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Koranic Schools in Senegal :
A real barrier to formal education?

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Abstract

This paper studies the substitution between formal education and informal religious education for Senegalese households. We use the timing of the opening of formal schools to estimate whether Koranic and formal education systems compete for the children's time. Adapting the diff-in-diff strategy in Duflo (2001), we assess the effect of school openings on Koranic and formal schooling. Our estimates show that formal school openings increase formal education attainment, especially in rural areas. Incidentally, this result highlights the lack of primary schools in rural areas : an additional primary school increases the probability to start primary school by 13 percentage points around this school. We then estimate that an additional formal school decreases the time spent in Koranic schools. This proves that, while both school systems are independent in terms of organization and pedagogical content, they still compete for the children's time. This might increase the opportunity cost of formal primary school, and can narrow the political consensus around universal primary education.

Keywords : Koranic Schools, School demand, Senegal

JEL classification : D12, I28, O12

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1. Introduction

Sahelian countries post among the lowest primary school enrollment rates in the world. In these Muslim countries, state education does not include religious teaching. So religious education takes place in the informal sector. The pervasive influence of Koranic schools in contemporary Senegal has been neglected by development planners and researchers.¹

In the Sahel as elsewhere, religious and public educations may compete against each other for children's time. The economic literature has extensively studied the consequences of a competition between two school systems (mostly) in developed countries. Some competition between private and state schools is likely to improve the efficiency of both public and private schools. It actually decreases the share of captive pupils, and hence increases incentives towards pedagogic efficiency. In practice, evidences for a systematic increase in learning achievement of pupils due to competition are at best limited.²

The potential competition with religious education may very well have spillovers on the incentives faced by the formal education system in Senegal as elsewhere. However, Senegalese Koranic schools do not provide formal skills i.e., math, reading and writing. Thus, the first order effect of this competition is drastic : children who enroll in Koranic school and do not enroll in formal school end up having no formal education. This raises the question of the competition between both educations. When enrollment in public and religious schools are mutually exclusive, it is obvious that private and religious educations are in competition.³ However, in Senegal, Koranic education can either be part-time or full-time, so that some children attend simultaneously formal and Koranic schools. Hence, the substitution between formal and Koranic enrollments is not trivial.

A recent paper, Dev, Mberu, and Pongou (2012), emphasizes that the choice of investment in "ethnic" and formal human capital may have strategic complementarities between members of the same ethnic group, especially when the ethnic group is important in the local population. They support this idea with the comparison of formal and Koranic enrollment rates between ethnic groups in different places of Nigeria. However, our article is, to our knowledge, the first attempt to quantitatively study the competition between Koranic and formal educations. We find the question whether there is a competition between Koranic education and formal education interesting for at least two reasons. First, this potential competition would imply

1. Andrabi, Das, Khwaja, and Zajonc (2006) estimate the proportion of children attending religious primary schools in Pakistan. The purpose of their paper is to compare the rate of Koranic school enrollment reported by newspapers with the actual enrollment rate. However, it is not relevant to our study.

2. See Jepsen (2002) for a summary of US studies, Card, Dooley, and Payne (2010) for Canada, and Hsieh and Urquiola (2006) for Chile.

3. Indeed, Card, Dooley, and Payne (2010) find cross-system responses to school openings.

that formal education may have an additional opportunity cost for Senegalese households, i.e., Koranic education. Second, Muslim brotherhoods have strong political ties in Senegal. Hence, the existence of a competition between formal and Koranic educations may narrow the political consensus around universal (formal) primary education.

Nevertheless, the absence of substitution between Koranic education and formal education is credible. The timetables are compatible, as Koranic education is sometimes provided part-time. In addition, being taught any subject might improve cognitive skills, and in turn the learning ability in other disciplines. So complementarity between Koranic and formal educations is conceivable.

In this paper, we estimate the effect of school openings on Koranic and formal school enrollments. We base our identification strategy on school opening dates. In fact, we identify the effect of school openings on education outcomes with a double difference strategy : we compare the difference in education outcomes between cohorts in communities with school openings, with the difference between the same cohorts in communities without school opening (or with a school opening at a different date not relevant for the cohorts in the sample). We find that a formal school opening increases formal school enrollment, and decreases Koranic school enrollment (as measured by the number of years in Koranic schools). This shows that Koranic school is a substitute to formal school for some parents.

Section 2 presents Islam and Koranic schools in Senegal. After describing our dataset, section 3 provides some descriptive statistics on Koranic school enrollment. In section 4 we present our empirical strategy to study the possible substitution between Koranic and formal schooling followed by the results. In conclusion, we discuss the link between this substitution and universal primary education.

2. The Senegalese cultural context

2.1. Islam in Senegal

Muslims account for 94%⁴ of the Senegalese population. Islam came from North Africa in the 10th century and was initially the religion of the elite along the trans-Saharan trading routes, according to Robinson (2004). In the 19th century, a massive conversion movement swept through all of society's strata, fueling the army of "Jihads" against the European colonizers and non-Muslim states (Robinson, 1985).

4. Source : CIA - The World Factbook : <https://www.cia.gov/library/publications/the-world-factbook/geos/sg.html>

It is important to bear in mind that the country is renowned today for its tolerant Islam (despite some isolated confrontations between Muslim factions). Most Senegalese Muslims (90%) are members of Sufi brotherhoods (known in Arabic as “tariqah”, “confrérie” in French). Senegalese Sufi brotherhoods differ from the Arabic Islam (at least) by the fact that the master-disciple relationship is particularly strong. There are two main Islamic brotherhoods in Senegal, namely the Tijanyyah and the Muridiyyah, and they represent over 80% of Senegalese Muslims.

Tijanyyah originated from Algeria and came to Senegal in the early 19th century. On the other hand, the Muridiyyah, founded by Sheikh Ahmadou Bamba in 1885, is a native Senegalese brotherhood well established in Senegalese society. The attractiveness of the Muridiyyah seems to be due to its adaptation to the local social context. Sy (1980) explains that the Muridiyyah appeared in the 19th century in response to colonial influence and hierarchical Wolof society. Although it reportedly ranks second in size, it is the most active brotherhood and is particularly successful at attracting urban youth. Redistribution in the brotherhood and commercial networks make it economically powerful. For example, Murids are reported to be involved in informal trade around touristic places in cities like Paris, Rome or New-York. Tuba, their holy city,⁵ is an impressive illustration of the brotherhood’s economic success : the modern city rose up out of the peanut fields, built by remittances from disciples all around the world. It is now probably the second largest city in Senegal, with over 450,000 inhabitants in 2002 according to the Population census data.

Outside these brotherhoods, a new Islamist movement known locally as “Ibadou” has been spreading throughout the urban elite. It is considered as more fundamentalist ; but we did not find any reliable source to provide accurate information on the extent of the phenomenon.

2.2. Koranic schools in Senegal

In common with many other countries, state schools offer little or no religious education. In 2002, the government included religious teaching in the formal curriculum (cf. Charlier, 2002) and national languages in primary schools. Both measures were not actually implemented, but in 2010, a ministerial decree was indeed introduced to constitute a committee for the elaboration of Koranic school curricula⁶.

So children are mostly taught religious knowledge in (informal) Koranic schools. This section gives a short presentation of Koranic schools in Senegal.

5. It is the birthplace of the brotherhood’s founder, Sheikh Ahmadou Bamba, and is located in the groundnut basin in the region of Diourbel, about 90 miles East of Dakar.

6. cf. <http://www.jo.gouv.sn/spip.php?article8664>

Although they are often perceived merely as institutions that put children on the streets begging, Koranic schools actually encompass a broader reality. On the contrary, one of their main characteristics is probably their flexibility and adaptation to the needs of the parents. Koranic schools are a purely informal system, and to some extent, Koranic masters can be considered as individual entrepreneurs. Indeed, they receive no financial support from their “religious hierarchy”, but instead are paid by their followers. While there is no official tuition fee in Koranic schools, parents are expected to help their children’s Koranic master as much as they can. As a consequence, curricula, organization and density of Koranic schools are highly endogenous to the local context.

Senegalese Koranic schools take a variety of forms. Some pupils attend Koranic school part-time, and go to a formal school on school days, while others attend Koranic school full time, and cannot attend formal school. There is no rigid pedagogic curriculum in informal Koranic schools in Senegal as in neighboring countries. However, three levels can be identified : (Following World Bank, 1999)

- The primary Koranic level : once children are able to speak, typically between three and five years old, they are often sent to Koranic school where they are given a basic knowledge of the Koran.
- The secondary Koranic level : some of the children who have memorized large portions of the Koran are then taught “Islamic science”, i.e. translating the holy book and the written traditions of the religion.
- Higher Koranic studies : a few students proceed to this level, usually with eminent masters and often in prestigious Islamic universities in North Africa or other Muslim countries.

This structure seems to be very similar in many Muslim Sub-Saharan regions. The first two Koranic levels are locally known as “écoles coraniques” in French and “daara” in Wolof. This elementary teaching begins with learning the Koran by heart without understanding it, begging the question as to what skills are actually transmitted. Although students are taught to read and write Koranic verses, they rarely master Arabic. The ultimate aim of this school is to prepare the children to become good Muslims.

The main values transmitted are obedience, respect, and submission. Pedagogical strategies may include corporal punishment and begging for food, whenever the child lives with the Koranic master. These harsh treatments are supposed to allow students to experience humility and solidarity, both highly valued in Sufi Islam ⁷.

7. As is certainly not always the case, the violence inflicted on Koranic students by their masters is somehow

As traditional Koranic schools do not have any precise timetables or curricula, unlike the formal education system, there is no guarantee of the quality of the teaching. However, there have been attempts to modernize them. The most significant example of this is the development of Franco-Arab schools (“*école franco-arabe*” similar to “*madrassa*” in other contexts) since the 1950s, with recent growth in the 2000s (Gandolfi, 2003), in an endeavor to balance formal and religious schooling. This paper included Franco-Arab schools among formal schools, as the curricula include reading, writing, and math. In some Franco-Arab schools, pupils even take the national exams (*ibid.*). Another example is the development of pre-school Islamic institutions, providing an alternative to traditional Koranic schools in Dakar. One of the particularities of both examples is that these modern institutions have relatively high fees.⁸

It is also believed that children learn more away from their parents, who cannot then interfere with the master’s strict discipline (Perry, 2004). In this case, as tuition in traditional Koranic schools is usually “officially” free, and Koranic masters cannot afford to feed all their pupils, Talibes⁹ are fed by neighbors. It is indeed a common practice for some families to feed some Talibes. However, it is also very common to see Koranic students begging for food at traffic lights in some areas (especially downtown Dakar).

It is very hard to obtain accurate estimates of the number of children fostered out to Koranic masters. A recent household survey in Senegal estimates that they represent approximately 1% of boys aged 15 or under (see Beck, 2009). This leads to a rough approximation that 5% of boys’ Koranic schooling takes place in Koranic boarded schools.¹⁰ Children’s rights advocates tend to alarm public opinion and officials, since children fostered out to Koranic masters often live in extreme poverty. The media often focus on urban Talibes begging with tin cans on the streets of business districts and tourist areas, dressed in rags and in poor health. The local press and internet¹¹ regularly cover stories on Koranic masters exploiting their Talibes by forcing them to collect a certain amount of money per day under the threat of physical punishment. *Understanding Children’s Work* (2007)¹² estimates that 90% of child

tolerated and deemed normal treatment, cf. Sy (1980) and the first pages in Kane’s famous novel, *Ambiguous Adventure*.

8. (Gandolfi, 2003) mentions up to CFAF 1,000, i.e., 1.5€, per month in Dakar for pre-school institutions.

9. Koranic school students in Wolof although there is some confusion here, since the term refers to disciples in the broad sense and therefore any Murid followers.

10. We estimate that boys aged 15 have spent on average 2.5 years in Koranic school, and assume they have spent 1% of their time in boarding Koranic schools following Beck (2009).

11. See, for example : <http://www.irinnews.org/report.aspx?reportid=50001>

12. Inter-Agency Research Cooperation Project on child labor involving the ILO, UNICEF and the World Bank.

beggars in Senegal are Talibes or former Talibes. Perry (2004) analyzes the discrepancy between these assertions and the local population's experience, in a small-scale study of rural Wolof Tijane.

2.3. Relations between Koranic and formal schools

The first reason why Koranic school and formal schools may compete is the opportunity cost of children's time. Timetables of Koranic school and formal schools are usually compatible when needed. However, combining both educations may be difficult, especially when a child is additionally expected to work at home.

Koranic schools may have comparative advantages. Sending children to Koranic school may have economic returns because of informal networks. For example, the economic success of the Murids makes Murid Koranic schools potentially useful to be able to benefit from the brotherhood's powerful network in the informal sector (World Bank, 1999) and in illegal migration channels.¹³

In addition, among the skills taught in Koranic education, Koranic schools transmit moral values, and in particular the respect for the parents. Hence, parents could invest in shaping their children's propensity for being loyal (i.e. helping them). When reaching old-age, parents will have to rely on their children's support as there is virtually no access to formal pension systems in Senegal. In his Nobel lecture, Becker (1993) argues that economists have excessively relied on altruism for the enforcement of inter-generational contracts and suggested instead accounting for the endogenous formation of preferences within the family (Becker 1993 and 1996). Some evidence of such strategic parental behavior in Senegal is illustrated in Auriol and Demonsant (forthcoming). Based on a primary small-scale household survey in rural Northern Senegal, they show how migrant sons from the village elite are more likely to remit when they did not attend primary school and instead may have been sent to Koranic school¹⁴.

There may also be cultural reasons why parents send their children to Koranic schools and not to formal schools. Some Senegalese see the state as a legacy of colonization and, by contrast, see Islam as closer to Senegalese traditions. Indeed, Islam has been a way to mobilize the Senegalese against the colonizers during the 19th century. However, this tends to neglect the fact that Senegal has been independent for over 50 years now. Using a lexical and morphosyntactic analysis of semi-structured interviews, Huet-Gueye and de Léonardis (2005) show how this view can be expanded to the competition between Koranic schools and formal

13. See for instance Lacomba (2000) about Murid networks in Spain.

14. Although lack of Koranic school information in their data prevented them from validating this assumption

schools. They find that the divide between “traditionalists” and “modernists” clearly shapes Koranic and formal schooling choices.

The fact that some parents choose between formal and Koranic education may also have political consequences. The two main Muslim brotherhoods represent approximately 80% of the Senegalese population, and have strong political ties (see, e.g., Villalon, 1995). For instance, Abdoulaye Wade, the former Senegalese president, is a known fervent Murid. He has visited Tuba (the Murid holy city) less than a week after both of his presidential election victories in 2000 and 2007 (Thiam, 2010), and has often been criticized for favoring the Murids (Smith, 2009).

Brotherhoods are used to give implicit or explicit voting instructions (*ndiggels* in Wolof, see Villalon, 1995, Salzbrunn, 2002, Thiam, 2010 or Antil, 2010). Thiam (2010) cites interviews in national newspapers where voters report to have returned their votes to Wade in 2007 because of the Murid voting instruction. He reports a voting share for Wade in Tuba of 85% in 2007 (vs. a national average of 55%).

If Senegalese households need to make a clear-cut choice between Koranic and formal educations, the brotherhoods may not strongly support universal primary education. Instead, they may favor the religious education of their followers. Tuba, claiming 500,000 inhabitants, has banned state primary schools, to avoid any “westernization” of the city (Guèye, 2002). We did not find any evidence that brotherhoods actively lobby against formal education outside of Tuba. However, politicians clearly seek for the brotherhood’s voting instructions, and this might soften their incentives to promote formal education. The political will to introduce religious education in the formal school curricula may reveal the influence of Muslim brotherhoods.

3. Data and descriptive statistics on Koranic schooling

3.1. The dataset

In this paper, we use the EBMS dataset.¹⁵ It is a national household survey conducted in Senegal in 2003 covering 1,800 households. The data collected contain retrospective information on the (formal) education of household members and their relatives (parents, siblings and children), including retrospective information on the formal school career. It also includes

15. EBMS is a survey of household education and well-being in Senegal : “*Education et Bien-être des Ménages au Sénégal*”. This survey was designed by a team of researchers from Cornell University, USA and from LEA-INRA, France, and conducted in association with the Centre de Recherche en Economie Appliquée (Dakar, Senegal). The authors would like to thank Christelle Dumas and Sylvie Lambert for making the data available.

information on the living conditions : possession of durable goods, employment status, health, etc. The survey also includes unique (to our knowledge) information on Koranic schooling, with data on Koranic school length for each household member aged between 5 and 21. It does not include any other information on Koranic school career, and in particular no retrospective information. Details and descriptive statistics of the variables used in this paper are given in the appendix.

The EBMS survey was designed to resurvey some of the pupils that took school attainment tests during the previous PASEC Senegal survey.¹⁶ The PASEC survey randomly selected 20 second grade pupils from 99 primary schools in 1995. The households in the neighborhoods of 60 schools surveyed by PASEC were resurveyed in the EBMS. In each of these neighborhoods, the maximum number of households possible with at least one PASEC child (up to 20) were surveyed. Other households in the school's catchment area (village or neighborhood in urban areas - called communities hereafter) were surveyed, bringing the total number of households surveyed in each community up to 30. All the information used in this survey was collected during the EBMS survey.

This particular sampling design has certain repercussions on inference issues. First, each surveyed community has a school at least since 1995. As a result, Koranic school enrollment is observed provided formal schooling is also available. This tends to underrepresent remote areas where there were no primary schools until recently. Second, PASEC households are in our sample because they enrolled a child in second grade for the 1995/1996 school year. Consequently, recently formed households are probably underrepresented in our sample. Households with very low preferences for formal schooling may also be underrepresented. Finally, children included in the PASEC school panel are excluded from our sample to avoid further selection bias.

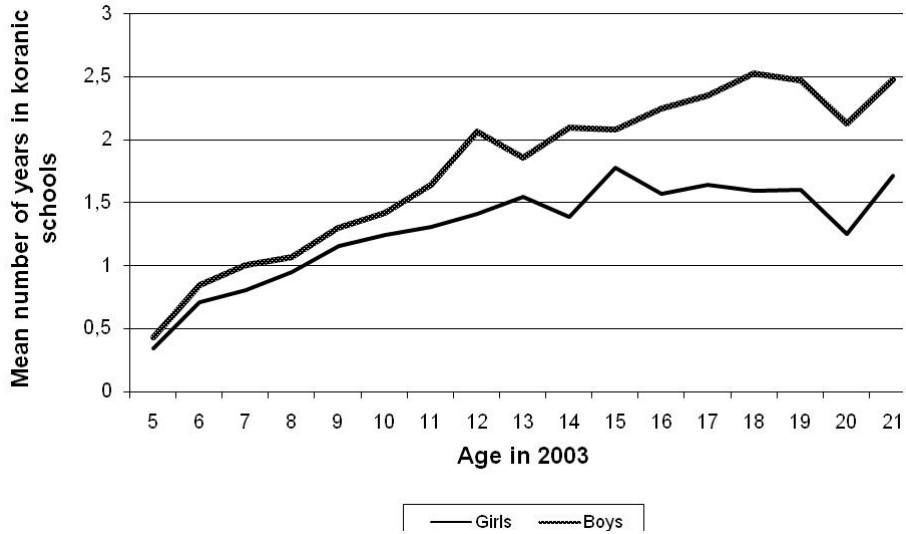
The next section presents some descriptive statistics on Koranic school enrollment in our sample, and then analyzes its determinants.

3.2. Statistics on Koranic school

In Figure 1, we plot the average length of Koranic school against age in 2003. Two effects can explain the differences between the enrollment rates of the older and the younger cohorts.

16. PASEC is an education system analysis program : "*Programme d'Analyse des Systèmes Educatifs de la CONFEMEN*" (created in 1991 following the Jomtien Conference on *Education for All*). CONFEMEN is the oldest organization in the union of French-speaking countries : "*Conférence des Ministres de l'Éducation ayant le français en partage*" set up in 1960. PASEC conducted a panel survey in Senegalese primary schools between 1995 and 2000. This panel included school attainment tests. For further information on the PASEC Programme, see <http://www.confemen.org/>

FIGURE 1: Length of Koranic school and age in 2003

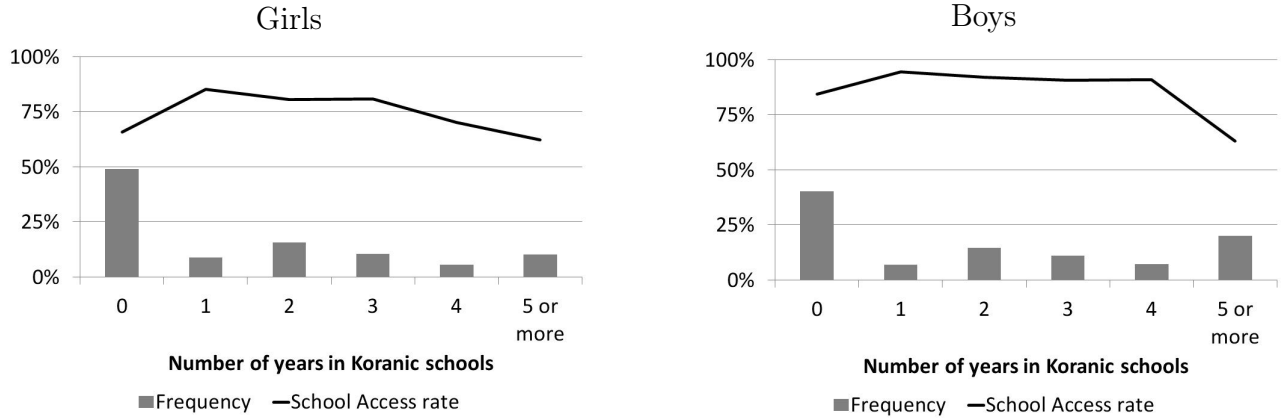


First, the proportion of children in the older cohort who have attended Koranic school only after data collection is smaller. Second, the difference in Koranic school enrollment between the two cohorts is affected if Koranic school enrollment decreases (or increases) over time. It is theoretically impossible to disentangle the two mechanisms with the data at hand. However, we observe that the number of years spent in Koranic school does not increase after 18 years old for the boys and 15 years old for the girls. Consequently, we make the following assumption : girls over 15 and boys over 18 have finished their Koranic schooling. We consider girls between 15 and 21 and boys between 18 and 21 for the statistics of section 3. We use the sample of all children aged 15 to 21 in section 4, to increase the sample size. Therefore, we bear the risk of having the corresponding regressions contaminated by incomplete Koranic education.

Figure 2 shows the distributions of the length of Koranic school for girls and boys. We observe, in our sample, that approximately half of the girls and 40% of the boys have never attended Koranic school. The majority of children who go to Koranic school attended it for two to three years. Only 15% of girls and 27% of boys attend Koranic school for more than three years.

Figure 2 also shows the formal school access rate and for each extra year of Koranic school. The children who have never been to Koranic school have a lower formal school enrollment rate than those who have a few years of Koranic schooling. A total of 66% of girls with no Koranic education and 85% of girls with one year of Koranic education have attended formal school (respectively 84% and 94% for boys). However, the proportion of children having attended formal school decreases significantly after three years of Koranic schooling for girls and four years for boys.

FIGURE 2: Joint distribution of formal school access and length of Koranic school for boys and girls



Note : 1752 observations (Girls 15 to 21 y. o.)

Note : 780 observations (Boys 18 to 21 y. o.)

However, figure 2 does not give any precise information about the potential substitution between Koranic education and formal education. In fact, the demand for Koranic education and the demand for formal education are likely to be highly correlated. For instance, some children, especially girls, could well be excluded from any schooling system for financial reasons. This would explain why Koranic and formal schooling are correlated for these children. One robust result we obtain, though, is that Koranic schooling and formal education are far from incompatible : 39% of girls and 49% of boys have attended both.

3.3. Determinants of Koranic schooling

In Table 1, we estimate different specifications for the determinants of Koranic school enrollment for girls and boys. In columns 1 and 3 we estimate two specifications of a probit model for the determinants of attending a Koranic school. In columns 2, and 4, we run an OLS model predicting the number of years in Koranic school. We include in the sample all girls aged 15 to 21, and all boys aged 18 to 21, as we observed in Figure 2 that girls over 15 and boys over 18 have probably finished their Koranic schooling.

Standard economic theories summarized recently by Glewwe (2002) and Orazem and King (2008) give insights on the factors affecting the demand for education. The framework is mainly based on the seminal work of Becker (1967) : the costs and benefits of education determine the level of education demanded.

Concerning the benefits of Koranic education, learning religion is probably the main reason why children enroll in Koranic school. The preferences for religious education are probably strongly heterogeneous, and the data do not include any proxy for this. We nevertheless observe that ethnic group is a strong determinant of Koranic schooling, which might be explained by differences in preferences for religious education. The main ethnic group in

TABLE 1: Determinants of Koranic school enrollment for girls and boys

	Girls		Boys	
	Has ever attended Koranic school (probit) (1)	Number of years in Koranic school (OLS) (2)	Has ever attended Koranic school (probit) (3)	Number of years in Koranic school (OLS) (4)
Age	-0.063** (0.016)	-0.051+ (0.028)	-0.042 (0.047)	-0.080 (0.098)
Rural	-0.220 (0.138)	-0.159 (0.225)	-0.125 (0.179)	0.279 (0.356)
Wealth (Possession of durable goods)	0.177** (0.055)	0.257** (0.087)	0.106 (0.073)	0.586** (0.182)
Father's Education	0.031 (0.028)	0.005 (0.051)	0.030 (0.038)	-0.160* (0.065)
Mother's Education	0.045 (0.028)	0.062 (0.062)	-0.011 (0.050)	-0.128 (0.118)
The household's head works in the formal sector	-0.088 (0.090)	-0.338* (0.134)	-0.013 (0.121)	-0.087 (0.281)
The household's head is farmer	0.107 (0.124)	0.085 (0.224)	0.019 (0.189)	-0.043 (0.366)
Ethnic group : Pulaar	0.080 (0.132)	0.108 (0.255)	0.195 (0.149)	0.867* (0.427)
Ethnic group : Serere	-0.482** (0.157)	-0.784** (0.212)	-0.907** (0.143)	-1.377** (0.309)
Ethnic group : Dioula	-0.673** (0.216)	-0.973** (0.252)	-0.501** (0.181)	-0.790* (0.353)
Ethnic group : Mandingue	0.047 (0.223)	0.161 (0.360)	0.085 (0.290)	0.283 (0.560)
Ethnic group : Soninke	0.657* (0.295)	1.403* (0.593)	0.315 (0.324)	0.587 (1.295)
Ethnic group : Others	0.013 (0.308)	-0.347 (0.587)	-0.680 (0.619)	0.010 (0.739)
Observations	1680	1673	747	746
R^2		0.063		0.109
log-likelihood	-1082		-454.1	

Notes : ** p<0.01, * p<0.05, + p<0.1. Robust standard errors in parentheses

Senegal, Wolof, is taken as a reference. Two ethnic groups attend Koranic school significantly less : the Serer and the Diola. The average number of years of Koranic schooling is between 0.5 and 1 year lower respectively for Serer and Diola girls (with a sample average of 1.6 years of Koranic schooling) and between 0.8 and 1.4 years lower for Serer and Diola than Wolof boys (average : 2.4 years). The Soninké ethnic group (and to some extent the Pulaar) posts higher Koranic school attendance among both boys and girls. Regressing the number of years spent in Koranic school on the ethnic groups explains 7.9% of the variance for boys and 4.6% for girls, whereas regressing the highest grade attended in formal school on the ethnic groups explains 1.4% of the variance for boys and 2.9% for girls. Ethnicity explains a larger part of the variance in Koranic school than in formal school enrollment. In addition, models (2) and (4) of Table 1, most of the variance explained can be attributed to ethnic groups, as these model explain 10.9% of the variance for boys and 6.3% for girls. This underlies the fact that culture is probably a strong determinant of Koranic schooling. The differences between ethnic groups in Koranic school enrollment may be an illustration of the differences in the valuation of religion, or of the values transmitted by Koranic schools. This may be partially explained by religious brotherhood effects, since ethnic group and brotherhood affiliation are related as mentioned in the first section. Unfortunately, we do not observe brotherhoods in the data to further explore this.

Religious skills associated with Koranic school are not easy to define, and may depend on the context. Hence, the quality of Koranic education remains a theoretical concept. However, teaching strategies in Senegalese Koranic schools are known for being highly heterogeneous. The quality of Koranic schools is very variable, according to Senegalese people themselves. The data at hand do not provide any insight into that. The Koranic school system is not centralized. Hence, the local quality of Koranic education may depend on the context. Besides the parental preferences for religious knowledge, the economic returns to Koranic school may be one of the motives for Koranic school enrollment. As mentioned earlier, Koranic school may provide networks which can be valuable on the (informal) job market (World Bank, 1999). Again, Table 1 does not control for these mechanisms. It is nevertheless worth noting that there are probably less or no returns to Koranic school enrollment in the formal sector. This could explain why girls are less likely to be enrolled in Koranic schools when the household head works in the formal sector. In addition, boys have shorter Koranic school careers when the father has a higher formal education. It could be that one of the costs of a long Koranic school career is the incompatibility with a long formal school career. However, these results can also be due to different preferences. Indeed, the values parents want to transmit to their children may be less “traditional” when the family is involved in the formal sector.

The cost of Koranic school may be especially difficult to bear under credit constraints. However, the financial costs of Koranic school may be very heterogeneous. Indeed, many Koranic schools do not have any official fees. Instead, the social norm is that households help Koranic masters. This social norm is probably softened when households face strong credit constraints. In addition, boarding Koranic schools may even have negative costs in some cases, when the child is fed through begging. The effects of credit constraints on Koranic school enrollment are therefore undetermined. Table 1 does not include any proxy for the heterogeneity of implicit or explicit costs of Koranic schools between households. We nevertheless observe that boys and girls spend more time in Koranic schools in wealthy households.

Finally, the coefficient of age is negative and significant for girls. This means that young girls have spent more time in Koranic schools, which is probably a sign of recent expansion of Koranic school enrollment.

4. Substitution between Koranic and formal schooling

4.1. Identification strategy

This section studies the substitution between Koranic and formal school enrollments in Senegal. Our identification strategy is based on the opening of formal schools. Equations (1) present our estimations of interest :

$$\begin{cases} \text{Formal School}_{cai} = f\left(\alpha \text{Nb Schools}_{ca} + X_{cai}\beta^f + \lambda_c^f + \gamma_a^f + \varepsilon_{cai}^f\right) \\ \text{Koranic School}_{cai} = f\left(\delta \text{Nb Schools}_{ca} + X_{cai}\beta^k + \lambda_c^k + \gamma_a^k + \varepsilon_{cai}^k\right) \end{cases} \quad (1)$$

Note : f is a parametric function, which varies with the dependent variable (this allows to write probit models and OLS the same way : f is the identity for the OLS ; $f(u) = \mathbb{1}(u > 0)$ for probit models).

$\text{Formal School}_{cai}$ denotes the formal school achievement of child i , from community c and of age a . $\text{Koranic School}_{cai}$ is the Koranic school achievement of this child. The variable of interest is Nb Schools_{ca} : the number of formal schools in community c available for the children of age a in 2003 (age in 2003 defines a cohort, called cohort a thereafter). This variable could be endogenous for at least two reasons : schools are not randomly located, and the number of schools tends to increase over time. Therefore, the specification includes a set of community dummies (λ_c^f and λ_c^k) and a set of age-group dummies (γ_a^f and γ_a^k), in order to control for this potential endogeneity. X_{cai} are the control variables of child cai .

The intuition behind the specification in model (1) is straightforward. We control for age and community dummies, so the model is identified with the community-specific age profile of school enrollments. α and δ answer whether this community-specific profile is correlated with the number of schools available for a given age-group in a given location. Hence α answers a

simple question : does an additional formal school promote education? The significance of δ determines whether an additional formal school promotes Koranic education.

Our estimation can therefore be interpreted as a double difference : we measure whether the differences in school enrollment between cohorts within communities are correlated with school openings in these communities. Simplifying the argument, we compare in each community children who are too old to have benefited from the opening of schools (cohort O) with the younger ones (cohort Y). In communities where a school opened, we expect the difference in school enrollment between cohorts O and Y to be higher than in the rest of the country, and measure it with α .

$Nb\ Schools_{ca}$ is the number of formal schools in community c available for the children of age a in 2003. Its definition is not obvious, as school entry ages are not uniform in Senegal. However, we postpone the discussion on the choices of $Nb\ Schools_{ca}$ to section 6.2.

What happens when a school opens in a particular place? The availability of formal schools provides a useful proxy for variations in the price of “formal” human capital. If parents sometimes need to make a choice between Koranic and formal education, the expected Koranic enrollment rate could marginally decline. This section presents the economic reasoning behind why our results give an answer to a relevant public policy issue.

Model (1) focuses on the effect of formal school openings on the “consumption” of religious education. We can consider religious and formal educations as two goods in the household’s consumption set. Let us assume that $Nb\ Schools_{ca}$ is a useful proxy for variations in the “price” of formal education. In the standard microeconomic theory, the effect of a decrease of the price of formal education on Koranic education is called a cross-price effect. Cross-price effects include two different economic mechanisms : the substitution and income effects. The substitution effect is the most intuitive. When a formal school opens, the relative price of formal education to Koranic education decreases, so some children shift from Koranic to formal education. The income effect can also be easily interpreted in our case. Again, assume that a formal school opens : for children who would have gone to formal school anyway, travel time decreases, so that the time constraint slacks off. As a result, it could induce an increase in the length of Koranic school, as free time generated can be reallocated to other activities. The sign of this later effect is almost certainly known : it is positive for normal goods, and human capital is probably a normal good in the Sahelian context. So the time spent in Koranic schools is likely to increase as the budget and/or time constraints are relaxed. Our economic intuition is that this effect is negligible.

The policy question in this paper is to what extent both education systems compete in Se-

negal. Hence, the question is whether Koranic and formal school enrollments are substitutes. We assume that both forms of educations are normal goods in Senegal. Hence, if the opening of formal schools decreases Koranic schooling, there is substitution between both school enrollments (and the substitution effect overrides the presumably negligible income effect).

4.2. Potential selection bias

This paper is based on the estimation of (1) on the EBMS sample described in section 3. The fact that this sample is not nationally representative might be a problem, as the composition of our sample may be related to education history of the individuals. For example, if girls marry earlier when they are uneducated, some girls from households with low demand for education may have already left the sampled households in places where there were no schools nearby. Formally, we write the selection process in a simple form :

$$\begin{cases} Selection_{cai} = \mathbb{1}(\alpha^s Education_{cai} + X_{cai}\beta^s + \lambda_c^s + \gamma_a^s + \varepsilon_{cai}^s > 0) \\ Education_{cai} = f(\alpha^e Nb Schools_{ca} + X_{cai}\beta^e + \lambda_c^e + \gamma_a^e + \varepsilon_{cai}^e) \end{cases} \quad (2)$$

In equation (2), the estimation of α^e without addressing the selection issue is biased if either ε_{cai}^s is correlated to $Nb Schools_{ca}$, or $\alpha^s \neq 0$. Neglecting the non-linearity of f , we can write a reduced-form equation of (2) :

$$Selection_{cai} = \mathbb{1}(\alpha^r Nb Schools_{ca} + X_{cai}\beta^r + \lambda_c^r + \gamma_a^r + \varepsilon_{cai}^r > 0) \quad (3)$$

In this equation, $\alpha^r \neq 0$ if and only if there is a selection issue (i.e. the hedonic estimation of α^e in equation (2) is biased). We cannot estimate equation (3), as we do not have a nationally representative sample at hand. However, we can estimate an imperfect version of this equation : we know the size of the selected sample, and can see whether this size is correlated with $Nb Schools_{ca}$. The sum at the community-cohort level of the linearization of (3) gives equation (4) (Assuming that the total number of observations by community-cohort is fixed) :

$$Nbobs_{ca} = \alpha^{r'} Nb Schools_{ca} + \bar{X}_{ca}\beta^{r'} + \lambda_c^{r'} + \gamma_a^{r'} + \varepsilon_{ca}^{r'} > 0 \quad (4)$$

In equation (4), $Nbobs_{ca}$ is the number of selected observations (i.e. observations in our sample) by community-cohort, \bar{X}_{ca} is the average of X_{cai} in the community-cohort. Table 2 gives the estimation of equation (4). The number of observations is slightly greater for the community-cohorts with a higher number of schools, with up to 0.5 additional observations per additional school (average of 4 observations by community-cohort), but this is not statistically

TABLE 2: Correlation between the number of observations by community-cohort and the number of schools

	Boys		Girls	
	Rural areas	Urban areas	Rural areas	Urban areas
Number of primary schools at age 8	.676 (.419)			
Number of secondary schools at age 10		.119 (.453)		
Number of primary schools at age 10			.034 (.349)	
Number of secondary schools at age 12				.559 (.352)
Control variables	Yes	Yes	Yes	Yes
Cohort dummies	Yes	Yes	Yes	Yes
Community dummies	Yes	Yes	Yes	Yes
N	217	196	217	196
R^2	.499	.295	.41	.352

Notes : Probit model. Dependent variables : number of observations by community-cohort for cohorts aged 15-21 in 2003. Heteroskedasticity-robust standard errors in parentheses. * significant at 10%; ** at 5%; *** at 1%. Control variables included in all regressions : community-cohort average of wealth, household head works in the formal sector, household head is a farmer, ethnic dummies, cohort and community dummies.

significant.

Table 2 showed no sign of selection issue for boys : we have approximately the same number of observations when $Nb\ Schools_{ca}$ is high. However, one may be worried by the power of this test. In addition, while the same number of observations is constant with the number of schools, it could still be that the observations are not the same in the community-cohorts with more schools. For example, children could be poorer, or with different parental education, when there are less schools around. In equation (3), this happens when, conditional on $Selection_{cai} = 1$, $Nb\ Schools_{ca}$ and X_{cai} are correlated (because $\alpha_r \neq 0$) :

$$Nb\ Schools_{ca} = X_{cai}\beta^{r''} + \lambda_c^{r''} + \gamma_a^{r''} + \varepsilon r''_{cai} \quad (5)$$

We estimate equation (5) in Table A.2 in the appendix. This Table shows no sign that the composition of our sample is significantly different when $Nb\ Schools_{ca}$ is higher (at least based on observable characteristics), as the F-test are not significant.

5. Main results

This section estimates the effect of school openings on school attendance. We estimate equation (1). This specification estimates the effect of the opening of new schools on formal and Koranic school achievements, controlling for community dummies and age-group dummies. The identification is therefore a diff-in-diff estimation. It relies on the correlation between the community-specific differences in education between cohorts and the opening of schools. The estimation of model (1) is given in Table 3.

In Table 3, columns 1 to 4 estimate the effect of the opening of formal schools on formal

TABLE 3: Enrollment Choices and school openings

	Formal school				Koranic school			Nb. of years (OLS)	
	Enrolled at least until : Grade 1 (Probit)	Grade 4 (Probit)	Grade 7 (Probit)	Last Grade (OLS)	Enrolled for at least : 1 Year (Probit)	4 Years (Probit)	6 Years (Probit)		
Rural boys	Number of primary schools at age 8	.123 (.047)***	.152 (.051)***	.155 (.082)*	1.165 (.344)***	-.06 (.072)	-.186 (.063)***	-.196 (.098)**	-.548 (.358)
	Control variables	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
	Cohort dummies	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
	Community dummies	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
	N	662	720	666	720	681	695	544	709
	log-likelihood or R^2	-306.201	-362.228	-337.982	.276	-385.856	-320.872	-195.408	.254
Urban boys	Number of secondary schools at age 10	.062 (.033)*	.071 (.023)***	.031 (.034)	.372 (.214)*	-.047 (.023)**	-.031 (.045)	-.042 (.045)	-.385 (.215)*
	Control variables	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
	Cohort dummies	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
	Community dummies	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
	N	655	704	755	755	701	667	556	701
	log-likelihood or R^2	-179.252	-254.768	-415.173	.28	-392.495	-352.098	-222.234	.199
Rural girls	Number of primary schools at age 10	.139 (.048)***	.069 (.042)	.067 (.04)*	.905 (.295)***	.041 (.046)	-.041 (.049)	-.073 (.036)**	.039 (.241)
	Control variables	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
	Cohort dummies	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
	Community dummies	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
	N	684	710	541	712	689	487	404	691
	log-likelihood or R^2	-324.465	-337.422	-181.435	.414	-352.14	-209.552	-94.484	.247
Urban girls	Number of secondary schools at age 12	.027 (.02)	.042 (.023)*	-.036 (.03)	.131 (.225)	.002 (.032)	.006 (.026)	.023 (.027)	.046 (.178)
	Control variables	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
	Cohort dummies	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
	Community dummies	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
	N	712	772	772	772	730	687	401	730
	log-likelihood or R^2	-249.811	-340.547	-405.54	.296	-433.217	-275.449	-112.108	.19

Notes : Probit models (average marginal effects reported) and OLS. Dependent variables : see each column heading. Robust standard errors clustered by community-cohort in parentheses. * significant at 10%; ** at 5%; *** at 1%. Control variables included in all regressions : wealth, household head works in the formal sector, household head is farmer, ethnic dummies, cohort and community dummies.

education. Columns 5 to 8 estimate their effect on Koranic education. In each case, we estimate three probit specifications, with different dependent variables : has ever been enrolled, completed fourth grade in formal school (or 4 years of Koranic school), completed 7th grade (or 6 years of Koranic school) (Table A.3 in the appendix displays comparable estimates for each grade in formal school and year in Koranic school).¹⁷ For these probit specifications, we report the average (in our sample) of the marginal effect of an additional formal school on school achievement. We also estimate in column 4 and 8 OLS specifications explaining the highest grade attended in formal school, and the number of years in Koranic school. Table 3 includes the specifications for each sample in a different line, namely : rural boys, urban boys, rural girls and urban girls.

Columns 1 to 4 in Table 3 basically check that formal school openings increase formal

17. In the Senegalese formal school system, 7th grade is the first grade of secondary school.

school achievement. This seems to be the case, and marginal effects are quite large. In rural areas, an additional primary school seems to increase the education levels of both boys and girls by approximately one year on average. For girls, it mostly increases the probability to start primary school (by nearly 15 percentage points). For boys, it shifts all the distribution of primary education, and increases the probability to reach the first grade of secondary school by approximately 15%. These effects are very large quantitatively. This probably means that formal school provision was very scarce in the villages surveyed in the 1990s. This is probably the reason why we have been unable to detect an effect of formal primary school openings on formal school attendance in urban areas : the provision of primary schools is probably less scarce in urban areas. Instead, we measure in Table 3 the effect of secondary school openings on formal school attendance.

Although the effect of a secondary school opening on formal school achievement is quantitatively smaller, it is still significant for boys in urban areas. We estimate that an additional secondary school increases formal school achievement by 0.4 grade approximately. Surprisingly, the marginal effect is larger for the access to 4th grade (7%) than for the access to the first grade of secondary school (7th grade, with 3%). This is not theoretically impossible : the possibility to enter secondary school may increase the option value of primary school enrollment in Senegal. In addition, there is an exam to enter secondary schools in Senegal, so that achieving primary school does not automatically gives access to secondary school. However, this is likely to signal an overly optimistic behavior of Senegalese households. For girls however, we were unable to show any effect of secondary school openings on formal school attendance in urban areas. The opening of a secondary school at age 12 only has a significant effect at the 10% level and only on the probability to reach 4th grade.

Columns 5 to 8 in Table 3 estimate the effect of formal school openings on Koranic school achievement. For boys, we find that formal school openings decrease Koranic school achievement. In rural areas, it decreases the probability to spend at least 4 years and at least 7 years in Koranic school. Therefore, it seems to decrease “long” Koranic school careers. The OLS specification estimates that the total effect of an additional primary school on the number of years spent in Koranic schools is -0.5, but this is not statistically significant.

For urban boys, the effect of formal school openings on Koranic school enrollment is also statistically significant. Formal school openings seem to decrease the probability to start Koranic school, and the probability to have a long Koranic school career. The effect of an additional formal school is quantitatively important (-0.4 years per additional school). It has to be compared with the effect of an additional formal school on formal school achievement

(+0.4 grade). This comparison is imperfect as grade repetition is very prevalent in Senegal (its annual rate is 15%), so that a child spends approximately 1.15 year per grade on average in formal school. However, it means that a large part of the additional time spent in formal school due to a formal school opening has been diverted from Koranic school in urban areas.

On the contrary, we do not find any significant effect of formal school openings on the Koranic school attendance of girls. In the OLS specifications in column 8, the size of the estimated effects are approximately 10 times smaller than for boys. This is normal in urban areas, where formal school openings do not really seem to affect girls' formal school attendance.

In rural areas, a formal school opening does not seem to affect Koranic education : it only seem to affect the probability of spending over 6 years in Koranic school. Given that it does not affect other levels of Koranic education (see Table A.3), this should not be taken into account.

6. Robustness checks

6.1. Community-specific time-trends

In this section, we present an alternative specification controlling for community-specific time-trends (or trends between cohorts). We found that an increase in the number of formal schools is correlated to changes in school enrollment choices. One could be worried that this is due to differences in economic development trends between communities that are not directly caused by school openings. For example, when there is economic growth somewhere, the state may open more schools in the area. In that case, the changes in school enrollment choices may be due to economic growth itself (e. g., an increase in the economic activity and hence new job opportunities which increase expected returns to education), and not only to the new schools itself. We adapt our main model to add a community-specific (linear) trend to both equations of model (6) :

$$\left\{ \begin{array}{l} \text{Formal School}_{cai} = f(\alpha Nb \text{ Schools}_{ca} + X_{cai}\beta + \lambda_c^f + \gamma_a^f - g_c^f \times a + \varepsilon_{cai}) \\ \text{Koranic School}_{cai} = f(\delta Nb \text{ Schools}_{ca} + X_{cai}\beta + \lambda_c^k + \gamma_a^k - g_c^k \times a + \varepsilon_{cai}) \end{array} \right. \quad (6)$$

In this model, g_c^f and g_c^k are community-specific linear trends between cohorts, respectively in formal and Koranic school attendance. However, the estimation of model (6) including all g_c^f and g_c^k , shows little power in the estimates of the effects of school openings on attendance. Instead, we identify a simplification given by :

$$\begin{cases} \text{Formal School}_{cai} = f(\alpha \text{Nb Schools}_{ca} + X_{cai}\beta + \lambda_c^f + \gamma_a^f + \kappa^f \overline{\text{Nb Schools}_c} \times a + \varepsilon_{cai}) \\ \text{Koranic School}_{cai} = f(\delta \text{Nb Schools}_{ca} + X_{cai}\beta + \lambda_c^k + \gamma_a^k + \kappa^k \overline{\text{Nb Schools}_c} \times a + \varepsilon_{cai}) \end{cases} \quad (7)$$

In model (7), $\overline{\text{Nb Schools}_c}$ reflects the “school opening rate” in the community, and is the average number of schools which opened in the community (over the estimation sample). We identify the coefficients κ^f and κ^k as corresponding to the part of the community-specific trend correlated to the average number of school openings in the community. The rest of the community-specific time trend (g_c^f and g_c^k in the model (6)) remains in the error term. The results of this estimation are given in Table A.4 in the Appendix. Overall, our estimates of the effect of school openings on school outcomes remain broadly unchanged. In addition, the coefficients for the correlation between the average number of school openings and the time trend in enrollment are rarely significant. In rural areas and for boys, the estimations that are significant show a negative correlation for the interaction between the average number of school openings and age. This would mean that in areas where a lot of schools open, older pupils have less formal AND Koranic education (controlling as much as we can for the specific effect of these school openings). First, this gives some (admittedly weak) support for the story where school tend to open in “booming” areas. Second, this does not seem to drive our main results, as we observe that school openings affect formal school and Koranic school enrollment decisions in opposite directions.

6.2. Definition of formal schools available for a child

This section discusses the definition of Nb Schools_{ca} , i.e., the number of formal schools in community c available for the children of cohort a (age a in 2003). This definition is not trivial, as the school entry age is variable in Senegal (in our data, it is approximately between 7 and 11 years old). Therefore, when a primary school opened when a child cai was 9, we do not know whether this school should be considered as relevant to her or not. The same applies for secondary schools : we don’t know which secondary schools are relevant to a given child. School entry age is variable, but in addition, grade repetitions increase further the variance of ages at the end of primary school¹⁸. On the top of that, primary school enrollment choices can depend on future educational possibilities, and in particular on the presence of a nearby secondary school.

18. The annual rate of grade repetition is about 15% in Senegal, see Ministry of Education, Senegal (2005)

In order to determine when a secondary school opening affects a given child, we estimate equation (8) :

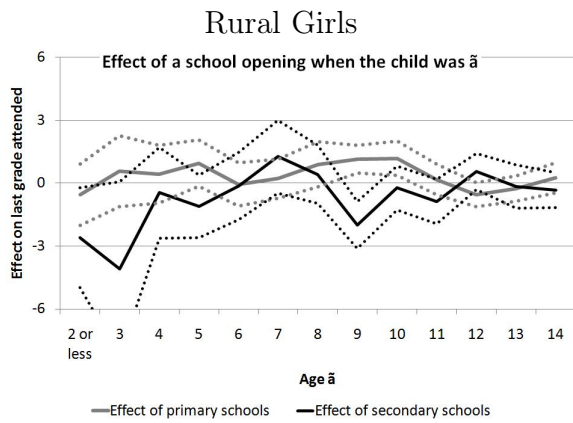
$$Formal\ School_{cai} = \alpha_{p\tilde{a}} Nb\ Primary\ Schools_{ca\tilde{a}} + \alpha_{s\tilde{a}} Nb\ Secondary\ Schools_{ca\tilde{a}} + X_{cai} \beta^f + \lambda_c^f + \gamma_a^f + \varepsilon_{cai}^f \quad (8)$$

This is a modification of model (1) which takes into account the fact that the effect of an additional school on formal school achievement can be different depending on its opening date (and includes both primary and secondary schools). In this specification, the dependent variable is the highest grade attended in formal school. $Nb\ Primary\ Schools_{ca\tilde{a}}$ (resp. $Nb\ Secondary\ Schools_{ca\tilde{a}}$) is the number of primary (resp. secondary) schools that opened when the children of cohort a (in community c) was \tilde{a} years old. In Figure 3, we plot the estimates of $\alpha_{p\tilde{a}}$ and $\alpha_{s\tilde{a}}$ in model (8) separately for urban boys, rural boys, rural girls and urban girls. In each graph of Figure 3 (Rural Girls, Urban Girls, Rural Boys, Urban Boys), we plot the coefficients $\alpha_{p\tilde{a}}$ and $\alpha_{s\tilde{a}}$ as a function of age \tilde{a} . Therefore, we plot the effect of an additional school opening when the child is of age \tilde{a} on formal school achievement as a function of \tilde{a} . This function is expected to be positive and decreasing. It should be positive because a formal school opening should have a positive effect (or null) on formal school achievement. It should be decreasing because when a child is too old when a school opens, she might have already left school or be already enrolled in an existing school, so that this new school opening has no effect on her.

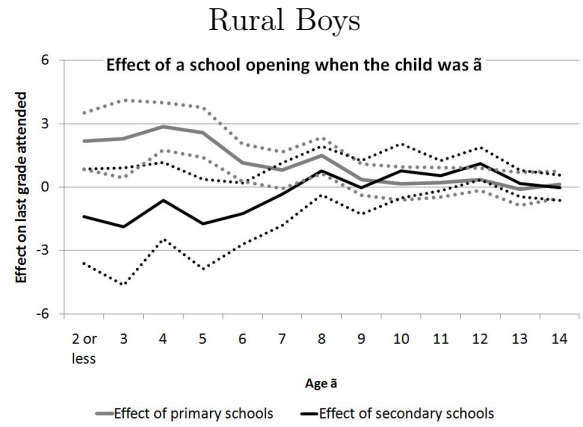
The curves in Figure 3 are easy to interpret for rural boys. Indeed, their school achievement increases if a primary school opens when they are 8 at most. The effect of a new primary school for a rural boy seems maximum when he was 5 at the school opening date, with nearly 3 additional grades of formal school per additional primary school. Hereafter, we arbitrarily choose that all primary schools opened at age 8 are relevant for rural boys. For the time being, $Nb\ Schools_{ca}$ is the number of primary schools at age 8. As a robustness check, we test other choices of $Nb\ Schools_{ca}$ at the end of this section and in Table A.5.

For urban boys, the effect of new schools on school attainment is lower. However, we observe that the effect of secondary schools that opened below age 12 is systematically positive, with approximately 0.5 to 1 additional grade for an additional secondary school. The point estimates are rarely significant in Figure 3 : they are only significant for secondary schools opening at age 10. We arbitrarily choose that all secondary schools opened at age 10 are relevant for both rural and urban boys for the time being. As a robustness check, we test other choices of $Nb\ Schools_{ca}$ at the end of this section and in Table A.5.

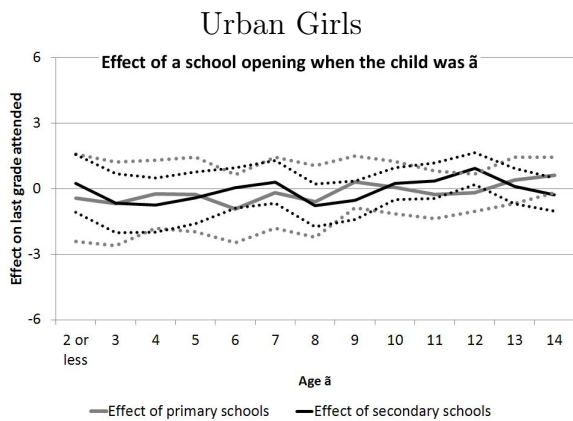
FIGURE 3: Effect of the opening of primary and secondary schools on highest grade attended by age



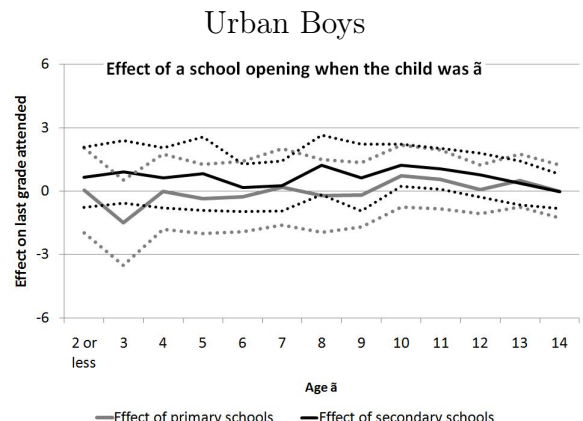
Note : 715 observations (Girls 15 to 21 y. o., Rural)



Note : 722 observations (Boys 15 to 21 y. o., Rural)



Note : 785 observations (Girls 15 to 21 y. o., Urban)



Note : 758 observations (Boys 15 to 21 y. o., Urban)

Notes for all graphs : The OLS coefficients of the effect of school openings on highest grade attended (see model (8)) is plotted against age. Robust confidence intervals at the 5% level clustered by community-cohort are given in dashed lines. Control variables : wealth, household head works in the formal sector, household head is a farmer, age, ethnic and community dummies.

For rural girls, Figure 3 is difficult to interpret. The effect of primary schools that opened below age 10 is often positive. Therefore, we choose that the number of primary schools opened at age 10 as our $Nb\ Schools_{ca}$ variable for rural girls. We test another choice of $Nb\ Schools_{ca}$ at the end of this section and in Table A.5.

For urban girls, we could not really interpret Figure 3. We choose that $Nb\ Schools_{ca}$ is the number of secondary schools opened at age 12, because this coefficient is the only significantly positive one.

The second specification check is based on our choices of variable $Nb\ Schools_{ca}$ definitions. Based on Figure 3, we made arbitrary choices on the proxies for the number of schools we use in the rest of the paper. This specification check tests robustness of the results with other variables that could have been chosen instead based on Figure 3. Table A.5 in appendix tests the specifications of Table 3 with different definitions of explanatory variables.

For rural boys, we test two alternative specifications. In the first one, the variable “number of schools” is the number of primary school at age 4, which is the maximum of the curve for rural boys in Figure 3. In the other one, the variable for the number of schools is the average of the number of primary schools between age 4 and age 8. To clarify this variable, let us illustrate it in a community with a single primary school. For children aged less than 4 when the primary school opened, this variable takes value 1. For children aged 5 when the school opened, this variable takes value 0.8 (the school was opened 80% of the time between 4 and 8); it takes value 0.6 for children aged 6 when the school opened, and so on. Therefore, it assumes that the effect of the opening of a formal school is maximal for children aged 4 or less when the school opens; that this effect decreases linearly with age at school opening, and vanishes for children aged 9 or more when the school opened. Overall, these specifications confirm the positive effect of new primary schools on formal education. In addition, in both cases, new primary schools seem to decrease Koranic education, although this is less significant.

For urban boys, we also test two alternative specifications. In the first one, our “number of schools” variable is the number of secondary schools at age 13. In the other one, we use the average number of secondary schools between age 10 and age 13. In both specifications, the effect of new formal schools on formal education is positive and significant, and the effect of new formal schools on the probability to spend 4 years in Koranic school is negative and significant.

We test another alternative specification for rural girls, replacing the number of primary schools at age 10 by the number of primary schools at age 11. The results are very similar to previous ones.

7. Conclusion

We use a unique Senegalese national household survey with information on formal and Koranic schooling to analyze the link between the two education systems. We first focus on the determinants of Koranic schooling and find that ethnic group variables are a strong determinant of both initial enrollment and length of Koranic education. This is consistent with the idea that Koranic schooling decisions are embedded in a cultural context.

The main contribution of this paper is the estimation of the substitution between Koranic education and formal education. Our empirical strategy is to estimate the response to the openings of formal schools. We find that formal school openings increase the highest grade attended in formal schools, and decrease the number of years in Koranic school. Therefore, both education systems seem to compete for the children's time : formal and Koranic educations are substitutes for boys, despite the fact that their curricula have virtually no intersection.

The existence of a substitute to formal education in Senegal can make it more difficult for this country to achieve universal primary education for at least two reasons. First, it can decrease the demand for formal education, as it increases the opportunity costs of formal education. However, these opportunity costs might become negligible when the quality of the formal school improves. Indeed, reaching universal primary education would probably require a vast improvement of the Senegalese formal school system anyways. Second, the political clout of Muslim brotherhoods in Senegal might lead politicians to defend religious education over the formal one.

These last two remarks question the desirability of formal school for the most conservative parts of the Senegalese society. Whether some aspects of the curricula of formal schools (e.g. teaching language inherited from the colonization, orientation towards the formal sector and the absence of religious teaching) make them less desirable for them remains an open question.

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Appendices

Variable definitions

Has ever attended formal school. takes value 1 if the child has ever been enrolled in a formal school and 0 otherwise.

Last grade attended. is self-declared.

Has ever attended Koranic school. takes value 1 if the child has ever been enrolled in A Koranic school and 0 otherwise.

Number of years in Koranic school. is self-declared.

Age. is self-declared and probably approximative. For example, there are more individuals aged 20 than 19 and 21 in the sample.

Rural. takes value 1 if the community is rural and 0 if it is urban.

Wealth (Possession of durable goods). is a composite indicator for possession of durable goods, obtained by a principal component analysis.

Father's education. takes value 1 if the father never went to school, 2 if he began but did not finish primary school, 3 if he finished primary school but did not began secondary school, etc.

Mother's education. takes value 1 if the mother never went to school, 2 if she began but did not finish primary school, 3 if she finished primary school but did not began secondary school, etc.

The household head works in the formal sector. takes value 1 if the household head declares working in the formal sector, 0 otherwise.

The household head is farmer. takes value 1 if the household head declares working in any agricultural activity, 0 otherwise.

Ethnic groups. are self declared. Fulbe and Halpulaar are grouped together in the Pulaar group.

Number of primary schools opened at age a . is the number of primary schools cited in the community questionnaire opened before child i reaches age a .

TABLE A.1: Descriptive statistics for the variables of this paper

Variable	Mean	Std. Dev.	Min.	Max.	N
Has ever attended formal school	0.754	0.431	0	1	3129
Last grade attended	5.072	3.671	0	13	3105
Has ever attended Koranic school	0.572	0.495	0	1	2985
Number of years in Koranic school	1.998	2.53	0	16	2975
Age	17.691	1.952	15	21	3129
Wealth (Possession of durable goods)	0.151	0.966	-1.479	2.82	3123
Rural	0.478	0.5	0	1	3129
Father's education	2.257	1.973	1	8	3065
Mother's education	1.583	1.232	1	8	3060
The household head works in the formal sector	0.297	0.457	0	1	3129
The household head is farmer	0.298	0.457	0	1	3129
Ethnic group : Wolof	0.364	0.481	0	1	3129
Ethnic group : Pulaar	0.218	0.413	0	1	3129
Ethnic group : Serere	0.174	0.379	0	1	3129
Ethnic group : Dioula	0.058	0.235	0	1	3129
Ethnic group : Mandingue	0.135	0.342	0	1	3129
Ethnic group : Soninke	0.015	0.12	0	1	3129
Number of primary schools opened at age 8	3.142	2.49	0	12	3129
Number of secondary schools opened at age 10	2.572	2.992	0	11	3129
Number of primary schools opened at age 10	3.335	2.53	1	12	3129
Number of secondary schools opened at age 12	2.768	3.14	0	12	3129
Number of boys in the community-cohort	3.768	2.322	0	13	413
Number of girls in the community-cohort	3.809	2.251	0	12	413

Notes : All children aged 15-21 are in the sample, unless specified. This is the sample for the main results (including Table 3)

Number of boys in the community-cohort. is the number of boys born in community c and of age a in 2003.

Number of girls in the community-cohort. is the number of girls born in community c and of age a in 2003.

TABLE A.2: Partial correlation between our IVs and the observable variables

	Rural Boys Number of primary schools at age 8	Urban Boys Number of secondary schools at age 10	Rural Girls Number of primary schools at age 10	Urban Girls Number of secondary schools at age 12	
Asset index	-.01 (.02)	.006 (.036)	.009 (.026)	.008 (.033)	
Father's education	.006 (.006)	-.002 (.01)	.002 (.01)	.001 (.007)	
Mother's education	-.027 (.016)*	-.028 (.018)	.013 (.018)	-.013 (.011)	
Ethnic groups (ref : Wolof)	Peul	-.048 (.027)*	.087 (.058)	-.061 (.038)	
	Serere	-.006 (.028)	-.032 (.044)	-.056 (.03)*	
	Dioula	-.003 (.036)	.106 (.114)	.033 (.054)	-.066 (.156)
	Mandingue	.021 (.032)	.096 (.13)	-.039 (.048)	.007 (.083)
	Others	-.018 (.036)	-.089 (.07)	.018 (.059)	-.084 (.065)
Head is farmer	-.041 (.021)*	.012 (.1)	-.005 (.027)	.04 (.112)	
Head works in the formal sector	-.004 (.037)	-.011 (.044)	-.095 (.061)	-.01 (.029)	
Cohort dummies	Yes	Yes	Yes	Yes	
Community dummies	Yes	Yes	Yes	Yes	
N	730	760	718	792	
Joint significance of the coefficients shown here	F-statistic	1.028	1.198	.454	
	p-value	.421	.4	.294	

Notes : OLS estimations. Dependent variables : see column headings. Cohort and communities dummies included in all regressions. Robust standard errors clustered by community-cohort in parentheses. * significant at 10%; ** at 5%; *** at 1%.

TABLE A.3: Regressions with all education levels
Enrolled at least until :

	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Year 9	Last Year
	(Probit)	(Probit)	(Probit)	(Probit)	(Probit)	(Probit)	(Probit)	(Probit)	(Probit)	(OLS)
Rural boys	Number of primary schools at age 8	.123 (.047)***	.16 (.053)***	.205 (.048)***	.152 (.051)***	.088 (.068)	.155 (.082)*	.162 (.092)*	.061 (.069)	1.165 (.344)***
	Control variables and dummies	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
	N	662	654	668	720	720	666	645	598	720
	log-likelihood or R ²	-306.201	-309.775	-314.393	-362.228	-387.132	-419.558	-337.982	-296.499	-226.123
Rural boys	Number of primary schools at age 8	-.06 (.072)	-.091 (.074)	-.108 (.065)*	-.186 (.063)***	-.146 (.064)**	-.196 (.098)**	-.129 (.095)	-.129 (.098)**	-.548 (.358)
	Control variables and dummies	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
	N	681	681	695	695	654	544	526	709	709
	log-likelihood or R ²	-385.856	-385.726	-375.747	-320.872	-273.269	-195.408	-144.506		
Urban boys	Number of secondary schools at age 10	.062 (.033)*	.064 (.034)*	.062 (.029)**	.071 (.023)***	.075 (.035)**	.03 (.037)	.031 (.034)	-.001 (.033)	.372 (.214)*
	Control variables and dummies	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
	N	655	679	704	704	755	755	755	755	755
	log-likelihood or R ²	-179.252	-192.353	-218.717	-254.768	-327.309	-386.432	-415.173	-415.336	-353.497
Urban boys	Number of secondary schools at age 10	-.047 (.023)**	-.079 (.032)**	-.079 (.019)***	-.031 (.045)	-.012 (.039)	-.042 (.045)	-.068 (.056)	-.012 (.045)	-.385 (.215)*
	Control variables and dummies	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
	N	701	701	701	667	648	556	456	701	701
	log-likelihood or R ²	-392.495	-408.991	-406.303	-352.098	-295.72	-222.234	-154.243		
Rural Girls	Number of primary schools at age 10	.139 (.048)***	.142 (.049)***	.048 (.042)	.069 (.042)	.07 (.044)	.106 (.046)**	.067 (.04)*	.077 (.048)*	.905 (.295)***
	Control variables and dummies	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
	N	684	681	710	710	710	710	541	433	712
	log-likelihood or R ²	-324.465	-324.208	-335.828	-337.422	-341.883	-330.29	-181.435	-124.638	-63.072
Rural Girls	Number of primary schools at age 10	.041 (.046)	.048 (.047)	.025 (.047)	-.041 (.049)	-.011 (.052)	-.073 (.036)**	-.04 (.034)	-.04 (.036)**	.039 (.241)
	Control variables and dummies	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
	N	689	677	572	487	442	404	276	691	691
	log-likelihood or R ²	-352.14	-347.469	-285.925	-209.552	-160.551	-94.484	-57.348		
Urban Girls	Number of secondary schools at age 12	.027 (.02)	.037 (.021)*	.032 (.019)*	.042 (.023)*	.072 (.023)***	.066 (.026)**	-.036 (.03)	-.052 (.035)	.131 (.225)
	Control variables and dummies	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
	N	712	705	754	772	772	772	772	772	772
	log-likelihood or R ²	-249.811	-259.816	-299.094	-340.547	-378.111	-415.632	-405.54	-387.372	-337.982
Urban Girls	Number of secondary schools at age 12	.002 (.032)	-.0001 (.035)	-.021 (.028)	.006 (.026)	.022 (.022)	-.023 (.027)	.008 (.024)	-.008 (.024)	.046 (.178)
	Control variables and dummies	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
	N	730	730	730	687	592	401	401	730	730
	log-likelihood or R ²	-433.217	-432.987	-365.211	-275.449	-193.161	-112.108	-97.358		

Notes : Probit models (average marginal effects reported) and OLS. Dependent variables : see each column heading. Robust standard errors clustered by community-cohort in parentheses. * significant at 10%; ** at 5%; *** at 1%. Control variables included in all regressions : wealth, household head works in the formal sector, household head is farmer, ethnic, cohort and community dummies.

TABLE A.4: Control for a correlation between the school opening rate in the community and community-specific trends in education

	Formal school				Koranic school				Nb. of years (OLS)						
	Grade 1 (Probit)	Enrolled at least until : Grade 4 (Probit)	Grade 7 (Probit)	Last Grade (OLS)	1 Year (Probit)	Enrolled for at least : 4 Years (Probit)	6 Years (Probit)	(15)							
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(16)
Number of primary schools at age 8	.123 (.047)***	.076 (.049)	.152 (.051)***	.12 (.053)**	.155 (.082)*	.136 (.083)*	1.165 (.344)***	.95 (.36)***	-.06 (.072)	-.117 (.074)	-.186 (.063)***	-.207 (.064)***	-.196 (.098)**	-.212 (.101)**	-.548 (.358)
Community mean of (Number of primary schools at age 8) * age		-.016 (.01)*		-.012 (.009)		-.011 (.01)	-.092 (.062)			-.029 (.01)***		-.013 (.011)		-.009 (.011)	-.1 (.059)*
Control variables	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Cohort and community dummies	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
N	662	662	720	720	666	666	720	720	681	681	695	695	544	544	709
log-likelihood or R^2	-306.201	-305.06	-362.228	-361.523	-337.982	-337.411	.276	.278	-385.856	-382.445	-320.872	-320.133	-195.408	-194.978	.254
Number of secondary schools at age 10	.062 (.033)*	.058 (.034)*	.071 (.023)***	.069 (.023)***	.031 (.034)	.035 (.034)	.372 (.214)*	.349 (.209)*	-.047 (.023)**	-.05 (.024)**	-.031 (.045)	-.041 (.044)	-.042 (.045)	-.048 (.047)	-.385 (.215)*
Community mean of (Number of secondary schools at age 10) * age		-.0009 (.002)		-.0005 (.002)		.001 (.003)	-.007 (.018)			-.001 (.003)		-.002 (.003)		-.001 (.003)	-.013 (.014)
Control variables	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Cohort and community dummies	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
N	655	655	704	704	755	755	755	755	701	701	667	667	556	556	701
log-likelihood or R^2	-179.252	-179.158	-254.768	-254.749	-415.173	-415.12	.28	.28	-392.495	-392.446	-352.098	-351.796	-222.234	-222.178	.199
Number of primary schools at age 10	.139 (.048)***	.116 (.051)**	.069 (.042)	.085 (.053)	.067 (.04)*	.058 (.05)	.905 (.295)***	.766 (.367)**	.041 (.046)	.008 (.064)	-.041 (.049)	-.062 (.052)	-.073 (.036)**	-.093 (.045)**	.039 (.241)
Community mean of (Number of primary schools at age 10) * age		-.007 (.009)		.004 (.009)		-.003 (.007)	-.038 (.062)			-.01 (.01)		-.006 (.01)		-.005 (.006)	-.016 (.046)
Control variables	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Cohort and community dummies	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
N	684	684	710	710	541	541	712	712	689	689	487	487	404	404	691
log-likelihood or R^2	-324.465	-324.218	-337.422	-337.313	-181.435	-181.375	.414	.414	-352.14	-351.694	-209.552	-209.426	-94.484	-94.289	.247
Number of secondary schools at age 12	.027 (.02)	.031 (.022)	.042 (.023)*	.037 (.025)	-.036 (.03)	-.055 (.033)*	.131 (.225)	.124 (.255)	.002 (.032)	-.003 (.035)	.006 (.026)	.014 (.031)	.023 (.027)	-.004 (.044)	.046 (.178)
Community mean of (Number of secondary schools at age 12) * age		.0009 (.002)		-.001 (.002)		-.004 (.003)	-.001 (.019)			-.0009 (.003)		.001 (.002)		-.006 (.006)	-.017 (.013)
Control variables	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Cohort and community dummies	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
N	712	712	772	772	772	772	772	772	730	730	687	687	401	401	730
log-likelihood or R^2	-249.811	-249.702	-340.547	-340.448	-405.54	-404.735	.296	.296	-433.217	-433.168	-275.449	-275.33	-112.108	-110.946	.19

Notes : Probit models (average marginal effects reported) and OLS. Dependent variables : see each column heading. Robust standard errors clustered by community-cohort in parentheses. * significant at 10%; ** at 5%; *** at 1%. Control variables included in all regressions : wealth, household head works in the formal sector, household head is farmer, ethnic, cohort and community dummies.

TABLE A.5: Robustness check : regressions with other instruments

	Formal school				Koranic school			Nb. of years (OLS)	
	Enrolled at least until : Grade 1 (Probit)	Grade 4 (Probit)	Grade 7 (Probit)	Last Grade (OLS)	Enrolled for at least : 1 Year (Probit)	4 Years (Probit)	6 Years (Probit)		
Rural boys	Number of primary schools at age 8	.123 (.047)***	.152 (.051)***	.155 (.082)*	1.165 (.344)***	-.06 (.072)	-.108 (.065)*	-.196 (.098)**	-.548 (.358)
	Control variables	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
	Cohort and community dummies	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
	N	662	720	666	720	681	695	544	709
	log-likelihood or R^2	-306.201	-362.228	-337.982	.276	-385.856	-375.747	-195.408	.254
	Number of primary schools at age 4	.096 (.047)**	.059 (.046)	.135 (.065)**	.837 (.318)***	.089 (.061)	.031 (.067)	-.171 (.095)*	-.178 (.363)
	Control variables	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
	Cohort and community dummies	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
	N	662	720	666	720	681	695	544	709
	log-likelihood or R^2	-307.334	-364.765	-338.468	.273	-385.5	-376.75	-196.67	.251
Urban boys	Average of the number of primary schools between age 4 and age 8	.131 (.062)**	.103 (.073)	.255 (.119)**	1.449 (.57)**	.03 (.084)	-.025 (.083)	-.37 (.166)**	-.344 (.389)
	Control variables	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
	Cohort and community dummies	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
	N	662	720	666	720	681	695	544	709
	log-likelihood or R^2	-307.003	-364.412	-336.911	.275	-386.16	-376.805	-194.789	.252
	Number of secondary schools at age 10	.062 (.033)*	.071 (.023)***	.031 (.034)	.372 (.214)*	-.047 (.023)**	-.079 (.019)***	-.042 (.045)	-.385 (.215)*
	Control variables	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
	Cohort and community dummies	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
	N	655	704	755	755	701	701	556	701
	log-likelihood or R^2	-179.252	-254.768	-415.173	.28	-392.495	-406.303	-222.234	.199
Rural girls	Number of secondary schools at age 13	.037 (.02)*	.072 (.017)***	.052 (.026)**	.487 (.195)**	-.003 (.022)	-.044 (.02)**	-.047 (.029)	-.255 (.181)
	Control variables	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
	Cohort and community dummies	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
	N	655	704	755	755	701	701	556	701
	log-likelihood or R^2	-179.912	-252.594	-413.921	.283	-393.385	-407.182	-221.437	.198
	Average of the number of secondary schools between age 10 and age 13	.057 (.03)*	.087 (.025)***	.051 (.035)	.541 (.234)**	-.017 (.027)	-.076 (.025)***	-.054 (.051)	-.333 (.28)
	Control variables	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
	Cohort and community dummies	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
	N	655	704	755	755	701	701	556	701
	log-likelihood or R^2	-179.581	-253.83	-414.681	.282	-393.292	-406.539	-221.781	.198
Rural girls	Number of primary schools at age 10	.139 (.048)***	.069 (.042)	.067 (.04)*	.905 (.295)***	.041 (.046)	.025 (.047)	-.073 (.036)**	.039 (.241)
	Control variables	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
	Cohort and community dummies	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
	N	684	710	541	712	689	572	404	691
	log-likelihood or R^2	-324.465	-337.422	-181.435	.414	-352.14	-285.925	-94.484	.247
	Number of primary schools at age 11	.085 (.046)*	.039 (.036)	.068 (.036)*	.662 (.262)**	.003 (.037)	-.01 (.038)	-.073 (.029)**	-.113 (.205)
	Control variables	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
	Cohort and community dummies	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
	N	684	710	541	712	689	572	404	691
	log-likelihood or R^2	-325.816	-337.99	-181.019	.412	-352.421	-286.012	-93.853	.248

Notes : Probit models (average marginal effects reported) and OLS. Dependent variables : see each column heading. Robust standard errors clustered by community-cohort in parentheses. * significant at 10%; ** at 5%; *** at 1%. Control variables included in all regressions : wealth, household head works in the formal sector, household head is farmer, ethnic, cohort and community dummies.