lamichhane and Tsujimoto, 2017) and secondary education (Ssewanyana et al., 2011; Kakuba, 2015). These have not particularly been concerned with the specific situation of non-enrolment, however. For most of sub-Saharan Africa, Lewin (2007) framed the reasons for non-enrolment as pertaining to source of income, location, parents' civil status, disability, social stigma, or other vulnerabilities. A recent study (Mpyangu et al., 2014) investigating why

(1) Data from the UNESCO Institute for Statistics were accessed 11 November 2022 via the World Bank: <https://data.worldbank.org/indicator/SE.PRM.UNER.ZS?locations=ZG>

(2) *Non-enrolment* is the term used in both the literature and this paper to refer to children who have never enrolled in school.

children in Uganda were not in school showed that financial constraints remained a major cause for dropouts but were not so strong a factor in non-enrolment. However, these results are not representative of the whole Ugandan population, and the age group considered for out-of-school children was 6–12, which overestimates out-of-school children due to late enrolment (after age 6), a phenomenon still common in Uganda, especially in rural areas.

Profound inequalities pervade the country. Specifically, for several decades, the Karamoja region has presented development indicators (including education) that contrast with the rest of the country (Burnett and Evans, 2014). With sporadic insecurity and a pastoral way of life, the area has witnessed the failure of numerous development programmes (Bevan, 2008; Krätli, 2010). Various programmes have targeted school-going-age children in Karamoja over the years. The most important was the Alternative Basic Education for Karamoja programme, introduced in 1998 to provide access to primary education to children in pastoralist families (Krätli, 2009; Brown et al., 2017). The literature documents factors related to the individual/household (poverty and negative perceptions about education), to the education supply (absenteeism, low quality of teachers, long distances to school, and violence in schools), and to the development of new casual job opportunities in the mining sector (Krätli, 2001; Burnett and Evans, 2014; Brown et al., 2017).

We focus on how this spatial heterogeneity acts in national indicators and models. To provide nationally representative results, this paper is based on an in-depth analysis of a 10% sample of the latest Uganda Population and Housing Census (UPHC, 2014) data. Population census data provide information on school attendance and enrolment of all household members and have the advantage of completeness, enabling small population analyses within the general population and a localized study of specific population groups. We merged this individual-level database with district-level data extracted from the annual publication of data by the Ministry of Education and Sports (2014), which provides a detailed picture of administrative data on some key education-supply indicators.

Can non-enrolment be associated with specific characteristics of children and their households, or is it more a function of supply-related factors, such as insufficiency in service provision? Are education needs unmet? Does gender affect enrolment? Are the answers to these questions relatively homogeneous in the entire country?

In this paper, we intend to (a) document the proportions of children who have never been to school across the country through descriptive analysis of data and mapping; (b) study the relationship between individual, household, and district-level characteristics and the probability of non-enrolment in both Karamoja and the rest of the country using logistic regression analysis; and (c) investigate the differences in national predictors for non-enrolment while taking into account heterogeneity within the country through multilevel modelling.

After a descriptive analysis, we conduct a comparative analysis of school enrolment in Karamoja and the rest of Uganda. We show the contrasting scenario of a key variable, sex of the child in both models, and how the national picture conceals this reality and therefore misrepresents this variable's effect. We then use multilevel techniques to better model district-level variation in school enrolment.

I. Non-enrolment in Uganda

In this section, we provide details on the Ugandan school system and the measure of non-enrolment as well as its historical and spatial dimensions. Although increasingly fewer children have never been to school, the proportion having never accessed basic education is still disproportionately higher for some districts in north and north-eastern Uganda than in central or western Uganda.

1. The education system and trends in non-enrolment

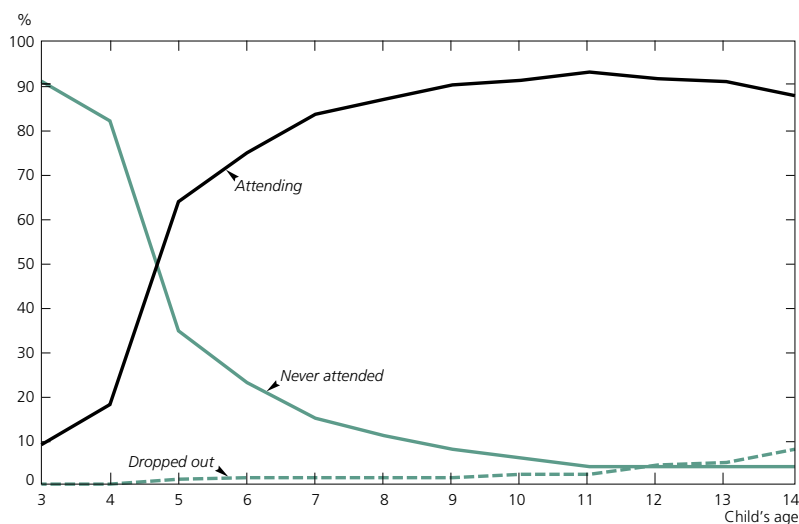
The education system in Uganda is based on a four-tier model: primary education; secondary education; business, technical, and vocational education and training (BTVET); and tertiary education. It consists of 7 years of primary education for pupils aged 6–12, followed by 4 years of lower (ordinary) and 2 years of upper (advanced) secondary education. At the end of primary, children sit the primary leaving examination. Graded pupils obtain a Primary Leaving Certificate, and those with the highest marks are admitted to secondary education. Primary-school completers can also follow a 3-year crafts course at a technical school. After secondary education, students may go to university, teacher colleges, or BTVET institutions (De Kemp and Eilor, 2008).

The 2014 population census provides more detailed information on household members than on people in institutions or hotels or those categorized as homeless during the census. Therefore, our analyses are drawn from ordinary households only. Institutions such as hospitals and prisons are excluded from the data set, but children in boarding schools, considered as belonging to households of their parent/guardian, and in specific settings, such as refugee camps, are included.

The data show that at the official age for primary education (age 6), many children are still not enrolled, especially at the youngest ages (Figure 1). As expected, at early primary-school ages, children who have dropped out are outnumbered by non-enrolled children. School dropouts occur mainly after age 10 but remain minimal. Non-enrolled children account for most cases of out-of-school children at lower primary-school ages.

We focus on children aged 9–11 to eliminate most cases of late entry into the school system, while remaining within the primary-school age bracket.

Figure 1. Non-enrolment and dropouts between ages 3 and 14 in Uganda, 2014

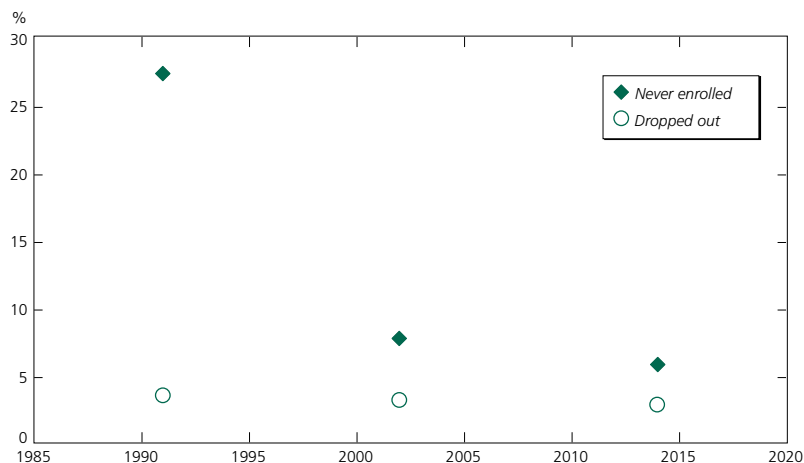


Source: Authors' calculations from a 10% sample of the Uganda Population and Housing Census, 2014.

Although primary schooling in Uganda officially ends at age 12, we have chosen to limit the age group to 9–11 to make comparisons with other African countries where primary education officially stops at 11.⁽³⁾

According to census data, the proportion of children having never enrolled decreased from 27% in 1991 to about 6% in 2014 (Figure 2). This spectacular

Figure 2. Non-enrolment and dropouts for children aged 9–11 in Uganda, 1991–2014



Sources: Authors' calculations from 10% samples of the Uganda Population and Housing Censuses, 1991, 2002, and 2014.

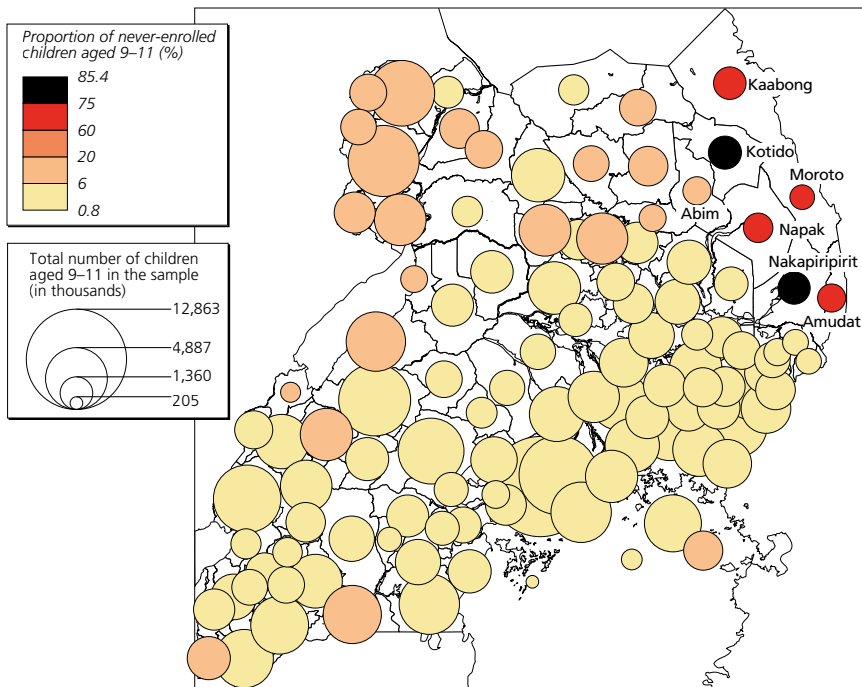
(3) This age bracket was agreed on in the context of an international research project involving West African countries where at age 12, children are supposed to enter secondary school (Delaunay et al., 2021).

improvement cannot be dissociated from the universal primary-education initiative implemented since January 1997. The year 1997 is characterized by an upsurge in enrolments over the previous year. By 2002, the proportion of children aged 9–11 that had never been to school had decreased to about 8%. However, the following decade witnessed only a modest improvement, if not stagnation, in non-enrolment rates. Indeed, according to the 2014 census, the proportion of never-enrolled children aged 9–11 was rather low (5.9%) and similar for boys and girls (Kakuba et al., 2019; Nankinga et al., 2020; Delaunay et al., 2021).

2. Children who have never enrolled in school: a spatial perspective

A preliminary analysis shows that a significant variation in enrolment exists between some of the districts in the north-eastern parts of Uganda and the rest of the country (Golaz et al., 2021). Looking at the proportions of never-enrolled children by district confirms that these children are not evenly distributed across the country (Figure 3), suggesting that specific factors may be associated with (non-)enrolment. Many districts of north and north-western Uganda, and a few in the west and east, were disadvantaged for having a

Figure 3. Proportion of never-enrolled children aged 9–11 by district in Uganda, 2014



Source: Authors' calculations from a 10% sample of the Uganda Population and Housing Census, 2014; authors' construction using Magrit (<http://magrit.cnrs.fr>) with manual interval discretization.

proportion of never-enrolled children considerably above the national average (10%–20%). However, it is in the north-eastern part of the country that we see the highest proportions of non-enrolment: above 60% in 6 out of 7 districts located in Karamoja (Figure 3), in sharp contrast with the rest of the country (Appendix A).

Table 1 compares the school enrolment status of children in Karamoja and the rest of Uganda in 2014: 68% of children who lived in Karamoja had never been to school, against only 4% (on average) of those who lived elsewhere. This is corroborated by findings of the National Household Survey Report for 2016 where the net enrolment rate at primary for Karamoja was 37%, about half the national average (79%) (UBOS, 2018). However, children living in Karamoja only constituted 2.7% of our total sample, and children who had never enrolled in Karamoja constituted about a third of non-enrolment cases at the national level. It is therefore prudent that we look critically at these children's situation.

Table 1. School enrolment status of children aged 9–11 in Karamoja and the rest of Uganda, 2014

School enrolment status	Karamoja (%) (1)	Rest of Uganda (%) (2)	Uganda as a whole (%)	Number of children
Ever enrolled	32	96	94	272,230
Never enrolled	68	4	6	16,902
Total	100	100	100	289,132

Note: Chi-square test between (1) and (2) yields a p value of $< .001$.
Source: Authors' calculations from a 10% sample of the Uganda Population and Housing Census, 2014.

II. Explaining non-enrolment in Karamoja and the rest of Uganda

The 2014 population census data can be used to assess the correlates of never having enrolled in the districts of Karamoja and the rest of Uganda. As opposed to a household survey, a 10% sample of the census data provides sufficient observations regarding children aged 9–11 for analysis at the district level. We consider explanatory variables at the child, household, and contextual (district) levels, guided by previous work (CEPED et al., 1999; UIS et al., 2004; Bringé and Golaz, 2017). We present these variables, perform a descriptive analysis, and run separate logistic regression models for Karamoja, the rest of Uganda, and Uganda as a whole, investigating factors that explain the probability of never being enrolled. In these analyses, we use a logit model because the dependent variable is binary (Bressoux, 2010).

1. Selected variables

Individual and household-level variables are directly accessible in the census database. At the individual level, the selected characteristics are age (9–11), sex, orphanhood status, disability status, and relationship to the household head. In many African societies, children do not live exclusively in their biological parents' household. The 2011 Uganda Demographic and Health Survey data show that more than 25% of children aged 9–11 lived away from their parents and that this proportion increased with age (Golaz, 2015). Some may be orphaned and taken in by relatives, some often live in other households closer to better schools, while others are already involved in labour. Some challenges at the household level are also expected to influence access to the education system.

Here, the selected characteristics are sex and age of the household head, household head's marital status, religion, and education level. In this paper, the age of the household head is categorized as less than 35, 35–59, and 60 and older, to consider the implications of both young and older persons' headship status for schooling outcomes. Other variables refer to the household in general, regarding structure, wealth status, and location: household size and number of children under 5, main source of income, remittances received, wealth index status of the household, distance to the closest public primary school, and rural or urban residence of the household. We categorized household size into three groups: fewer than six people, six to nine people (the most frequent), and 10 people and above. Household wealth has been found to be strongly correlated to many schooling outcomes, including access to basic education, even in the wake of primary-education universalizing initiatives in sub-Saharan Africa (Lewin and Sabates, 2011). Given that data on household expenditure or income were not readily available, we used principal component analysis to categorize households into five wealth quintiles,⁽⁴⁾ as previously recommended and used (Filmer and Pritchett, 2001). The place of residence (urban or rural) may dictate differences in school quality and distribution, the supply of teachers, the types and sources of household income, and other cultural/attitudinal factors that may affect children's access to education. Distance to the nearest public primary school may have implications for accessing basic education, as almost all children in Uganda walk to school daily. We chose to keep this variable as continuous.

The three district-level variables we used are supposed to be the main contextual variables influencing access to primary school in Uganda (Mpyangu et al., 2014; Yameogo, 2018). They are a combination of variables stemming from census data and computed at the district level (the propor-

(4) The wealth index was obtained by principal component analysis from a set of 27 variables, such as housing characteristics and asset ownership (land, television, car, refrigerator, etc.) following the example set by Kobiané (2004).

tion of household heads having completed at least primary education) and district-level information from the Ministry of Education, produced via a school census (the ratio of the school-age population to the number of available classrooms and the ratio of the number of pupils to the number of available toilets within school premises, called the pupil–stance ratio). The first therefore approximates the socio-economic status of the district, and the last two are proxies for the quantity and quality of school supply.

2. Striking differences between Karamoja and the rest of Uganda

Table 2 reveals significant differences between Karamoja and the rest of Uganda for all selected individual and household variables, apart from sex of the household head. The differences in age are partly due to Karamoja having a younger population and to classical age-reporting issues, with a stronger attraction for rounded-off ages in Karamoja, creating a visible artificial bulge at 10 years for children and at 60 for household heads. In Karamoja, three-quarters of the children aged 9–11 were living in a household in which the head had no education, whereas in the rest of Uganda most household heads had primary education. Three-quarters of children had household heads who reported being Catholic in Karamoja, whereas only 40% of children had a Catholic household head in the rest of the country. In Karamoja, more than a third of children lived in households where the head was in a polygamous union compared with 16% in the rest of the country. Finally, 84% of children in Karamoja lived in ‘very poor’ households versus only 19% of children in the rest of Uganda.

The three district-level characteristics also show differences across the country (Figure 4 and Table 3). The first two present Karamoja districts as extreme, but they also shed light on important variations across the rest of the country. The proportion of household heads with primary education, ranging from 7% to 84%, had a mean of 17% in Karamoja versus 43% in the rest of the country. The ratio of the school-age population to the number of available classrooms, ranging from 25 to 279, had a mean of 140 in Karamoja versus 52 in the rest of the country. The third characteristic—the pupil–stance ratio, ranging from 24 to 129—is more difficult to interpret, with various districts or groups of districts with very high ratios across the country. This variable does not show significant differences, with schools in Karamoja seemingly better equipped for the number of children they enrol than in the rest of the country’s schools.

Given that Karamoja’s sample represents only 2.7% of the total sample, the distribution of the total sample for Uganda is very close to that of the rest of Uganda, whatever the characteristic considered (Tables 2 and 3).

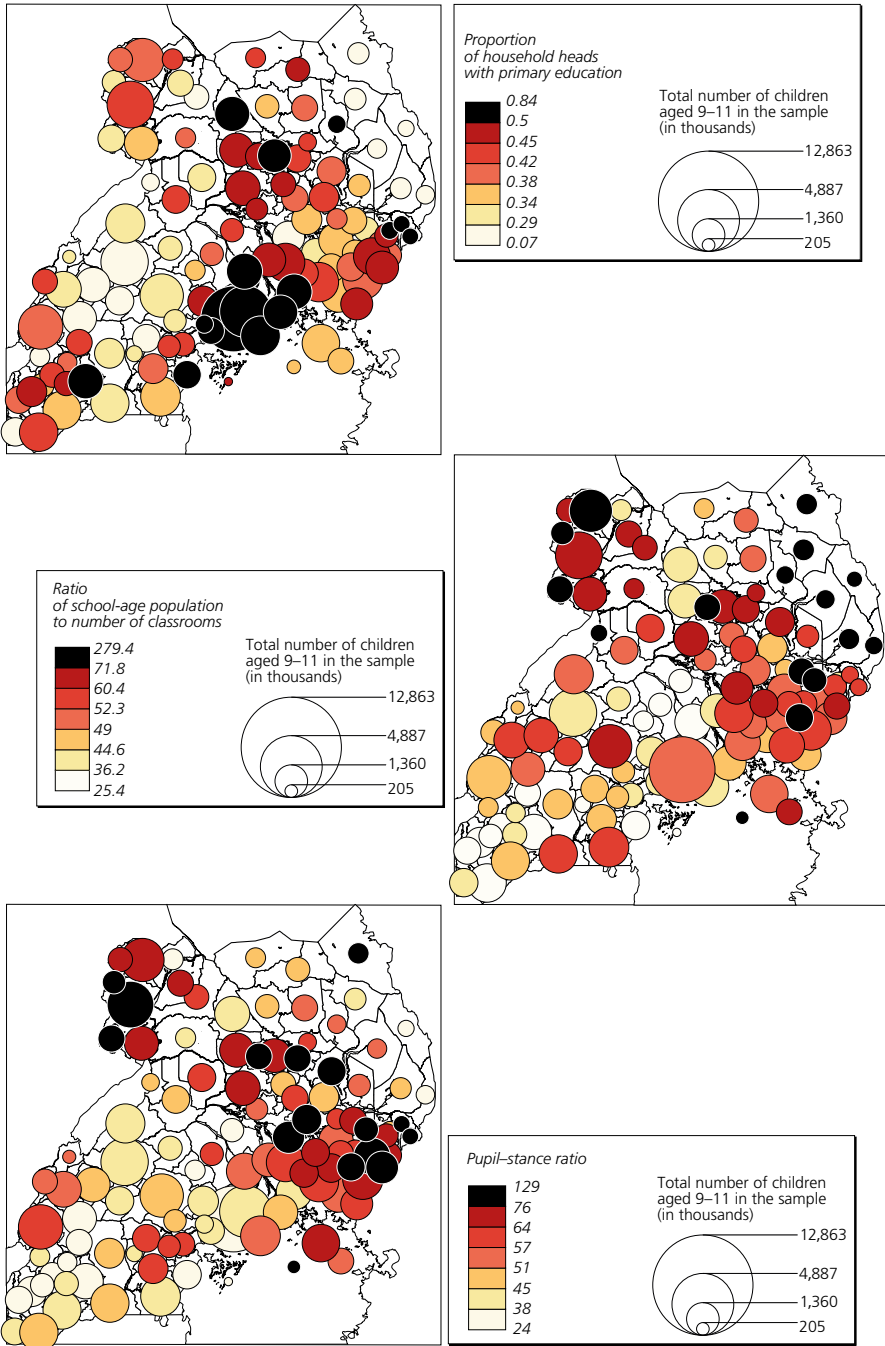
Table 2. Sociodemographic characteristics of children aged 9–11 in Karamoja, the rest of Uganda, and Uganda as a whole, 2014

	Karamoja (1)	Rest of Uganda (2)	Uganda as a whole	Chi-square test (1) – (2)
Categorical variables (in %)				
<i>Child characteristics</i>				
Age				
9	31	34	34	***
10	47	37	37	
11	22	29	29	
Sex				
Male	48	51	51	***
Female	52	49	49	
Orphanhood status				
Orphan	13	9	9	***
Non-orphan	87	91	91	
Relationship to household head				
Child of head	80	74	74	***
Other relative	20	25	25	
Non-relative	1	1	1	
Disability status				
Not disabled	95	94	94	***
Disabled	5	6	6	
<i>Household head characteristics</i>				
Educational level				
None	76	17	18	***
Primary	13	57	56	
Secondary	7	19	19	
Tertiary	4	7	7	
Sex				
Male	77	78	78	*
Female	23	22	22	
Age group				
< 35	23	19	20	***
35–59	57	67	66	
60+	20	14	14	
Religion				
Catholic	77	38	39	***
Anglican	12	33	33	
Muslim	1	14	14	
Pentecostal/Born again/Evangelical	3	10	10	
Others	7	5	4	
Marital status				
Never married	1	1	1	***
Married, monogamous	52	67	67	
Married, polygamous	36	16	16	
Widowed	9	10	10	
Separated/divorced	2	6	6	

Table 2 (cont'd). Sociodemographic characteristics of children aged 9–11 in Karamoja, the rest of Uganda, and Uganda as a whole, 2014

	Karamoja (1)	Rest of Uganda (2)	Uganda as a whole	Chi-square test (1) – (2)
<i>Household characteristics</i>				
Size (no. of persons)				
1–5	20	24	24	***
6–9	59	57	57	
10 or more	21	19	19	
Children under age 5				
None	37	33	33	***
Only 1	31	36	36	
2 or more	32	31	31	
Remittances received				
No	78	84	83	***
Yes, money	8	7	7	
Yes, goods	12	8	8	
Yes, both money and goods	2	1	1	
Wealth index				
Very poor	84	19	21	***
Poor	6	22	22	
Middle	4	22	22	
Rich	4	22	22	
Very rich	2	15	15	
Main source of income				
Subsistence	82	78	78	***
Business	4	8	8	
Salaried	4	10	9	
Family, friends, or institutional support	4	2	2	
Other	6	2	3	
Place of residence				
Urban	13	20	20	***
Rural	87	80	80	
Continuous variable				
Distance to the nearest public primary school (in km)				
Mean	5.61	2.76	2.84	
SD	8.34	3.53	3.78	
Frequencies	7,970	281,162	289,132	
*** $p < .001$. ** $p < .01$. * $p < .05$.				
Source: Authors' calculations from a 10% sample of the Uganda Population and Housing Census, 2014.				

Figure 4. District-level predictors of enrolment in Uganda, 2014



Sources: Authors' calculations from a 10% sample of the Uganda Population and Housing Census, 2014, and the results of the Annual School Census 2014 (Ministry of Education, Science, Technology and Sports, 2014); authors' construction using Magrit (<http://magrit.cnrs.fr>) with quantile discretization.

Table 3. District-level variation between Karamoja, the rest of Uganda, and Uganda as a whole, 2014

	Karamoja		Rest of Uganda		Uganda as a whole	
	Mean	SD	Mean	SD	Mean	SD
Share of household heads who completed primary education	0.17	0.13	0.43	0.13	0.43	0.13
Ratio of school-age population to number of classrooms	140.28	64.63	51.70	16.87	57.24	30.93
Pupil–stance ratio	48.71	17.69	57.21	18.22	56.68	18.23
Number of districts	7		105		112	

Sources: Authors' calculations from a 10% sample of the Uganda Population and Housing Census, 2014, and the results of the Annual School Census 2014 (Ministry of Education, Science, Technology and Sports, 2014).

3. Considerable differences in the correlates for non-enrolment

Applying the same logistic regression model brings out striking results. (Table 4). Differences in sample size and case distribution between Karamoja and the rest of Uganda call for caution in assessing the results. We therefore present them step by step. All continuous variables were standardized.

Individual-level variables

At the individual level, the child's sex has contrasting effects on non-enrolment in Karamoja and the rest of Uganda. Girls were significantly more likely to be out of school in Karamoja, as were boys in the rest of the country. At the national level, however, this variable was not significantly associated with school enrolment status. Older children were less likely to be out of school than younger ones, which shows that in both Karamoja and the rest of Uganda, some children still start school at very late ages, such as 10 or 11.

Our findings show that non-orphans were consistently less likely to be out of school than their orphaned counterparts in most of Uganda, but not in Karamoja, implying that orphanhood is a strong factor inhibiting access to basic education in the rest of the country. Relatives of the household head, and even more so unrelated children, were more likely to be out of school than the children of the household head. Being disabled was not found to negatively impact the probability of ever being enrolled in Karamoja, contrary to the situation in the rest of Uganda.

Household-level variables

Children under female household heads were less likely to be out of school than those under male heads, and this factor was statistically significant for both the Karamoja and rest of Uganda models, although stronger in Karamoja. Older household heads were less likely to host non-enrolled children, another stronger factor in Karamoja.

Table 4. Logistic regression on the probability of non-enrolment in Karamoja, the rest of Uganda, and Uganda as a whole, in 2014

Variables	Karamoja		Rest of Uganda		Uganda as a whole	
	Coef.		Coef.		Coef.	
Constant	2.746		-0.890		0.562	
<i>Individual/household characteristics</i>						
Age (Ref. = 9 years old)						
10	-0.280	***	-0.611	***	-0.523	***
11	-0.403	***	-0.954	***	-0.858	***
Sex (Ref. = Male)						
Female	0.379	***	-0.092	***	-0.032	
Orphanhood status (Ref. = Orphan)						
Non-orphan	0.003		-0.147	***	-0.142	***
Relationship to household head (Ref. = Child)						
Other relative	0.168	*	0.168	***	0.105	***
Non-relative	1.457	**	1.005	***	0.904	***
Disability status (Ref. = Not disabled)						
Disabled	0.194		0.637	***	0.551	***
Education level of household head (Ref. = None)						
Primary	-1.462	***	-0.804	***	-1.021	***
Secondary	-2.041	***	-1.080	***	-1.259	***
Tertiary	-1.694	***	-1.128	***	-1.318	***
Sex of household head (Ref. = Male)						
Female	-0.393	***	-0.230	***	-0.224	***
Age group of household head (Ref. = 18–34)						
35–59	-0.256	**	-0.103	***	-0.150	***
60+	-0.298	**	-0.195	***	-0.169	***
Religion of household head (Ref. = Catholic)						
Anglican	-0.202	*	-0.215	***	-0.390	***
Muslim	-0.597		-0.150	***	-0.467	***
Pentecostal/Born again/Evangelical	-0.397	*	-0.181	***	-0.393	***
Other	0.159		-0.039		-0.131	**
Marital status of household head (Ref. = Never married)						
Married, monogamous	-0.200		-0.165	*	-0.157	*
Married, polygamous	-0.170		-0.193	*	-0.046	
Widowed	-0.129		-0.339	***	-0.369	***
Separated/divorced	-0.407		-0.174	*	-0.272	**
Number of household members (Ref. = 1–5)						
6–9	0.189	*	-0.120	***	-0.071	**
10 or more	0.259	*	-0.046		-0.015	
Number of children under age 5 (Ref. = None)						
Only 1	0.008		0.057	*	0.010	
2 or more	-0.224	**	0.037		-0.050	

Table 4 (cont'd). Logistic regression on the probability of non-enrolment in Karamoja, the rest of Uganda, and Uganda as a whole, in 2014

Variables	Karamoja		Rest of Uganda		Uganda as a whole	
	Coef.		Coef.		Coef.	
Remittances received (Ref. = No)						
Yes, money	0.191		-0.120	**	-0.008	
Yes, goods	-0.048		-0.024		0.077	*
Yes, both money and goods	0.230		-0.097		-0.086	
Wealth index (Ref. = Very poor)						
Poor	-0.736	***	-0.309	***	-0.532	***
Middle	-0.957	***	-0.511	***	-0.702	***
Rich	-1.341	***	-0.672	***	-0.824	***
Very rich	-1.179	***	-0.890	***	-0.858	***
Main source of income (Ref. = Subsistence)						
Business	-0.372	*	-0.080		-0.049	
Salaried	-0.645	**	-0.012		0.053	
Family, friends, or institutional support	-0.322	*	0.382	***	0.276	***
Other	-0.281	*	0.277	***	0.349	***
Place of residence (Ref. = Urban)						
Rural	0.656	***	0.152	***	0.089	**
Distance to nearest public primary school	0.074	***	0.101	***	0.078	***
<i>Contextual characteristics</i>						
Proportion of household heads with primary education	-0.868	***	-0.111	***	-0.454	***
Ratio of school-age population to number of classrooms	-0.125	***	0.319	***	0.430	***
Pupil-stance ratio	-0.217	***	0.043	***	-0.016	
*** $p < .001$. ** $p < .01$. * $p < .05$.						
Sources: Authors' calculations from a 10% sample of the Uganda Population and Housing Census, 2014, and the results of the Annual School Census 2014 (Ministry of Education, Science, Technology and Sports, 2014).						

Children under more educated household heads were less likely to be out of school than those whose household heads had never enrolled. This points to an intergenerational educational disadvantage for children whose parents had not been to school, which is even stronger in Karamoja. Religion was found to be significantly related to school enrolment but only outside Karamoja, where higher proportions of never-enrolled children tended to have Catholic household heads. In Karamoja, where most people are Catholic, religion was a less significant factor. In the rest of Uganda, widows tended to send children in their household to school more than all other categories of marital status.

In Karamoja, marital status of the household head and household size had no significant relationship with school enrolment. In the rest of Uganda, average-sized households (6–9 people) were less likely to be home to children that had never been to school than smaller households.

Household wealth or income is a highly statistically significant factor for non-enrolment. This relationship is even stronger in Karamoja, where most households are considered very poor. The relationship between the main sources of income and non-enrolment is less clear, with only marginal income-source categories being significant in the rest of Uganda (support/other types of income), whereas receipt and/or the nature of remittances did not seem to significantly impact school enrolment.

Children living in rural areas were more likely to be out of school than those in urban areas. This variable had much stronger coefficients in Karamoja than in the rest of Uganda, pointing to difficulties faced by rural children in the region. Children living further from public primary schools were less likely to have been enrolled than their counterparts located closer to the schools.

Contextual variables

As expected, children in districts with a higher proportion of educated household heads were less likely to be out of school in the whole of Uganda, but even less likely in Karamoja than in the rest of the country.

Whereas higher school-age children–classroom and pupil–stance ratios were associated with non-enrolment in the larger part of the country, in Karamoja it was the opposite: non-enrolment was associated with low children–classroom and pupil–stance ratios. The first variable shows that an insufficient number of classrooms might deter children from enrolling in school in most of Uganda, but in Karamoja children tend to enrol in school in places where there were fewer classrooms to the number of children. Although a need for a larger classroom supply exists in Karamoja, as Appendix Table B.1 shows, this is not what is keeping children away from schools. In Karamoja, a lesser availability of toilet facilities in relation to the number of pupils means a higher probability of enrolment, whereas in the rest of the country, lower chances of enrolment are found when toilet facilities are shared by a high number of pupils.

Although the main predictors for non-enrolment are, in both cases, relationship to the household head, education level of the household head, and household poverty, the stories told by the Karamoja model and that of the rest of Uganda models differ, both from each other and from what an aggregate model at the national level provides. Results in the model for the whole of Uganda were close to those in the one excluding Karamoja, which is based on 97.3% of the children aged 9–11 in the country. However, some of the coefficients differ remarkably, and for a few variables, even the sign or the significance status changes totally; for example, sex of the child (not significant in the national model), whether a household received remittances, and the school-supply-related contextual variables. In these cases, the national model brings out results that differ from both the model for Karamoja and that for the rest of Uganda. It therefore depicts neither the case for Karamoja nor that for the

rest of Uganda, and leaves one wondering whether national-level results make any sense for informing public policy.

III. Towards a better-adjusted national model for non-enrolment

Although most studies using national population data sets would stop at national multivariate results, the previous logistic regression models highlight the need for greater consideration of spatial heterogeneity when producing national results. It is necessary to model the role of specific variables better if these are to be the basis for policy formulation. For this purpose, and because of the hierarchical nature of education-related data, we use a multilevel model that extends the logistic regression model (Bringé and Golaz, 2017), factoring in district-level variability more appropriately.

1. Justification and way forward

The proportion of never-enrolled children varies significantly across districts, with most districts in the central and western parts of the country falling below the national average of 6%, while those in the north and north-eastern parts being significantly above the national average (Appendix Figure B.1).

To justify the use of a multilevel model further, we run an empty multilevel model (without covariates) that provides the variance σ between Level 2 units (districts). We specifically computed the intraclass correlation,⁽⁵⁾ using the following formula as guided by Bringé and Golaz (2017):

$$\rho = \frac{\sigma^2}{\sigma^2 + \frac{\pi^2}{3}} \quad (1)$$

The empty model gives a district variance of 1.372 for Uganda as a whole, which yields an intraclass correlation of 29%: when running analyses for the entire country, district-level factors explain about one-third of the model.

A multilevel model is therefore relevant, using a step-by-step approach and introducing new variables by group: individual-level variables related to the child; variables related to the household; and finally contextual (district-level) variables. We then model the possible interaction between sex and district in two different ways: first, by directly introducing an interaction between child's sex and a district-level variable and, second, by allowing the effect of child's sex to vary between districts.

2. Taking the hierarchical structure of the data into account

The district-level variance in the multilevel model first increases from 1.372 for the empty model to 1.423 when individual-level variables are introduced

(5) The intraclass correlation is commonly estimated by the share of the variance that stems from differences between districts.

(Table 5). It is common in multilevel modelling for variables to have smaller variations within groups than between them (Snijders and Bosker, 1994). Accordingly, the effect of child’s sex is rather homogeneous within districts, with high variations between them.

The district-level variance ultimately decreases to 0.345 for the full multilevel model (Table 5). Overall, the intraclass correlation therefore decreases from 29% to 9.5%, showing that the variables we added to the model contributed to explaining two-thirds of the differences between districts.

The coefficients obtained for district-level variables slightly differ from those obtained with the logistic regression model, but overall the logistic model did not overestimate their effects, as is often the case (Bringé and Golaz, 2017). Rather, multilevel modelling renders the pupil–stance ratio coefficient slightly negative and significant, close to what was found for Karamoja.

In the full multilevel model, the strongest factors associated with non-enrolment remain similar to what was found in the logistic model: less likely to be enrolled were younger children, those living in the poorest households,

Table 5. Predictors of non-enrolment in school of children in Uganda in 2014

	Share (%)	Empty model	Individual model	Household model	All variables
<i>Fixed parameters</i>					
Intercept		-3.057***	-2.610***	-1.370***	-1.475***
<i>Individual-level variables</i>					
Sex (Ref. = Male)					
Female	49		-0.062***	-0.047**	-0.047**
Age (Ref. = 9 years)					
10	37		-0.554***	-0.585***	-0.585***
11	29		-0.902***	-0.906***	-0.906***
Orphanhood status (Ref. = Orphan)					
Non-orphan	91		-0.118***	-0.104***	-0.104***
Relationship to household head (Ref. = Child)					
Other relative	25		0.150***	0.162***	0.162***
Non-relative	1		0.816***	1.029***	1.028***
Disability status (Ref. = Not disabled)					
Disabled	6		0.615***	0.603***	0.603***
<i>Household-level variables (treated as individual)</i>					
Education of household head (Ref. = None)					
Primary	56			-0.885***	-0.882***
Secondary	19			-1.195***	-1.192***
Tertiary	7			-1.266***	-1.265***
Sex of household head (Ref. = Male)					
Female	22			-0.283***	-0.282***
Age of household head (Ref. = Under 35)					
35–59	66			-0.108***	-0.108***
60+	14			-0.163***	-0.162***

Table 5 (cont'd). Predictors of non-enrolment in school of children in Uganda in 2014

	Share (%)	Empty model	Individual model	Household model	All variables
Religion of household head (Ref. = Catholic)					
Anglican	33			-0.124***	-0.127***
Muslim	14			0.003	-0.000
Pentecostal/Born again/ Evangelical	10			-0.079**	-0.081**
Other	4			0.072	0.069
Marital status of household head (Ref. = Never married)					
Married, monogamous	67			-0.199**	-0.199**
Married, polygamous	15			-0.211**	-0.212**
Widowed	10			-0.323***	-0.323***
Separated/divorced	6			-0.195**	-0.194**
Number of household members (Ref. = 1–5)					
6–9	57			-0.076***	-0.077***
10 or more	19			0.014	0.011
Number of children under age 5 (Ref. = None)					
1	36			0.038	0.039
2 or more	31			0.017	0.017
Remittances received (Ref. = No)					
Yes, money	7			-0.027	-0.027
Yes, goods	8			0.004	0.004
Yes, goods and money	1			0.019	0.015
Wealth quintile (Ref. = Very poor)					
Poor	21			-0.342***	-0.340***
Middle	22			-0.520***	-0.518***
Rich	22			-0.665***	-0.662***
Very rich	15			-0.909***	-0.901***
Main source of income (Ref. = Subsistence)					
Business	8			-0.123***	-0.123**
Salaried	9			-0.129**	-0.125**
Family, friends, or institutional support	2			0.243***	0.244***
Other	3			0.175***	0.176***
Place of residence (Ref. = Urban)					
Rural	80			0.294***	0.290***
Distance to nearest public primary school				0.096***	0.095***
<i>District-level variables</i>					
Share of household heads with primary education					-0.310***
School-going-age children– classroom ratio					0.476***
Pupil–stance ratio					-0.100*
<i>Random parameters</i>					
Variance (intercept)		1.372***	1.423***	0.920***	0.345***

*** $p < .001$. ** $p < .01$. * $p < .05$.

Sources: Authors' calculations from a 10% sample of the Uganda Population and Housing Census, 2014, and the results of the Annual School Census 2014 (Ministry of Education, Science, Technology and Sports, 2014).

and/or with less educated, unrelated household heads. Some variables had a weaker or less significant effect, like religion and remittances. The coefficients of the household heads' religion were much weaker than in the logistic model. Only children whose household heads were Anglican or Pentecostal were significantly less likely to have never been to school than those whose household heads were Catholic. Remittances were not found to be a significant factor for school enrolment in the multilevel models, although children whose households received goods seemed more likely to be out of school in the logit model. For both variables, strong district-level differences may have impacted the results.

Three variables are more strongly related to non-enrolment in the multilevel models than in the simple logistic regression model: child's sex, household's source of income, and place of residence. In the multilevel models, females were less likely to be out of school than males. This outcome was very close to the results for the rest of the country in the logistic model and the reverse for Karamoja. For the source of income, children under household heads in business and those in salaried work were less likely to be out of school than children of subsistence farmers in the multilevel model. The education disadvantage for children under subsistence farmers in Uganda has been documented (Roach, 2009; Kakuba, 2014). The weaker chances of enrolment for children in subsistence farming households, compared with those whose source of income is in business or salaried work, had not come out in the logistic regression model. In the multilevel model, children in rural areas were more likely to be out of school than those in urban areas. In all these cases, strong district-level differences were observed when comparing Karamoja with the rest of Uganda.

3. How can we better model the effect of sex?

Our first analyses brought to the fore diametrically opposed effects of child's sex on non-enrolment, with girls significantly more likely to be out of school in Karamoja and boys in the rest of Uganda.⁽⁶⁾ The coefficients obtained for this variable were almost 4 times higher in Karamoja than in the rest of Uganda. In the logistic regression model for the whole of Uganda, the coefficient was not significant, a midpoint that hides this variable's rather strong effect at the regional level, especially for Karamoja. In the results of the random-intercept multilevel model, the sex variable was significant and its coefficient negative, showing that, overall, within Uganda districts, boys were slightly more likely to be out of school than girls. These contradictions call for a better-fit model that would allow for coefficients that not only differ but possibly contrast in sign for the variable, child's sex, depending on the district considered.

To do this, we explored two methods (Appendix B). We first used a random-slope model, with a random coefficient on sex of the child. Secondly, we used an interaction model, by introducing an interaction variable between sex of

(6) Unobserved heterogeneity for the rest of the country is much lower and has been tested through a multilevel model on the subsample for the rest of Uganda.

the child and one of the district-level variables, the ratio of the school-age population to the number of classrooms. Interesting results emerge from both methods, the first with a stronger effect of child's sex and a measure of the district-level variance related to that variable, the second with a further reduction of the overall variance and a more detailed analysis of the interaction between child's sex and school provision at the district level. However, the results remain rather close to the random-intercept model—the simplest full multilevel model, which, as we have argued, is the one that should be used.

Conclusion

We have identified the predictors of never being enrolled for children aged 9–11 and measured their relative strength, using logistic and multilevel regression methods based on the most recent census data for Uganda (2014). While corroborating results from other studies, we underscore the low proportion of never-enrolled children (6%) compared with other African countries.

We show how at the national level, with all other factors held constant, the strongest predictors for non-enrolment were relationship to the household head, the latter's level of education, and wealth status of the household, highlighting the significance of the household environment for schooling outcomes. Non-enrolment tended to decrease with child's age and was higher for children with disabilities and orphans. Non-enrolment was equally associated with household-related factors. It was stronger for non-biological offspring of the household head or children living in male-headed households, and those whose household heads were under age 30, Catholic, single, and most importantly, not educated. It was more frequent for very small and very large households, the poorest ones, those with no means of subsistence, and those living in the rural part of the country, whose situation is exacerbated by an increase in the distance to the nearest public primary school. Non-enrolment was also more likely to be in districts where fewer household heads had completed primary education and school supply was deficient, showing that both supply and demand factors are critical in predicting school enrolment for children aged 9–11 in Uganda.

Furthermore, as in many developing countries, a gap exists between the capital city (Kampala) and the rest of the country, but one region stands out. In Karamoja, about 68% of children aged 9–11 had never been to school, only 17% of household heads had completed primary school (vs. 43% for the rest of the country), and schools were seemingly better equipped with adequate toilet facilities. The region had a pupil–stance ratio of 48:1 (vs. 57:1 for the rest of the country) but also relatively low teacher and classroom supply, with a school-age-children–classroom ratio of 140:1 (vs. 52:1 for the rest of the country), a result of low state investment in education in this region. Our models capture this heterogeneity between Karamoja and the rest of the country, but

do national results help our understanding of the factors of non-enrolment in Uganda? Can they inform effective policies at the subnational level? Using multilevel analysis enables us to model the effect of child's sex better than the commonly used single-level national models. Our statistical exploration of multilevel models (random intercept, random slope, and random intercept with an interaction variable) refine the exploration of the role played by sex and its district-level variability. Although each of these multilevel models brings relevant and specific information, we argue that the simplest (the random-intercept model) remains the best compromise between best fit and model complexity. Our results underscore the need to perform a preliminary, systematic study of spatial patterns in the data in order to take these patterns into account in the methodological design.

Although relationship to the household head, education of the household head, and household poverty are strong predictors for non-enrolment in both Karamoja and the rest of Uganda, our results point to variables for which a strong discordance exists between these two regions and national results. Sex of the child is one of them, with diametrically opposed effects in Karamoja compared with the rest of Uganda. Its non-significant association with non-enrolment at the national level suggests that in Uganda, boys and girls have equal access to the education system, as documented previously (UBOS, 2016; Psaki et al., 2018). But this does not hold at the subnational level: our results show a slight association between being a boy and non-enrolment in a greater part of the country, and a strong association between being a girl and non-enrolment in Karamoja.

A gender gap in favour of girls is common in high-income countries and those in Africa with high enrolment, but this gap has been attributed mostly to higher dropout rates among boys (Psaki et al., 2018). According to UNESCO (2016), non-enrolled primary-school-age boys are more likely than girls to enrol later, but we do not know whether this is valid for our age bracket (9–11 years). The under-enrolment of boys therefore requires further research. For Uganda, we could formulate hypotheses related to gender gaps in health conditions (boys are possibly more vulnerable than girls to incapacity and disease), in social positions (in many societies, young boys are considered an embarrassment to their unmarried mothers and might therefore be sent away more often than girls), and in economic expectations (in situations of dire poverty, boys might be expected to work; orphaned boys might become responsible for their younger siblings).

In Karamoja, families are still hesitant to send children to school, especially girls. Such patterns underscore the need for policies focused on girls in subnational contexts where communities do not seem to prioritize their primary education. Such patterns are also still prevalent in other pastoralist communities like the Maasai in Tanzania (Bonini, 2018) or the Tandroy in Madagascar (Deleigne, 2016). Gendered expectations and constraints differ, and policies

ought to address this. The same is true for many other variables, which, in a context of high heterogeneity, leads to questioning the relevance of national-level models and therefore many of the existing results at the national level.

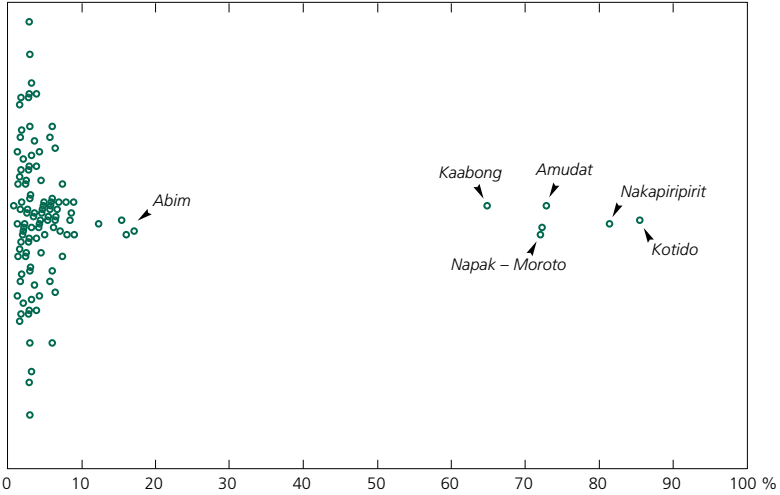
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APPENDICES

Appendix A: Never-enrolled children in Karamoja districts

Figure A.1. Proportion of never-enrolled children aged 9–11 by district



Note: Dots represent districts in Karamoja. This beeswarm plot is a one-dimensional scatter plot (the vertical offset is only meant to make all points visible); authors' construction.

Source: Authors' calculations from a 10% sample of the Uganda Population and Housing Census, 2014.

Appendix B: Towards a finer modelling of the effect of the child's sex

This section details two approaches meant to better assess the effect of the child's sex. In the first approach, we place a random coefficient on sex of the child, allowing its coefficient to vary from district to district. In the second, we create an interaction variable between sex of the child and a district-level characteristic in the random-intercept full multilevel model to capture this effect's variability. Both models converge and provide important results. As most variables present coefficients similar to the previous models, here we only discuss results for the variables involved in the studied interaction.

In the first method, the random-slope model presents significant random effects on both the intercept and the 'sex of the child' variable (Table B.1). The random coefficient on sex is much lower than that on the intercept, showing that the child's sex accounts only for a small part of the district variability. The coefficient of sex of the child is stronger and more significant than in the random-intercept model (the full multilevel model; see Table 5), emphasizing that boys are overall more likely to have never been in school than girls. For a random-slope model, we can neither calculate the global variance of the model (Kreft and de Leeuw, 1998) nor compare it to the previous models.

The second approach introduces an interaction variable between sex of the child and one of the district-level variables, the school-age population per classroom ratio. This variable was chosen on the basis of average values obtained for Karamoja that were largely above the national average (Table 3). This approach offers the possibility of introducing different effects according to the value of the chosen district-level variable. To dichotomize it, the value for Abim, the Karamoja district with the best education indicators (Figure 4; Appendix Figure A.1), was used as a cut-off point. Eleven districts were above the cut-off (the seven Karamoja districts, Maracha and Yumbe in north-western Uganda, Buliisa in western Uganda, and Butaleja in eastern Uganda).

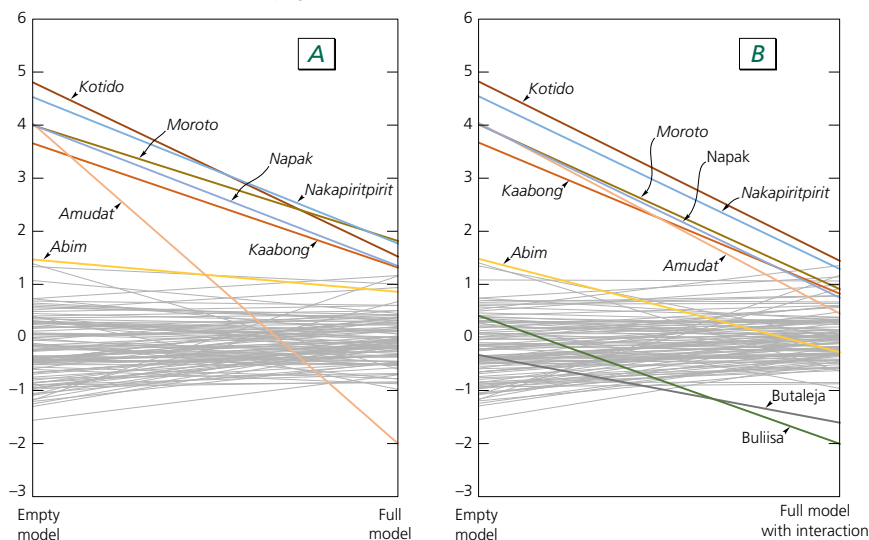
The variance of the interaction model (Table B.1, last column) is slightly lower than the full random-intercept multilevel one, resulting in a slightly lower intraclass correlation (9% instead of 9.5%). We can draw three conclusions from the coefficients of the interaction variable. First, as expected, the relative advantage of girls in districts with a low or medium number of school-age children per classroom is stronger than what we found in the random-slope model, for all districts. Conversely, in districts with a high number of school-age children per classroom, boys are significantly more likely to be enrolled in school than girls, all else equal. Lastly, the ratio of school-age children to classroom has a stronger effect on girls than boys.

Table B.1. Sex and children–classroom ratio in the various multivariate models

	Contextual logit model	Random-intercept model	Random-slope model	Random-intercept model with interaction
Fixed parameters				
<i>Individual-level variable</i>				
Sex of child (Ref. = Male)				
Female	−0.032	−0.047*	−0.099***	
<i>District-level variable</i>				
Children–classroom ratio	0.430***	0.476***	0.420***	
<i>Interaction variable</i>				
Sex of child × Children–classroom ratio (Ref. = Male × < 0.78)				
Male × > 0.78				1.731***
Female × < 0.78				−0.115***
Female × > 0.78				1.951***
Random parameters				
Variance (intercept)		0.345***	0.261***	0.323***
Variance (sex)			0.037***	
*** $p < .001$. ** $p < .01$. * $p < .05$.				
<i>Sources:</i> Authors’ calculations from a 10% sample of the Uganda Population and Housing Census, 2014, and the results of the Annual School Census 2014 (Ministry of Education, Science, Technology and Sports, 2014).				

Another way to assess the model’s fit is to check the residuals, as recommended in previous studies (Delaunay, 1999; Courgeau, 2007; Bringé and Golaz, 2017). To go further, we can do so for the empty model, the full model, and the interaction model. We have seen that adding all variables to the model reduces district heterogeneity by two-thirds. Most of the initially unexplained differences between districts in Karamoja and the rest of the country have been reduced in the full multilevel model (Figure B.1A). Here, the variance of the full model, and that of the full model with interaction (e.g. the standard deviation of the district residuals), is lower than that of the empty model. The full model with interaction (Figure B.1B) allows for a better fit on the district of Amudat, but two of the non-Karamoja districts with a high children–classroom ratio, i.e. Butaleja and Buliisa, now stand out, showing that this model, although globally slightly better than the random-slope model, as shown in Table B.1, provides less convincing results for these two districts.

Figure B.1. Residuals of random-intercept multilevel models (empty, full, and interaction models)



Interpretation: The district of Amudat presents a high positive residual in the empty model, showing that this model does not sufficiently explain non-enrolment in that district. The full model (A, right axis)—better overall—over-captures it, and the value of the residual is now negative and well below most of the others.

The full model with interaction (B, right axis) also presents a smaller overall variance, and captures non-enrolment in Amudat better. However, other districts, such as Buliisa and Butaleja, now depart from the average, showing that non-enrolment in these districts is not measured as well for them as it was in the other models.

Sources: Authors' calculations from a 10% sample of the Uganda Population and Housing Census, 2014, and the results of the Annual School Census 2014 (Ministry of Education, Science, Technology and Sports, 2014).

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Christian KAKUBA et Valérie GOLAZ • LES ENFANTS N'AYANT JAMAIS ÉTÉ SCOLARISÉS : DANS QUELLE MESURE L'HÉTÉROGÉNÉITÉ RÉGIONALE CONDITIONNE-T-ELLE L'ACCÈS À L'ENSEIGNEMENT PRIMAIRE EN OUGANDA ?

Bien que l'Ouganda fasse partie des premiers pays subsahariens à avoir instauré un programme d'enseignement primaire universel en 1997, environ 6 % des enfants âgés de 9 à 11 ans n'avaient jamais été scolarisés en 2014. L'analyse d'un échantillon de 10 % de la population recensée en 2014 met en évidence des inégalités régionales frappantes. Au moyen de régressions logistiques, cet article compare la sous-région du Karamoja avec le reste du pays et avec le pays dans son ensemble. Les analyses multiniveaux réalisées montrent que le niveau d'instruction du chef de ménage et l'indice de richesse du ménage influencent la scolarisation des enfants, toutes régions confondues. Par ailleurs, alors que le sexe de l'enfant n'a pas d'effet significatif au niveau national, la probabilité de n'avoir jamais été scolarisé se révèle significativement plus grande pour les filles du Karamoja, et pour les garçons dans le reste de l'Ouganda. Les attentes et les contraintes liées au genre diffèrent, et les politiques publiques doivent en tenir compte. Ces résultats remettent en question la validité des modèles appliqués uniquement au niveau national dans un contexte de forte hétérogénéité spatiale.

Christian KAKUBA y Valérie GOLAZ • NIÑOS QUE NUNCA HAN SIDO ESCOLARIZADOS: ¿CÓMO AFECTA LA HETEROGENEIDAD REGIONAL EL ACCESO A LA EDUCACIÓN PRIMARIA EN UGANDA?

Aunque Uganda fue uno de los primeros países subsaharianos en introducir un programa de educación primaria universal en 1997, alrededor del 6 por ciento de los niños de 9 a 11 años nunca habían asistido a la escuela en 2014. El análisis de una muestra del 10 por ciento de los datos del último censo de población y vivienda (2014) pone de manifiesto llamativas desigualdades regionales. El artículo compara la subregión de Karamoja con el resto del país y con el país en su conjunto mediante regresiones logísticas distintas. Los análisis multinivel muestran que el nivel de educación del jefe de familia y el índice de riqueza del hogar influyen en la escolarización de los niños, en todas las regiones consideradas conjuntamente. Además, aunque el sexo de los niños y niñas no tiene un efecto significativo a nivel nacional, la probabilidad de no haber asistido nunca a la escuela es significativamente mayor para las niñas en Karamoja y para los niños en el resto de Uganda. Las expectativas y limitaciones vinculadas al género difieren, y las políticas públicas deben tenerlo en cuenta. Así, estos resultados cuestionan la validez de los modelos aplicados únicamente a nivel nacional en un contexto de fuerte heterogeneidad espacial.

