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Abstract

Primary school enrolment rates are very low in francophone Africa. In order to enhance education supply, many countries have launched large teacher recruitment programmes in recent years, whereby teachers are no longer engaged on civil servant positions, but on the basis of (fixed-term) contracts typically implying considerably lower salaries and a sharply reduced duration of professional training. While this policy has led to a boost of primary enrolment, there is a concern about a loss in the quality of education.

In this paper we analyse the impact on educational quality, by estimating nonparametrically the quantile treatment effects for Niger, Togo and Mali, based on very informative data, comparable across these countries. We find that contract teachers do relatively better for low ability children in low grades than for high ability children in higher grades. When positive treatment effects were found, they tended to be more positive at the low to medium quantiles; when negative effects were found they tended to be more pronounced at the high ability quantiles. Hence, overall it seems that contract teachers do a relatively better job for teaching students with learning difficulties than for teaching the 'more advanced' children. This implies that contract teachers tend to reduce inequalities in student outcomes. At the same time, we also observe clear differences between the countries. We find that, overall, effects are positive in Mali, somewhat mixed in Togo (with positive effects in 2nd and negative effects in 5th grade) and negative in Niger. This ordering is consistent with theoretical expectations derived from a closer examination of the different ways of implementation of the contract teacher programme in the three countries. In Mali and, to some extent, in Togo, the contract teacher system works more through the local communities. This may have led to closer monitoring and more effective hiring of contract teachers. In Niger, the system was changed in a centralized way with all contract teachers being public employees, so that there is no reason to expect much impact on local monitoring. In addition, the extremely fast hiring of huge numbers of contract teachers may also have contributed to relatively poor performance in Niger. These results are expected to be relevant for other sub-Saharan African countries, too, as well as for the design of new contract teacher programmes in the future.

JEL Classification

O15, I 21, C14

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1. Introduction

With a rapidly increasing youth population and swift increases in the proportion of children attending school, many developing countries are facing serious difficulties in recruiting and financing qualified teachers. Therefore many African countries have been experimenting with alternative teacher training and recruitment programmes employing so-called "*contract teachers"* instead of traditional civil servants. These new teachers are usually hired on fixed-term contracts with shorter training and lower remuneration. Similarly, contract teachers have also been employed in Latin America and South Asia (for an overview, see Duthilleul 2005). Despite the widespread introduction of contract teacher programmes in many countries from the mid-1990s onwards, there does not seem to exist a detailed microeconometric evaluation of the effects of this policy change.

In this paper, we analyse the effect of the reform process on student achievement in the three francophone sub-Saharan African countries Mali, Niger and Togo. While these countries show many social, economic and cultural similarities and introduced the contract teacher programmes to cope with similar problems, the way these programmes were implemented and the characteristics of the actual contracts used vary considerably.

The differences in the results of earlier studies for individual African countries (PASEC 2003, 2004, 2005a, 2005b, Vegas and de Laat 2003, Bourdon, Frölich and Michaelowa 2006) suggest that these specific characteristics may determine the success or failure of these programmes. This calls for a direct country-comparison using comparable data and a uniform estimation approach. It is the objective of this paper to provide this comparison. In addition, this paper attempts to improve upon the estimation techniques used in earlier studies by estimating quantile treatment effects. Apart from the general advantage of nonparametric estimations to avoid functional form assumptions, this has the additional benefit of providing us with detailed information on the effect of contract teachers on different segments of the student population.

This paper is related to two distinct strands of the literature. The first concerns questions of teacher incentives and working conditions. While studies on the effects of physical inputs have not yet reached fully conclusive results (see e.g. Hanushek 2003 versus Krueger 2003), there is growing recognition that these effects are, at best, rather limited. Therefore, for industrialised and developing countries alike, scholars have turned increasingly to the analysis of incentives and institutional conditions of teaching and learning. The discussion covers performance pay (see e.g. Lavy 2002, 2004 for Israel; Kingdon and Teal 2007, and Muralidharan and Sundararaman 2006 for India; Glewwe, Ilias and Kremer 2003 for Kenya; Spretsma and Waldenberg 2007 for Brazil), standardised exams (Bishop and Wößmann 2004), private

education and school choice (King, Orazem and Wohlgemuth 1999, Angrist et al. 2002 and Angrist, Bettinger and Kremer 2004 for Colombia; and Hoxby 2000, 2003a, 2003b mainly for the United States) , teacher monitoring (Banerjee and Duflo 2006, Duflo and Hanna 2005, and Kremer et al. 2005 for India), and monitoring by local communities (Reinikka and Svensson 2004 for Uganda, Francken Minten and Swinnen 2005 for Madagascar). In addition, the impact of teacher quality and its relation to academic and professional qualifications has received increased attention (Rivkin, Hanushek and Kain 2005; Hanushek et al. 2005; Clotfelter, Ladd and Vigdor 2006; Aaronson, Barrow and Sander 2003; Angrist and Guryan 2004; Rockoff 2004, for the United States), just as specific teaching innovations (see e.g. Machin and McNally 2004 for the "Literature hour" in the United Kingdom). For a review of some of this literature with a focus on developing countries, see Glewwe and Kremer (2006) or Wößmann (2005).

The second strand of the literature is specific to developing countries in their efforts to reach the objective of providing at least basic education to all. This objective has been codified not only in the Education for All (EFA) objectives in 1990 and in 2000, but also in the Millennium Development Goals. The countries facing the greatest problems in meeting the challenge are primarily located in sub-Saharan Africa. According to recent estimates, granting access to school for all primary-aged children in this region will require an expansion of the teaching force by 68% over the next decade (UNESCO-UIS 2006). This challenge is even greater in the francophone countries of the Sahel region (Mingat and Suchaut 2000). According to Bruns et al. (2002, Tables 1.1 and 2.4) so far, only 45% of African children complete primary school, and all francophone sub-Saharan African countries except Gabon and Togo show figures that lie below or around this regional average. Out of seven countries with primary completion rates at 25% or below, six are francophone. With primary completion rates below 20% and an overall net primary enrolment rate of only 31%, Niger held the sad record of the worst performer worldwide at the end of the 1990s (UNESCO-UIS 2005, PASEC 2005a). With primary completion rates of below 15%, Mali was in an even worse position until the mid 1990s, but has improved considerably thereafter (World Bank 2006a).

Collecting evidence for the specific characteristics of the education systems in those countries which reached the EFA objectives, MINEDAF (2002) suggests that primary teacher salaries should not be greater than 3.5 times GDP per capita. Towards the end of the 1990s, in many francophone African countries, including Mali, Niger and Togo, teacher salaries were clearly beyond this benchmark. In the Sahel countries Mali and Niger, primary teacher salaries even amounted to more than 6 times GDP per capita (MINEDAF 2002, p. 117). The most extreme case was Niger, with a ratio as high as about 10 times GDP per capita (UNESCO-UIS 2006,

p. 87). This figure was more than ten times higher than the corresponding figure for India (World Bank 2006b in combination with Duthilleul 2005, p. 25) and about six times higher than in OECD countries (OECD 2002, Table D6.1).

At such high salaries in relation to national income, it was obviously impossible to hire the necessary number of teachers to meet the rising demand for education exacerbated by high population growth. To a somewhat lesser extent, the same applies for Mali and Togo as well as for a large number of other predominantly francophone African countries. From the mid-1990s onwards, for most countries, engaging contract teachers at considerably lower salaries than traditional civil servants appeared to be the sole solution for staffing their schools (Ndoye 2001, Mingat 2004). Even earlier, parents had often resorted to private initiatives, opening their own schools with privately engaged teachers, on contracts at considerably lower rates than those foreseen in the public sector.

However, stakeholders in the education system generally fear that an important loss in education quality may go hand in hand with this new employment strategy. These fears have to be taken seriously, especially as the seminal work by Rivkin, Hanushek and Kain (2005) identifies teachers and teaching quality as the key determinant of education quality.

This paper will analyse to what extent these fears are justified, and provide some evidence on which forms of contracts (or which types of programme implementation) exacerbate or mitigate potential problems. The paper is structured as follows: Based on information compiled by Bernard, Tiyab and Vianou (2004), as well as Duthilleul (2005), Section 2 first demonstrates the quantitative relevance of contract teacher programmes and their development over time for Mali, Niger and Togo, as well as for other countries of the region. This section also discusses the differences of contract conditions across countries. Section 3 provides an overview of the data available for the analysis of the contract teachers' impact on student achievement in the three comparison countries. Section 4 explains the estimation approach and Section 5 presents the results. Section 6 provides some conclusions and recommendations for education policy.

2. Teacher incentives, teacher contracts and working conditions

In most countries, teachers are employed as civil servants, except for short-term replacements, probation periods, or until they have reached the required qualification level (Duthilleul 2005). In recent years, however, the focus on increased access to education, along with high population growth rates and tight budget constraints, led to the broad-based introduction of *contract teacher* schemes, whereby teachers were hired on contracts rather than on civil-servant positions, usually combined with lower salaries and also lower professional pre-service training requirements. This

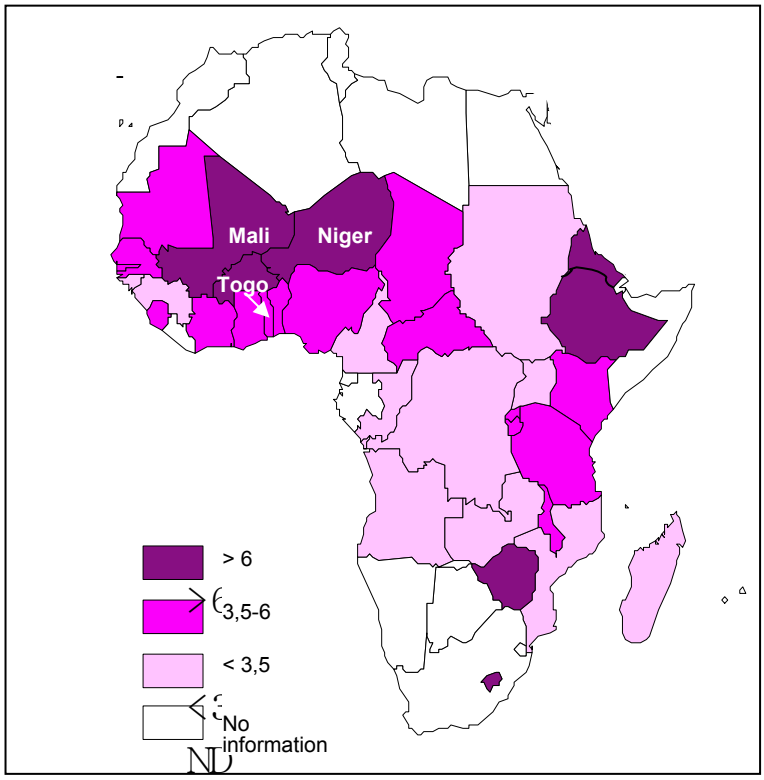
permitted a large increase in the number of teachers (see e.g. Ndoye 2001). While most countries in South Asia and Latin America started rather early and gradually introduced these changes without ever striving for a complete renewal of their teaching staff (see e.g. Govinda and Josephine 2004 for India, and Castro 2004 for Nicaragua), public policy reform in Africa was typically introduced later, i.e. towards the mid- or even late 1990s, but rather fast. In the early years of the new century, the period our empirical analysis will refer to, contract teachers already made up a sizeable share of the total teaching population (for current shares of contract teachers, see Table 1).

In Niger, no more civil servants were engaged in the teaching profession at primary level after the contract teacher programme had been put in place in 1998. In addition, as for many years funding had been insufficient to train and recruit teachers according to earlier rules and regulations, huge gaps had to be closed by the newly engaged contract teachers. After 1998, almost 2800 new teachers were recruited every year, as compared to an average of 520 per year between 1990 and 1998 (PASEC 2005a). Therefore in the year 2000, contract teachers already made up the majority of the primary teacher population (Bernard, Tiyab and Vianou 2004, p. 5). Thereafter this proportion has remained about constant (see left hand side of Table 1). In fact it seems that the long-term maintenance of teacher salaries far above market rates had effectively paved the way for a radical change in teacher employment policies once the traditional system finally collapsed. See Figure 1 for an overview of teacher salaries in sub-Saharan Africa at the end of 1990s, i.e. at the time when average teacher salaries (relative to GDP per capita) were at their peak. The unsustainable level of salaries thus triggered the contract teacher reform and led to salaries of the new contract teachers accounting for only one third of those in the civil service (see right hand side of Table 1). Nevertheless, budgetary problems in Niger have remained so serious that the regular payment of even the reduced salaries is not always guaranteed (see Table 2).

In Mali and Togo, the change was somewhat more moderate than in Niger and also started earlier. In both countries, it was initially driven by local communities who resulted in engaging their own (private) contract teachers when the state failed to provide them with the required staff. In Mali, the government also recruited the first contract teachers as early as in 1991, but numbers became significant only towards the end of the decade. After 1998, public contract teachers and traditional civil servants were typically recruited in about equal proportions (PASEC 2005b). Overall, contract teachers made up about 30% of the teaching staff in primary schools in 2000 (Bernard et al. 2004). As the recruitment of contract teachers by local communities accelerated even further thereafter, data for 2004 show that almost 65% of primary education teachers are

now working on contracts (see Table 1). It should also be noted that, while the policy shift towards the employment of contract teachers was certainly less abrupt than in Niger, the difference in salaries was even greater. A contract teacher in Niger still earns 3.5 times the national GDP per capita, i.e. about 35% of the average salary of traditional teachers. In Mali, the initial rates for contract teachers were only around 25% for public contract teachers and 15% for community teachers. In the year 2000, this corresponded to 1.5 times and 0.9 times GDP per capita respectively (Bernard, Tiyab and Vianou 2004). Only more recently, public teacher salaries, especially for contract teachers, were increased to reduce the gap. However, the pay for community teachers has remained unchanged (see Table 1).

Figure 1: Average salary of primary teachers relative to GDP per capita, 2000



Source: World Bank (quoted from MINEDAF 2002, p. 31).

In Togo, the public recognition and recruitment of contract teachers started in the mid 1990s, when the Local Initiative Schools (EDIL) were formally recognised. The government then also started to finance some of the EDIL teachers from the central budget. In 1999, 16% of EDIL teachers were paid by the Togolese government (World Bank 2002, p. 27). In parallel, the government started recruiting public contract teachers for other schools. This policy was adopted in response to the problem that there were not enough financial resources and training capacity to

expect all new teachers to fulfil the official requirements of a one-year professional training course in order to enter the teaching profession as a civil servant. In fact, such pre-service training was offered only in three years (1985, 1996 and 1997) within the whole period since 1983 (PASEC 2004). As shown in Table 1, in 2001, this led to an overall proportion of contract teachers of 65% about half of which were engaged by the state, and half by local communities. Their remuneration corresponded to about 50% and 20% of traditional teacher salaries respectively.

Table 1: Distribution and remuneration of primary teachers according to their statute

Country	Breakdown by statutes (%)			Wages relative to GDP per capita				
	Civil servants	Contract teachers		Civil servants			Contract teachers	
		public[1]	private[2]	Total	Full	Assistants[3]	public[1]	private[2]
Benin (2005)	54,7	16,4	29,0	5,2	5,7	3,9	2,1	1,1
Burkina Faso (2002)	64,1	23,6	12,2	5,8	7,1	5,1	5,6	2,2
Cameroon (2002)	34,9	20,4	44,7	5,3	5,7	4,1	1,4	0,8
Chad (2003)	38,4	17,2	44,4	7,4	8,2	6,0	1,7	0,4
Congo, Rep. of (2005)[4]	55,0	14,0	31,0	2,8	2,9	2,62	1,3	na
Guinea (2003)	30,9	38,9	30,1	3,4	3,5	2,7	1,9	1,2
Ivory Coast (2001)	87,3	0,0	12,7	4,8	5,0	3,0	-	-
Madagascar (2003)	46,1	0,0	53,9	4,4	-	-	-	1,0
Mali (2004)	35,7	34,7	29,6	7,5	-	-	4,8	1,0
Niger (2003)	46,0	50,2	3,8	8,9	10,5	8,0	3,5	-
Senegal (2003)	43,6	41,5	15,0	5,7	6,2	4,9	2,6	na
Togo (2001)	35,0	30,5	34,6	6,4	7,8	5,4	3,3	1,3
Average (12 countries)	47,6	24,0	28,4	5,6	6,2	4,5	2,8	

[1] *Public*: under contract with public authorities

[2] *Private*: engaged by and/or under contract with parents or local communities. This does not always correspond to the local terminology. In Togo, for instance, community teachers tend to be classified as "public" while the term "private" refers exclusively to expensive and well equipped schools run by other external providers such as the church.

[3] *Assistants* are public employees engaged as a support of full teachers.

[4] In Congo, salaries are calculated relative to GDP in 2003 in order to avoid the artificial effect of the change in petroleum prices in 2005.

Source : World Bank (Africa Region) and Pôle de Dakar (2007, p. 66), slightly updated by the authors.

Table 1 displays the above described characteristics of Mali, Niger and Togo in their regional context. It shows that firstly, the engagement of contract teachers has indeed become a widely spread phenomenon in the whole region. And secondly, it shows that contract conditions in terms of both remuneration and responsible authorities (public or private) vary considerably across countries. Privately employed contract teachers earn much lower salaries than traditional teachers in all countries, and often much less even as compared to the new public contract

teachers. In addition, the privately engaged contract teachers do not only face the potential challenge of a fixed-term contract which may or may not be renewed, but must also be expected to be much more closely monitored by the parents in the responsible local community who actually (directly or indirectly) finance their post.

Further cross-country differences in contract teacher programmes exist with respect to entry requirements in terms of educational attainment and professional training. Typically, professional training has been considerably reduced from several years in specialised teacher training institutes ("Ecoles Normales") to a few months, or even weeks provided by diverse institutions, or to on-the-job training under the mentorship of senior teachers. This reduction in teacher training also reduced the cost incurred by the education system, in particular as teacher candidates often received scholarships during this training period, i.e. before being actually employed in schools.

In some countries like Guinea, cuts in the duration of professional training have gone hand in hand with a redefinition of course content and an attempt to adjust the curricula to issues truly relevant to teaching practice. A mandatory training period of 15-18 months including 6-9 months of practical teaching experience under the supervision of a senior colleague was built into the new recruitment procedure (Faoura 2004, pp. 105ff.). In Mali, teacher candidates who have not attended other forms of pedagogical training, have to follow a three-month course preparing them for their work (PASEC 2005b). As opposed to the situation in Guinea and Mali, contract teachers in Niger initially only received a 45-day training and even the latter requirement was not always met in practice (PASEC 2005b). If some contract teachers have effectively attended longer training courses, they can be assumed to have been candidates for traditional teaching positions who have not been able to find a position on the labour market. Traditional civil servant teachers had to follow a training administered in the "Ecole Normale" for one or two years. Only recently, yet another reform seems to have increased the initial training requirements even for contract teachers to one year, too (Ndoye 2004). In Togo, finally, contract teachers do not necessarily get any professional training at all. In some cases, they benefit from a three-month course supported by the World Bank and administered ex post. NGO have also come in to bridge the gap, but on an irregular basis.

Similar cross-country differences exist with respect to educational attainment required to enter the teaching profession. While in Guinea and Mali upper secondary education is required as a minimum, contract teachers in Niger may also start from a level of completed 10^{th} grade ("BEPC") if they clear the entrance exam. In Togo, the baccalauréat was required initially, but

requirements were later reduced to junior secondary completion and the clearance of an entrance exam just like in Niger.

Table 2 shows the magnitude of the contract teacher reforms on the French speaking part of the African continent and gives details about their implementation.

Last but not least, it should be noted that some countries such as Mali and Togo (to some extent) develop a career development plan for their contract teachers, e.g. by defining steps on how to integrate contract teachers into the traditional system later. In Niger, it is intended to render contracts permanent after four years. In surprisingly many countries – including Mali and Togo – the contracts for public contract teachers are even supposed to be permanent right from the beginning. Nevertheless, contract teachers are clearly in a less secure position than traditional civil servants. In Togo, for instance, a large number of contract teachers was fired in 1999 as a result of a strike. The differences in contract teacher schemes are summarised in Table 2.

Let us now consider what kind of effects on student learning we can expect from the various features of the contract teacher programmes discussed so far. Theoretically, we will have to consider the following potential effects: (1) an effect of the new educational and training requirements for entry into the teaching profession, (2) an incentive effect of the teaching contract, (3) a selection effect (changed demand for and supply of new teachers), and (4) a dynamic effect. Let us consider these effects individually.

Table 2: Characteristics of West African contract teacher programmes

Country	Category (local names)	Reasons for reform	Minimum level of education and training	Duration of professional pre-service training	Duration of contract	Career plan or seniority bonus	Source of financing	Employer Management	Regularity of payment
Benin	State contract teachers	limited state resources	Junior secondary	Training periods in a 4-year sequence	2 years renewable once	Under discussion	State	State	Yes
	Community teachers	"Spontaneous" schools	Flexible	Flexible			Parents	Local	Generally yes
Burkina Faso	Community teachers		Flexible		fixed-term contract		Regional	Community-Based	
	Contract teachers	Limited state resources	Secondary+ Selection	1 year	Permanent	Yes	State / external	Decentralized level	Yes
Cameroon	Vacataire	Limited state resources	Secondary+ Selection	1 year	Formally 2 years, but considered as permanent	No till 2006	State	Decentralized level till 2006	No
	Community teachers	Local initiatives	Flexible		1 year	No	Parents	Community	
Chad	Community teacher	Limited state resources /creation of community schools	end junior secondary + selection process of applicants	9 months on the job; 4 months for those with a diploma	9 months (school year) but can be transformed into permanent	No	Parents and state	Community	No
Congo (Rep. of)	Contract teachers	Limited state resources	Junior secondary+ selection process	2 years apprentice ship with continuous training	Formally 2 years, but considered as permanent	No			
	Volunteers	Local emergency program	Junior secondary+ selection process	not fully documented	1 year, but can be transformed into permanent	Local arrangements		Community, public service	Yes
	Community teachers (benevolents)	Parental initiative			Limited			Community	
Guinea	Contract teachers	Limited state resources	Full secondary + selection	9 or 12 months	1 year but can be transformed into permanent	No	State	Decentralized level	Generally yes
Madagascar	Contract teachers	Frozen recruitment for civil servants	Local initiatives	Flexible	Formally 1 year, but considered as permanent	Under discussion	State HIPC initiative	State	Generally yes
	Community teachers	Local initiatives	Junior or full secondary	sometimes	No contract	No	Parents and aid	Community	No
Mali	Contract teachers	Limited state resources	grades 11 or 12	3 months	Permanent	In progress	State	Decentralized level	Yes
	Community teachers	Local initiatives	Flexible				Donors / community	Communities / parents	
Mauritania	Temporary staff	Lack of competencies	Junior secondary	3 months	Permanent or 1 year	None	State	State	Yes
	Retirees					None	State	State	Yes
Niger	Contract teachers	Limited state resources	Junior secondary + 1 year in teacher training school + selection	1 year	Permanent contract after 4 years of experience	No	State + Aid	Decentralized level	No
Senegal	Educational volunteers	Limited state resources	Junior secondary+ selection process	3 months , 6 months after 2000	2 years for volunteers, half become permanent	Yes	State	Decentralized level	Yes
Togo	"Auxiliaries" or Contract teachers,	Limited state resources	Junior secondary+ selection process	from none up to 3years	Permanent	Yes, but limited	State	Decentralized	Yes
	Community teachers (volunteers)		Flexible	Irregular, only administered by NGO			Communities / parents / aid	Communities / parents	

Note: For further details, see Appendix A, Table A1.

Sources: Adapted and updated from Mingat (2004), Ndoye (2004) and Duthilleul (2005) using various World Bank education sector Country Status Reports (see e.g. World Bank 2002, 2004, 2005a, 2005b, 2006a, 2007 and World Bank (Africa Region) and Pôle de Dakar 2007) and expert communications.

(1) The effect of new education and training requirements

While recent studies show that the duration of teacher education and training is not necessarily a strong correlate of teacher quality and student learning (see e.g. Hanushek et al. 2005 for the United States; Michaelowa and Wechtler 2006, and Michaelowa and Wittmann 2007 for African countries), this outcome appears to result from decreasing returns after a certain minimum level of education and training, and/or could be a result of the low quality of the educational programmes themselves. For francophone African countries, for instance, it has been observed frequently that increasing primary teachers' educational attainment requirements from the BEPC to the baccalauréat does not bring about the expected change in student achievement (Michaelowa and Wechtler 2006). On the other hand, providing at least some professional training prior to job entry appears to be relevant. This is clearly confirmed by prior analysis for Togo (PASEC 2004). From this perspective, we would expect that Togolese contract teachers, many of whom might not have received any professional training at all, should be particularly disadvantaged.

If training and other educational requirements are directly related to the status of contract teachers, their effect cannot be disentangled from the other effects of the reform. However, as we will see later, we typically find some contract teachers whose educational attainment and professional training is beyond the minimum level, just as we find traditional civil servants with levels lower than officially required. This will give us some (albeit limited) scope to control for these effects.

(2) The incentive effect of the teaching contract

The incentive effect is the focus of what we would like to analyse in this paper. There are two possible directions of this effect. On the one hand, the unfavourable conditions of new teacher contracts could be regarded as unfair and demotivating, and short-term contracts could prevent personal investments in pedagogical training and school specific human capital. This is the main reason why many stakeholders in the education system, including traditional teachers, teacher unions, and many policy makers, even at ministerial level, are strongly sceptical with respect to the reforms and often consider a reversal. As Mali shows the greatest difference in salaries (at least initially, at the time our data were collected), from this perspective, we would expect the Malian contract teacher programme to be the least conducive to teaching quality. At the same time, teachers in Niger suffer from irregular payment of teacher salaries. While the recent literature does not suggest any

clear relationship between the level of teacher salaries and education quality (see e.g. Kremer et al 2005; Hanushek et al. 2005), serious remuneration problems of this kind generally remain unconsidered. They may be far more demotivating and thus put the programme in Niger in an even more unfavourable position than the Malian.

On the other hand, contract teacher programs may also bring about incentives conducive to better teaching and learning. These aspects seem to dominate in the eyes of policy makers in many non-African countries like India where stakeholders appear to be much more optimistic about the effect of contract teacher employment on education quality (Govinda and Josephine 2004, Duthilleul 2005). For teachers on non-permanent contract positions, further employment prospects generally depend (at least to some extent) on performance. Among the three countries considered here, non-permanent contracts exist in Niger (at least until four years of job experience), for community teachers in Mali, and for the majority of community teachers in Togo (i.e. as far as they have not been fully integrated into the public administration system yet). This may enhance their teaching effort.

In addition, the specific employment by local communities can be expected to induce another, even more relevant incentive effect. In the case of community teachers, parents themselves select and pay the teachers, so that firstly, parents have a high incentive to monitor, and secondly, the teachers are directly dependent on parents' satisfaction. This should ensure at least a minimum standard of performance such as regular appearance of the teachers at their workplace. Preliminary evidence for five West African countries indicates that this is indeed the case (Michaelowa and Wittmann 2007). Similar evidence is presented by Duthilleul (2005) for India, while Banerjee and Duflo (2006) and Kremer et al. (2005) suggest that results are less obvious in this country. In any case, there appears to be a general consensus on the relevance of effective monitoring and that in principle, local communities are in a favourable position to fulfil this role (Glewwe and Kremer 2006).

If there is a positive incentive effect of the kind discussed above, we should expect an advantage of the contract teacher programmes in Mali and Togo over the one in Niger. The latter relies, almost without exceptions, on public contract teachers alone. In addition, comparing Mali and Togo, we might expect an advantage of the Malian system, not only due to the higher share of community teachers among the contract teachers (no more now, but at the time our data were collected), but also due to the diminishing involvement of

parents and communities in Togo's EDIL, where the share of teachers directly paid by the community is declining.

(3) The selection effect

As far as the selection effect is concerned, the changed employment conditions could lead to a different composition of candidates applying for teaching positions. On the one hand, the reduced entry requirements could reduce entry costs and increase the attractiveness of (temporary) teaching positions. On the other hand, the inferior contract conditions might reduce the number of highly skilled candidates. In addition, the generally higher demand for teachers would lead us to expect a lower quality of the marginal (newly employed) teacher. Given the considerable acceleration of the teacher recruitment process in all countries, the latter is likely to dominate.

In all countries, the newly engaged teachers represent a significant percentage of young adults with secondary education attainment. The total number of students annually graduating from at least lower secondary education is currently around 30,000 in Mali, 12,000 in Niger, and 18,000 in Togo (see Appendix A, Table A2). Current annual increase in teacher recruitment lies between 2,000 and 3,500 persons. In Niger, the most extreme case, this represents about 20% of all qualified graduates. According to estimates of the UNESCO-Institute of Statistics (UNESCO-UIS 2006, p. 41) the numbers will still have to rise (annual requirements of ca. 6,000 additional teaching positions in Niger, 5,000 in Mali and 1,500 in Togo). If the number of graduates remains unchanged, Niger would then be in the extreme situation of recruiting half of all young adults with at least lower secondary educational attainment as primary teachers. There may thus not be too much choice among candidates. As all countries considerably accelerated their recruitment along with the introduction of the contract teacher schemes, it is difficult to derive any strong hypothesis with respect to the relevance of this effect in the different countries.

(4) The dynamic effect

The dynamic effect, finally, refers to a potential change of teacher behaviour regarding their life cycle planning. In particular, the inferior contract conditions may induce a reduced retention period of teaching staff and thus higher turnover. This effect could lead to a different distribution of job experience before and after the reform, with a higher proportion of young and inexperienced teachers. This in turn is likely to have an impact on overall teaching quality (see e.g. Hanushek et al. 2005).

However, the actual relevance of this effect depends crucially on general labour market conditions. In the case of all three countries considered here, alternative employment opportunities in the modern sector are extremely limited. Currently, in Mali and Niger, only about one out of four secondary graduates finds a job in the formal, non-agricultural economy. In Togo, it is only one out of ten (see Appendix A, Table A2). The dynamic effect therefore does not seem to be highly relevant in any of the three countries for the time being.

As we will see below, the data at hand will allow us to estimate the overall impact of the contract teacher status without, however, allowing us to distinguish between the individual effects. A consideration of the dynamic effect cannot be provided at all because we cannot observe teachers over time. However, as we have seen, this effect does not appear to be overly relevant in our case anyway.

Taking together the above arguments on education and training, incentives, and selection effects, we observe that at least the latter two let us expect Niger to face the greatest difficulties with its contract teacher programme. In Niger, potential disincentives through irregular pay appear to be high, and positive incentives rather limited as the programme is fully anchored in the public administration system. And even the selection effect must be expected to be negative due to the limited supply of qualified candidates. With respect to Mali, the most critical issue appears to be the incentive effect. If there does exist an important disincentive related to low salary levels, Malian contract teachers should do very badly. However, if the positive incentive effect related to parental responsibility and community monitoring dominates, Mali with its high percentage of community teachers should do rather well. The case of Togo can be expected to lie somewhere in between, with a marked disadvantage only with respect to its failure to provide pre-service teacher training on a regular basis. The econometric part of this paper will show whether these expectations are confirmed by the empirical evidence.

3. Data and initial descriptive statistics

The empirical study of the effect of contract teacher programmes on education quality requires comprehensive information on teachers, schools and students. The "Programme on the Analysis of Education Systems" (PASEC)[1] collects such data for the 2nd and 5th grade of

[1] Original French title: "Programme d'analyse des systèmes éducatifs de la CONFEMEN", whereby CONFEMEN stands for the Conference of Francophone Education Ministers ("Conférence des ministres de l'éducation des pays ayant le français en partage").

primary schools in francophone sub-Saharan Africa. PASEC generally uses student, teacher and director questionnaires that are uniform for a number of core questions, so that results are comparable across countries. Education quality is measured in terms of student achievement in Math and French, which is assessed using standardized tests for all three countries considered here. The Math test contains a wide variety of items ranging from calculus over problem solving (application to situations of daily life) to simple geometry. The French test covers general understanding and orthography as well as grammar skills. Tests were administered in the classroom, item by item, following detailed instructions on the way to present each question and the time to be allocated to its response. Test results are coded in terms of the percentage of test items answered correctly in each of the two subjects French and Math. The tests and their results are not used for any official purposes, i.e. teacher assessments, and the final dataset is anonymous (without any names of schools, teachers or students). The tests comprise a majority of multiple choice items. The testing language is French.

Students are tested both at the beginning and at the end of the school year (pre-test in autumn and post-test in summer) so that a value added approach (Hanushek 1986) becomes possible. This is particularly relevant for our study because the effect of a contract teacher who may have taught the students only in the year of assessment needs to be distinguished from the effect of various other teachers who taught the class before. In francophone Africa, teachers tend to vary a lot over the years, i.e. they usually teach the same grade and do not follow the cohort.

PASEC surveys were carried out in Niger and Togo during the academic year 2000/2001, and in Mali in 2001/2002. In all cases, the sampling frame consisted of all primary school teachers included in the database available at the national Ministries of Education. Teachers of coranic schools were not included as they follow a different curriculum and teaching generally takes place in Arabic. Teachers in other private schools were included as long as they were registered by the Ministry. This was generally the case in Mali and Togo, but some community schools may have gone unnoticed or unrecognized.

In Togo, data was collected as a stratified random sample of teachers, whereby strata were defined according to different teacher characteristics related to their education, seniority and training. In this way, 120 teachers were drawn at both 2nd and 5^{th} grade, and consecutively, 12 students were selected at random in their classes. The intended sample thus contained a total number of 240 classes and 2880 students. In Niger and Mali, sampling was directly geared towards the evaluation of the effect of contract teachers. It was carried out in a way

that each inspection, i.e. each school district, should be covered, and within these districts, 70 out of 140 schools were drawn at random. Within these schools, one class at 2nd grade and one class at 5th grade level were randomly selected. Depending on whether the teacher of the classes drawn in this way was a civil servant or a contract teacher, a nearby school with similar characteristics was selected to provide evidence for the other type of teacher statute. Ideally, this procedure should have resulted in an equal number of contract teachers and traditional teachers. As, however, it was not always possible to find the opposite category for both grades simultaneously in the same school, the final sample does not really correspond to this ideal. In Niger, it is equally spread between contract teachers and teachers on traditional civil servant positions only for grade 2. In grade 5, we find twice as many civil servants as contract teachers. In Mali, contract teachers are overrepresented in the final sample in grade 2, whereas traditional teachers are overrepresented in grade 5. In both Mali and Niger, within each class, 15 students were randomly selected. In both countries, the intended sample therefore includes 4200 students in a total of 280 classes (of which 140 in 2nd and 140 in 5th grade).

To a certain extent, real numbers differ from intended numbers. In Togo, this is mainly related to a teacher strike during the initially intended sampling period which led to a one year delay of the sampling process and to changes in the actual teacher composition. Moreover, in all countries, some schools did not offer both grades to be covered in the survey and appropriate replacement schools could not always be found.[2]

The following table shows the actual number of classes contained in the data set for each country, separately for 2nd and 5th grade. In addition to regular civil servant teachers and contract teachers, there are also some other types of teachers, which include, in particular, teaching assistants and interns. These teachers are dropped in the analysis as we aim to compare the contract teachers with a well defined control group of regular civil servant teachers. In addition to this, we also drop teachers with more than 10 years of job experience for common support considerations. Since the reforms were enacted only relatively recently there cannot be any new contract teachers with more than 10 years of experience. Hence, the support of the variable job experience differs between civil servant and regular teachers and we need to impose a common support restriction for the nonparametric estimation approach.

More precisely, in Togo we observe contract teachers up to eleven years of job experience.[3] In Mali, we observe contract teachers up to eight years of job experience.[4] The situation is

[2] For further details on the sampling procedures in the three countries, see PASEC (2004, 2005a and 2005b).
[3] There is also one with 17 and one with 29 years of job experience, who are dropped.
[4] There is also one with 16 years of job experience, who is dropped.

somewhat different in Niger, where the reform was enacted even more recently, in 1998. There, we observe contract teachers with only up to four years of job experience, except from one with five years and three with eight years. As we attempt to adhere to the same sample and variable definitions across countries to keep results comparable, we use 10 years as the cut-off point in all countries for the main analyses. In addition, Appendix D shows estimates for Niger when only teachers with at most 4 years of job experience are retained. The results are very similar.

Due to this sample restriction only few regular teachers remain in Mali, which is likely to lead to rather imprecise estimates.[5,6]

Table 3: Number of teachers in the datasets

	Niger		Togo		Mali	
	2nd grade	5th grade	2nd grade	5th grade	2nd grade	5th grade
No. of classes	125	140	116	119	139	140
Contract teachers	59	27	40	42	74	50
Civil servants	58	92	70	64	48	76
Other teachers	8	21	6	13	17	14
After deleting 'other teachers' and teachers with more than 10 years of job experience						
Contract teachers	59	27	38	42	73	50
Civil servants	33	45	23	28	10	12

Note: In Niger, 10 classes were deleted where no or very limited information on student's test scores were available. In six classes, there were no test scores available at all, i.e. no tests were conducted. In four classes, test score data was available at most for four students.
In Togo, 6 classes were deleted: 2 classes because of lacking any data on students (presumably since teachers had changed), 2 very small classes with only six students and lacking test score data for two of them, and 1 class where no test scores were available at all. In addition, there was only *one* school that used double shift class management. This school is deleted as there cannot be any adequate comparison school.
In Mali, one class was deleted, since there were no student test scores available.

[5] If we had used a cut-off point even smaller than ten years we would have lost another 10 regular teachers in Mali. There are only few civil servants with less than 10 years of job experience, and 10 teachers with exactly 10 years of job experience.

[6] Similar constraints in the number of comparable observations also make it impossible for us to further distinguish contract teachers into the groups of public contract teachers and those engaged by parents and local communities.

Table 4: Selected characteristics of teachers, students and schools in our sample, by country, grade and teacher status

Variable (range)	Mali				Niger				Togo			
	Grade 2		Grade 5		Grade 2		Grade 5		Grade 2		Grade 5	
Type of teacher	Civil servants	Contract teachers	Civil servants	Contract teachers	Civil servants	Contract teachers	Civil servants	Contract teachers	Civil servants	Contract teachers	Civil servants	Contract teachers
Number of students	123	913	146	668	429	709	584	336	245	422	308	464
Number of classes	10	73	12	50	33	59	45	27	23	38	28	42
Test scores: post-test French	0.44	0.43	0.32	0.34	0.49	0.40	0.28	0.26	0.58	0.58	0.52	0.39
Test scores: post-test Math	0.36	0.42	0.32	0.35	0.47	0.38	0.31	0.28	0.51	0.51	0.50	0.39
Test scores: pre-test French	0.29	0.19	0.33	0.31	0.18	0.16	0.24	0.23	0.39	0.39	0.55	0.41
Test scores: pre-test Math	0.44	0.32	0.38	0.36	0.39	0.32	0.27	0.27	0.49	0.49	0.62	0.54
Socio-economic index based on family possessions (1-8)	0.90	0.62	0.96	0.60	2.50	2.37	2.34	2.87	2.65	1.95	3.71	1.96
Index of school equipment (0-16)	5.48	4.85	4.82	4.90	3.78	3.90	3.77	4.31	4.29	3.00	5.68	3.23
Class size	71.41	63.51	58.77	54.33	46.00	45.68	34.43	36.14	40.46	38.36	32.81	36.83
School located in rural area (0,1)	0.10	0.50	0.36	0.52	0.34	0.38	0.30	0.41	0.40	0.52	0.31	0.58
Teachers' age (in years)	35.01	29.83	36.53	31.93	30.08	27.79	30.07	28.74	34.62	32.52	36.01	34.09
Teachers' job experience (in years)	8.43	3.12	7.04	3.82	4.88	2.44	5.58	2.70	6.20	5.47	7.04	5.87
Teachers' educational attainment (0-6)	2.34	1.61	2.34	2.15	4.01	3.72	4.51	4.18	2.86	2.88	3.82	4.00
Teachers without pre-service training (0,1)	0.08	0.34	0.00	0.35	0.03	0.19	0.00	0.15	0.18	0.41	0.22	0.44

Note: The pre-test is conducted at the beginning of the school year (in autumn), the post-test is conducted at the end of the school year (in summer). Pre- and post-test are based on different items, so that the scores cannot be directly compared.

Table 4 provides an overview of some selected characteristics of students, teachers, classrooms and schools collected through the additional questionnaires for students, teachers and principals. Pupils were questioned along with the pre-test at the beginning of the school year, whereas teachers and principals were interviewed at the end of the year. The questionnaires provide information on a wide range of students' personal characteristics, family background, and prior educational history, as well as on personal characteristics and pedagogical methods of teachers and principals, and on school and classroom equipment, inspections, and interaction of school staff with the local community. In addition to those variables selected for Table 4, some more variables are listed in Appendix A, Table A3. But even the variables presented in the annex only represent a small subset of the overall information available. In Table 4, the columns show the averages of the different variables for classes taught by contract teachers and civil servant teachers respectively.[7]

Starting with test scores, Table 4 indicates that on average, in the sample for both 2nd and 5th grade, students taught by traditional teachers typically reached a higher or about equal percentage of correct answers than students taught by contract teachers. Only in the case of Mali 2nd grade Mathematics, we observe strongly higher scores with contract teachers. However, these differences may be related to factors other than the teachers' contract status. They may, for instance, be a consequence of the assignment of contract teachers to different learning environments, or to different characteristics of the teachers themselves.

In particular, it might be that contract teachers get to work with children who show lower abilities already at the beginning of the school year. The data provide some evidence for this in Togo 5th grade and in Mali 2nd grade. Moreover, at least in Mali and Togo, our data show a more favourable context for traditional teachers in terms of the socio-economic background of

[7] For some observations data has been missing as in some (rare) cases, teacher and director questionnaires were not duly filled in. Generally, when full questionnaires or test results were missing, the observations concerned had to be deleted from the data set. Whenever only information for individual variables was missing, however, missing values could generally be imputed using related questions taken from the same or other questionnaires. If information from several other variables could be included for imputation, imputation was carried out using linear regression on all of these variables. In addition, missing value indicators were generated. In other cases, the students' final scores are missing due to their absence on the day of the post-test. These missing values at the student level account for the bulk of missing observations. As in most of francophone sub-Saharan Africa, a relatively high rate of absence on the day of the final exam can be explained by early drop-out, by sickness, or by household and harvesting activities on the day of the evaluation. Simple correlation indicates that the occurrence of these missing values is independent of the teacher's statute as a civil servant or a contract teacher. We did some preliminary experiments with including missing value indicators in the regressions, which did not affect the results very much.

their students and school equipment. In addition, we tend to find contract teachers more often in rural than in urban schools. At the same time, for class size, there is no obvious advantage of either type of teachers.

Overall, the differences with respect to socio-economic background and educational resources are not very pronounced, and this should indeed not be the case given the PASEC sampling strategy, at least for Mali and Niger. However, with respect to teacher characteristics, we must expect considerable differences reflecting the relatively recent introduction of the contract teacher programmes and the legal constraints related to their implementation. At the same time, our modifications to the sample in order to insure common support for the age and job experience variables should already have brought about a certain convergence of mean values. Indeed, in our remaining sample, contract teachers are generally not more than two years younger and less experienced than traditional teachers. An exception is Mali, where we get differences up to about five years.

With respect to teachers' educational attainment, contract teachers show somewhat lower credentials than traditional teachers in Mali and Niger. The opposite is the case in Togo where the "baccalauréat" was temporarily imposed as an entrance condition for contract teachers. Indeed the value 4 of the education index, which we find in Togo 5th grade for contract teachers, stands for the level of the "baccalauréat". Despite prevailing regulations, this level is not reached by 2nd grade teachers, however. In Niger, the education level in our sample is lowest. Again this provides some evidence that official regulations are not observed. The average educational attainment of the teachers in Niger in our sample is in fact below the "BEPC" lower secondary attainment and corresponds to clearing grade 8-9.

Similarly, professional pre-service training that should have been attended (albeit for a short period of time) by all contract teachers in Mali and Niger, does not seem to have regularly been required in practice. While in Mali, the problem may come from the community teachers, there is no explanation of this kind for the case of Niger. Almost all traditional teachers in Mali and Niger, however, report having effectively participated in at least some pre-service training activities. Here again, this is not the case in Togo where it was officially required but not effectively offered for candidates to the teaching profession.

While being instructive about the only weakly binding character of public rules and regulations in our three countries, the above discussion does not offer any clear explanations for the difference in student achievement reached by contract teachers and traditional teachers respectively. Nevertheless, some differences remain and it appears to be worthwhile to compute the net effects by controlling for all confounding variables. In addition to the small

set of variables presented here for illustrative purposes, a much larger number of variables can be used as a basis to select appropriate controls. Both the variable selection and the actual estimation procedure will be described in detail in the following section.

4. Nonparametric evaluation of the impact of the contract teacher programme on education quality

To evaluate the impact of the contract teacher status on education quality, let Y_i^0 denote the outcome, e.g. Math and French proficiency at the end of the school year, of child *i* if being taught by a regular civil servant teacher. Y_i^1 represents the outcome of child *i* if being taught by a contract teacher instead. The average impact of the teacher's contract on a randomly drawn child is

$$E[Y^1 - Y^0].$$

While the average treatment effect provides an overall assessment of the average impact of the contract teacher programme, it is also of particular interest how the contract teachers change the distribution of the outcomes. Contract teachers may perform poorly e.g. with less or very able children. Even if the average treatment effect was zero, an increase in educational inequality could be considered as a negative impact of the contract teacher programme. For considering the distributional impact, we would like to estimate the distribution functions F_{Y^1} and F_{Y^0} of the potential outcomes and/or the quantile treatment effects:

$$Q^\tau(Y^1) - Q^\tau(Y^0),$$

where $Q^\tau(\cdot)$ refers to the τ-Quantile of the random variable in brackets.[8] The quantile treatment effects show the impact of the contract teacher programme for children at different locations in the ability distribution. If the treatment effects obey rank invariance such that an individual *i* who scores higher than an individual *j* if taught by a regular teacher also scores higher if both are taught by a contract teacher, and vice versa, this is the effect for an individual with ability τ. If ranks may cross-over in that the relative orderings of two individuals might change when taught by a contract teacher instead of a regular teacher, and if this change in the ranks is not fully random but related to the treatment variable, we cannot directly associate the τ quantile treatment effect with the individual with ability τ. Still it will

[8] Note that we are examining only the quantiles of the potential outcomes and not of the treatment effects. Identification of $Q^\tau(Y^1 - Y^0)$ would require additional assumptions on the joint distribution of the potential outcomes, which we do not want to impose. For considerations of educational inequality, the quantiles of the potential outcomes are sufficient.

be possible to examine the impact of contracts teachers on educational equality to see whether contract teachers compress or widen the outcome distribution. Overall it nevertheless seems reasonable that rank invariance should at least approximately hold: a weak pupil would still remain in the lower end of the outcome distribution if taught by a contract teacher, and vice versa.[9]

Since we are interested not only in, say, the median treatment effect, but in the entire outcome distributions, we estimate the entire distribution function of the potential outcomes. Identification is based on the conditional independence assumption

$$Y^1, Y^0 \perp\!\!\!\perp D \mid X, \tag{1}$$

as e.g. in Heckman, Ichimura and Todd (1997), Lechner (1999), Black and Smith (2004) or Firpo (2007). The binary variable D_i indicates whether child *i* was actually taught by a contract teacher (D_i=1) or by a regular civil servant teacher (D_i=0).

The conditional independence assumption requires that X contains all variables that determined the teacher statute and at the same time had an impact on the child's potential outcomes. We include in X a large number of variables characterizing the school (location, equipment and facilities, management and parental involvement), the socioeconomic background of the parents, and the child's proficiency in French and Mathematics at the beginning of the school year (pre-test scores). As mentioned before, the pre-test scores are very important for the plausibility of our identification approach as they reflect the child's otherwise unobserved ability as well as the impacts of previous inputs into the education production process. In addition, several teacher characteristics are included to ensure that the estimated impacts of contract teachers on student achievement are not due to differences in these other characteristics, e.g. job experience.

By the conditional independence assumption, we can identify the distribution functions of the potential outcomes by noting that

$$F_{Y^d}(a) = \Pr(Y^d \le a) = E[1(Y^d \le a)] = \int \left(E[1(Y \le a) \mid X, D = d]\right) dF_X \quad , d=0,1 \tag{2}$$

where the last equality sign follows from the conditional independence assumption (1). Now the quantiles can be derived by inverting the estimated distribution function. The treatment effects are thus fully *nonparametrically* identified by first estimating the conditional distribution functions nonparametrically and averaging then over the empirical distribution of X.

[9] It is rather the scarcity of teachers that led to the hiring of additional contract teachers and not a selective dismissal and replacement of regular teachers by contract teachers. The latter could have been an endogenous choice based on the anticipated treatment effects and could violate rank invariance.

A nonparametric matching estimator of the potential outcome distribution is

$$\hat{\Pr}(Y^d \le a) = \frac{1}{n}\sum_i \hat{m}_a(X_i, d) \quad , d=0,1 \tag{3}$$

where $\hat{m}_a$ is a nonparametric regression estimator of

$$m_a(x,d) = E[1(Y \le a) \mid X = x, D = d] \quad , d=0,1. \tag{4}$$

This nonparametric matching estimator is preferred to traditional regression analysis for two reasons: First, we want to avoid arbitrary functional form assumptions for which no justification can be given. Second, nonparametric regression allows for endogenous control variables that are not permitted in OLS or logit regression (Frölich 2006b).[10] This is particularly relevant here because of the inclusion of the ability tests at the beginning of the school year as control variables. These ability tests are correlated with unobserved ability that also likely influences the test results at the end of the school year.

There are several ways to estimate the conditional expectation function $m_a(x,d)$. A common choice would be Nadaraya-Watson kernel regression (= local constant regression). However, Nadaraya-Watson kernel regression is known to behave poorly in boundary regions (Fan 1992, Fan and Gijbels 1996). Instead of the local constant model implied by the Nadaraya-Watson kernel regression, a local linear or local parametric model is often more appropriate (Fan and Gijbels 1996). In particular, using a local parametric model that is closer to the true conditional mean function reduces bias (Gozalo and Linton 2000). Since $m_a(x,d)$ is bounded between zero and one, a local logit specification is used to implement the boundedness restriction in a natural way. The implementation of the estimator follows Frölich (2007) where the conditional expectation functions $E[1(Y \le a) \mid X, D]$ are estimated by local logit as in Frölich (2006a). More technical details on the estimator are provided in Appendix B.

The identification strategy requires $E[1(Y \le a) \mid X, D]$ to be well defined for every value in the support of *X*. This, in other words, requires that for every value of *X* contract teachers and regular teachers are observed. As mentioned in Section 3, we observe a wide range in the job experience of civil servant teachers but no or only extremely few contract teachers with more than 10 years of job experience. Hence the conditional mean would not be well defined for being contract teacher with a large job experience. Therefore all observations with more than 10 years of job experience are dropped, which also mitigates the differences in the age distribution.

[10] In other words, nonparametric matching relaxes the assumptions about the independence of the error term. Whereas in a traditional linear model it must be assumed that the error term is independent of the regressors, i.e.

5. Empirical results

The following tables and graphs provide the estimated quantile treatment effects of the contract teacher programme. The results are shown for different sets of regressors X and different bandwidth values to examine the robustness of the results.[11]

Three different sets of control variables are examined: Xset 1, Xset 2 and Xset 3. The regressor set Xset 2 is based on a rather extensive collection of variables that have been used as possible predictors of test scores in the literature. Estimation of education production functions has become a focus of many studies in recent years including numerous studies for developing countries ever since micro survey data have become available in the late 1990s. A recent summary is provided in the EFA Global Monitoring Report 2005 on education quality (UNESCO 2004). This set includes variables that capture the school environment and classroom equipment, school management, characteristics of the teachers and also the socioeconomic background of the pupils. In addition, we include French and Math proficiency at the beginning of the school year to capture unobserved ability of the pupils.[12] We do not include variables that are likely to have been causally affected by the contract teacher status, and would thus represent direct outcomes of the teacher status, such as teacher job satisfaction or salary.

Most of these variables, however, are not correlated with the treatment variable 'contract teacher'. Xset 1 therefore retains only a subset of variables that were significant in class-level regressions of the treatment variable on all these regressors in any of the three countries considered, see Table 5.

Table 5 shows a class-level logit regression of contract teacher status on several teacher and school and class-average pupil characteristics. The first three columns provide the regressions for the extensive regressor set Xset 2, where most coefficients are insignificant. Not surprisingly, this is especially the case for Mali and Niger reflecting the initial sampling strategy. The last three columns provide the regressions for the smaller Xset 1. Overall, the predictive power of Xset 1 is still very large. It should also be noted that some of the variables had to be dropped from some of the logit regressions because of coefficients tending to infinity due to perfect predictability given the small sample size. This happened with the last four variables in Table 5, marked with (-). These variables are *retained*, however, in the

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E[u|X,D]=0, this assumption can be relaxed here to E[u|X,D] = E[u|X], i.e. the error term could still be correlated with the regressors X.

[11] Inference is based on the bootstrap, where entire classes are re-sampled to account for within-class dependence. Otherwise, significance levels would be overstated. 500 bootstrap replications.

[12] This is the essence of the value-added approach (Hanushek 1986).

nonparametric regressions on the pupil level, where sample sizes are much larger, since they are in fact important predictors of contract teacher status.

Table 5: Determinants of contract teacher status

Dependent variable: Contract teacher	Mali	Niger	Togo	Mali	Niger	Togo
		Xset 2			Xset 1	
School location:						
Distance to next city at least one hour	2.51	**-2.84**	-1.82	**2.14**	-0.91	**-1.47**
Small village	-4.49	3.77	1.29			
Big village	-2.14	2.66	-1.53			
Pupil variables:						
Initial test score French	0.20	0.07	**1.47**	-0.22	-0.02	**0.23**
Initial test score Math	-0.29	-0.09	**-1.59**	0.08	0.00	**-0.18**
Indicator for 5th grade class	1.56	-1.49	2.13	-1.18	-0.62	0.94
Initial test French interacted with grade	-0.08	0.00	**-0.45**	0.04	0.01	**-0.07**
Initial test Math interacted with grade	0.06	0.01	**0.42**	-0.01	-0.01	**0.06**
Boy	0.04	-2.72	-0.12			
Age	-0.52	0.62	**-1.29**	0.45	0.15	-0.46
Socioeconomic status [a)]	4.06	-4.43	2.13			
Possession of TV, radio, rideo at home	-4.66	2.19	-0.47			
Indicator of child labour [b)]	-0.54	0.02	-0.01			
Regularity of meals [c)]	-0.27	-1.54	-2.76			
Number of schoolbooks (0,1,2) [d)]	0.92	2.00	**-6.40**	0.20	1.32	**-3.20**
Student gets help with studies at home	-1.59	3.53	4.77			
Student speaks French at home	-2.94	0.67	1.03			
Student repeats the current grade	-0.08	1.56	1.14			
Number of grades repeated previously	-0.19	-4.50	-0.43			
School variables						
Classize (on a typical day)	-0.03	0.01	0.02			
Percentage of girls in the class	0.02	-0.04	-0.03			
Number of students in the school	0.00	0.00	0.00			
School equipment [e)]	-0.16	0.45	-0.59			
Drinking water in school	1.44	**-2.81**	2.20	-0.87	-0.68	-0.04
Electricity in classroom	-1.29	-0.85	-2.69			
School has toilets	0.43	-0.74	**-3.18**	0.34	0.00	**-2.56**
Active involvement of parents in school issues	0.39	0.43	-1.80			
Frequent exchange among teachers	-0.70	1.37	2.53			
Male Director	1.66	**-2.50**	1.58	0.91	-0.78	-1.03
Education of director	0.15	-0.20	-0.31			
Training of director	-2.20	0.19	1.59			
School participates in a pilot programme, exchange programme etc.	-1.63	-0.57	**2.78**	-0.57	-0.23	**1.78**

Table 5 cont.

Dependent variable: Contract teacher	Mali	Niger	Togo	Mali	Niger	Togo
		Xset 2			Xset 1	
Teacher variables						
Male Teacher	0.26	-0.90	-0.66			
Age Teacher	**<u>-0.39</u>**	-0.05	**-0.26**	-0.15	-0.06	-0.12
Education Teacher	-0.28	-0.65	0.56			
Teacher speaks local language	1.94	0.11	0.32			
Inspector's visit during the last year	-	-1.58	**2.47**	-	-0.83	1.14
Job experience of teacher (in years)	-	**<u>-1.26</u>**	0.14	**<u>-0.78</u>**	**<u>-1.00</u>**	0.02
Double shift teaching	-1.63	-2.18	-			
Multi grade class	**-4.95**	0.74	-	-1.68	0.98	-
Blackboard and chalk available in class	-	0.83	0.21			
Constant	29.44	15.60	25.77	10.30	7.74	10.36
Number of classes	142	168	129	142	168	129
Pseudo R^2	0.481	0.558	0.579	0.505	0.412	0.440

Note: Coefficients significant at 5% level are marked in **bold**, significant at 1% are marked in **<u>bold underlined</u>**.
Variable names in **bold** identify variables included in the regressor set Xset 1.

[a)] Socioeconomic status: Sum of family possessions: fridge, electricity, flush toilet, access to tab water, plough, car, TV, radio, video, adjusted to urban/rural differences (0-1).

[b)] Indicator of child labour: Student helps with commercial activities, agricultural activities and/or animal husbandry (Sum of activities).

[c)] Regularity of meals: Sum of regularity of breakfast, lunch and dinner.

[d)] Student has a textbook for French, for Math or both (0-2)

[e)] Sum of 16 indicators of school equipment: electricity in class, library, lavatory, school canteen, availability of drinking water, court yard in school, availability of a sick-room with some medical equipment, sports ground with some equipment, garden, fence around the school, office for director, room for teachers, storage room, housing for director, housing for a guardian, housing for teachers.

The difference between Xset 2 and Xset 3 is that the latter also contains the variables *educational level of the teacher* and *pedagogical training of the teacher*. These two variables may be important predictors of educational achievement. At the same time, as they are part of the characteristics of the contract teacher status, they must be expected to be directly tied to the treatment variable. In principle, by definition, contract teachers receive only very little training and are subject to different educational requirements for admission. Hence, a change in the treatment variable would automatically entail a change in these two variables such that they cannot and should not be used as control variables. In practice, however, it seems that the various administrative rules are not always adhered to so that, for instance, teachers may have become civil servants without any pre-service training, too (see Section 3). Therefore, we examine results with and without these two variables. If effects differed significantly, the difference may be attributed to these two variables.

Table 6 presents the estimated *quantile treatment effects* for Xset 1. The results for the enlarged regressor sets Xset 2 and Xset 3 are provided in Appendix C. All results are reported for three different sets of bandwidth values, first for $(h_1, h_2, \lambda) = (0.5, 0.5, 0.25)$, then for $(h_1, h_2, \lambda) = (1, 1, 0.5)$, and finally for bandwidths chosen by cross-validation. Bandwidth h_1 is

used for the French and Math pre-test scores, h_2 for all other non-binary regressors, and λ for binary regressors. As discussed in more detail in Appendix B, the bandwidths chosen by cross-validation are certainly too large, since some kind of *asymptotic undersmoothing* is required for the matching estimator to reduce its bias. We therefore focus our attention on the first two sets of results and pay particular attention to the robustness of the results to bandwidth values and regressor sets.

The subsequent graphs (Figures 1-2 for Mali, 3-4 for Niger and 5-6 for Togo) show the estimated distributions of the potential outcomes: the solid line shows $\hat{F}_{Y^1}$ and the dashed line $\hat{F}_{Y^0}$. The horizontal distance thus reflects the quantile treatment effects displayed in Table 6. The graphs to the right show the effects on Math proficiency, the graphs in the middle give the effects for French proficiency, whereas the graphs to the left refer to the average of French and Math proficiency. Again, for Xset 2 and 3 the corresponding graphs are provided in Appendix C.

The results for the 2nd grade in *Niger* are very stable to bandwidth choice and the set of regressors. The effects are close to zero for the lower quantiles, and decrease almost monotonously to about –20 to –25 percentage points for the high ability students. Hence, whereas the low ability students do not seem to be affected by the teacher status, the high ability students seem to suffer from being taught by a contract teacher. The effects are very similar for French and for Math.

For the 5th grade, the estimates also tend to be negative but are small and insignificant. At the lower quantiles the effects remain slightly negative with the larger regressor sets 2 and 3. For the higher quantiles, the estimation results are unclear and sensitive to the choice of regressors included. (For Math, the effects tend to be negative. For French the results are unstable due to local colinearity.)[13]

In *Togo* the impacts tend to be positive for the 2nd grade and negative for the 5th grade. The positive effects for the 2nd grade are a bit larger for French than for Math. For French, they are significant around the median (about 10 to 14 percentage points) while they remain insignificant for Math. The estimates with Xset 2 and 3 are similar with often somewhat larger effects on Math.

[13] The kink in the estimated regression curve at higher quantiles for French for Xset 2 and particularly for Xset 3 is due to some kind of a locally high correlation among regressors. Therefore results for an additional regressor set Xset 3a are reported, where five disturbing variables have been removed: *socioeconomic status, media, child labour, small village* and *active involvement of parents in school matters*. For this Xset 3a the previously positive effects for French at higher quantiles vanish almost entirely. See the columns for Niger 5th grade in Table C.2.

The situation is different for the 5th grade. Here the effects are about zero for the low quantiles, and then decrease almost monotonously until –13 percentage points for Math for the high ability students. This pattern is very stable across bandwidth choices and Xsets. Effects are negative for both French and Math but more strongly so for Math.

In *Mali*, to the contrary, effects tend to be positive for both grades. For the 2nd grade, effects are insignificant for French, but significantly positive for Math. Judging from the significance levels, this effect seems to be most precise for the lower to medium quantiles. This implies that children at the *lower* end of the ability distribution seem to benefit most clearly from the contract teachers. The effects are smaller and less precisely estimated for Xsets 2 and 3 but remain positive for Mathematics, perhaps except for very large quantiles.

For the 5th grade, the effects are also positive for French and Math for the low to medium quantiles, but again significant only for Math and now only at the 10% level. For Xsets 2 and 3 the results are less precise and smaller. Hence, the evidence is less stable for the 5th grade, but overall tends to be positive rather than negative.

All in all, the above analysis quite strongly confirms our expectations that given the different characteristics of the contract teacher programmes in the three countries considered, we should also observe quite different results. As suggested by our initial hypotheses on both the incentive and selection effects, the contract teacher programme in Niger shows the worst results, i.e. either insignificant or clearly negative. To the contrary, the Malian results are consistently positive and significant in Math for both grades. This suggests that the potentially negative role of low salaries (if any) was overcompensated by the positive incentive effect induced notably by parental responsibility and monitoring in the case of Malian community teachers. As expected, Togo occupies an intermediate position which may be related to the fact that parental monitoring responsibility was reduced through the integration of parts of the contract teachers into the public administration system.

One could also suspect that Togo's relatively bad performance of contract teachers in 5th grade is related to their missing pedagogical training. However, the use of Xset 3 where this variable is controlled for, does not lead to any significant change. There is thus no evidence that the lack of training could drive the results. At the same time, as stated earlier, it may not be possible to fully separate the effect of education and training from the treatment itself. This aspect must therefore be interpreted with caution.

The second general observation is that results do indeed differ depending on students' ability level. Across all countries, the analysis by quantile of the ability distribution suggests that contract teachers do a relatively better job in low ability contexts. Whenever we observe

positive effects, they tend to become significant in low quantiles, and whenever we observe negative effects, they tend to become significant in high quantiles of the ability distribution. This implies that contract teachers tend to reduce inequalities in the student distribution.

In Mali and Togo, we also observe that contract teachers tend to be relatively more successful with younger students, i.e. they show a better performance in 2^{nd} as compared to 5^{th} grade. However, the opposite is the case in Niger. Overall, the influence of contract teachers is thus more clearly related to student ability within each grade level than to students' ability difference across grades.

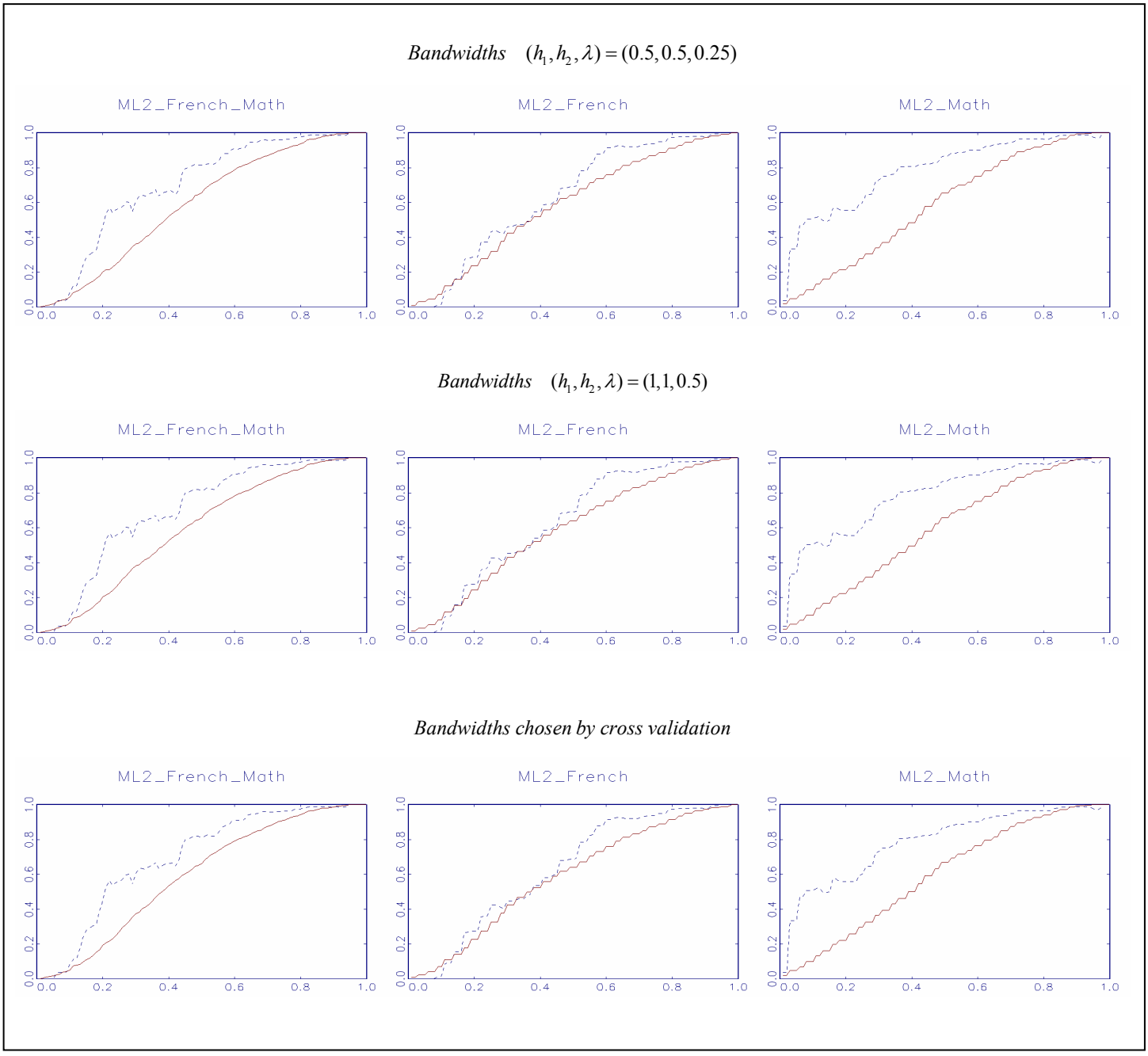
A possible explanation for this phenomenon could be that traditional civil servant teachers may be unwilling to move to disadvantaged areas, and unmotivated if they are still compelled to do so. Contract teachers, however, are often locally recruited and should therefore not face this problem. Moreover, coming from a similar background, they are more aware of the specific problems of children with learning deficiencies; they speak their language, know their parents and thus may be better able to deal with the situation. Contract teachers may thus outperform traditional teachers in a low-ability context, even if traditional teachers do better in a less disadvantaged student environment.

Table 6: Quantile treatment effects of teacher status (Xset 1)

	Mali 2nd		Mali 5th		Niger 2nd		Niger 5th		Togo 2nd		Togo 5th	
	French	Math	French	Math	French	Math	French	Math	French	Math	French	Math
					bandwidth 0.25							
τ=0.1	-2.5	7.8	11.9	5.5	-2.0	0.2	-0.2	-0.5	4.3	2.5	0.5	-2.7
τ=0.2	1.8	**14.7**	15.0	7.2	-1.5	1.3	-3.2	-4.4	*10.9*	8.0	-2.5	-7.6
τ=0.3	3.4	**22.9**	11.9	11.4	0.0	-4.3	-3.5	-2.5	4.4	3.0	-3.4	**-9.1**
τ=0.4	5.1	**28.3**	13.9	10.7	-2.0	-5.6	-2.1	-3.1	7.8	7.9	-3.3	-4.8
τ=0.5	0.1	**33.5**	10.6	*13.2*	-12.9	-11.1	-2.6	-0.2	**14.0**	5.4	-5.5	*-6.8*
τ=0.6	1.6	*21.4*	6.2	12.9	**-19.0**	**-23.1**	-0.1	-2.3	*13.9*	2.2	**-9.5**	-7.0
τ=0.7	3.5	*25.3*	2.9	13.4	**-24.6**	**-30.1**	-0.6	2.7	8.1	2.7	**-9.3**	**-12.7**
τ=0.8	10.0	28.8	2.6	-0.1	**-21.3**	**-25.1**	-1.4	-0.5	0.0	6.4	**-7.8**	**-11.9**
τ=0.9	18.9	13.5	9.1	-0.2	**-11.4**	**-10.1**	-8.7	-0.5	-1.3	1.9	-6.4	**-13.0**
					bandwidth 0. 5							
τ=0.1	-2.5	**7.8**	11.9	14.2	*-5.7*	1.2	0.3	2.4	3.3	5.0	1.1	-3.3
τ=0.2	1.7	**13.3**	14.8	8.8	-0.6	-2.3	-0.1	-0.1	5.0	2.7	-5.4	-4.8
τ=0.3	2.8	**22.4**	14.0	12.1	0.1	-7.6	0.0	-0.3	3.1	5.5	-2.8	-5.0
τ=0.4	4.8	*27.9*	13.9	13.5	-0.7	-5.7	0.2	-2.8	8.3	9.7	-0.6	-3.1
τ=0.5	-0.2	*33.3*	16.4	*14.8*	-5.6	-10.8	0.0	-0.1	**13.9**	10.2	-0.4	-2.0
τ=0.6	1.6	21.4	11.8	*15.0*	**-18.7**	-13.3	0.5	0.1	**15.3**	2.5	-0.8	-2.2
τ=0.7	3.8	25.1	11.7	*15.4*	**-22.0**	**-21.4**	0.2	0.2	15.6	10.3	*-5.8*	-5.4
τ=0.8	10.3	29.0	8.3	9.0	**-21.9**	**-21.6**	-0.6	-0.1	10.3	9.7	-4.3	**-8.9**
τ=0.9	18.9	13.6	12.5	0.7	**-11.5**	**-14.9**	-6.0	-4.3	2.8	6.3	-3.6	**-12.6**
					bandwidths chosen by cross-validation							
τ=0.1	-2.4	7.8	8.9	13.0	**-7.8**	1.2	0.0	2.3	0.2	7.4	-0.2	-3.8
τ=0.2	2.0	**14.6**	9.4	12.1	-5.0	-4.8	-0.2	-0.5	3.1	7.7	-5.0	-5.0
τ=0.3	3.2	**22.2**	11.0	13.9	-3.1	-9.8	-2.4	-2.3	-0.5	2.1	-2.5	-3.4
τ=0.4	4.9	**27.7**	13.7	*15.6*	-7.5	-12.8	-1.5	-4.6	2.6	7.4	-0.1	-0.2
τ=0.5	-0.3	**31.2**	16.5	*15.5*	-12.8	-12.8	-2.6	-4.7	4.9	8.2	-0.1	-0.4
τ=0.6	1.4	**21.1**	9.8	*18.2*	**-18.8**	-14.7	-0.1	-2.9	8.2	5.7	-2.1	-2.1
τ=0.7	3.7	24.6	12.2	*18.4*	**-19.3**	*-14.5*	-2.7	-2.1	*10.8*	5.9	-3.0	-5.0
τ=0.8	10.1	28.3	11.5	17.1	**-15.7**	**-13.6**	-3.2	-6.1	9.0	8.2	-4.6	-6.8
τ=0.9	18.8	13.2	14.9	12.2	-3.4	**-9.9**	-3.7	-2.5	3.1	6.4	-6.7	**-9.6**

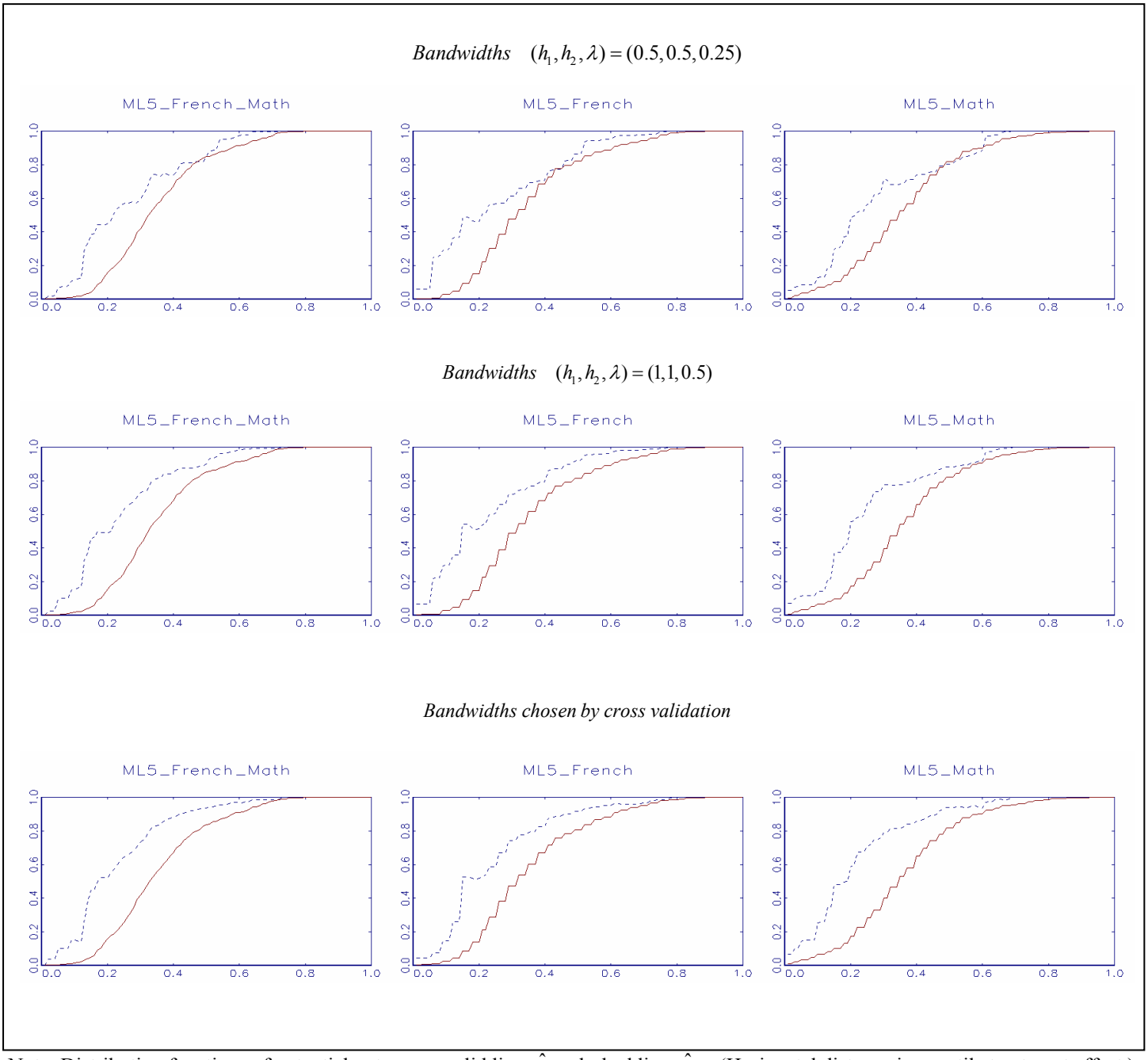
Note: Percentage points treatment effects, significant at 10% are marked in *italics*, significant at 5% are marked in **bold**, significant at 1% are marked in **bold underlined**.

Figure 1: Potential outcomes for Mali 2nd grade (Xset 1)



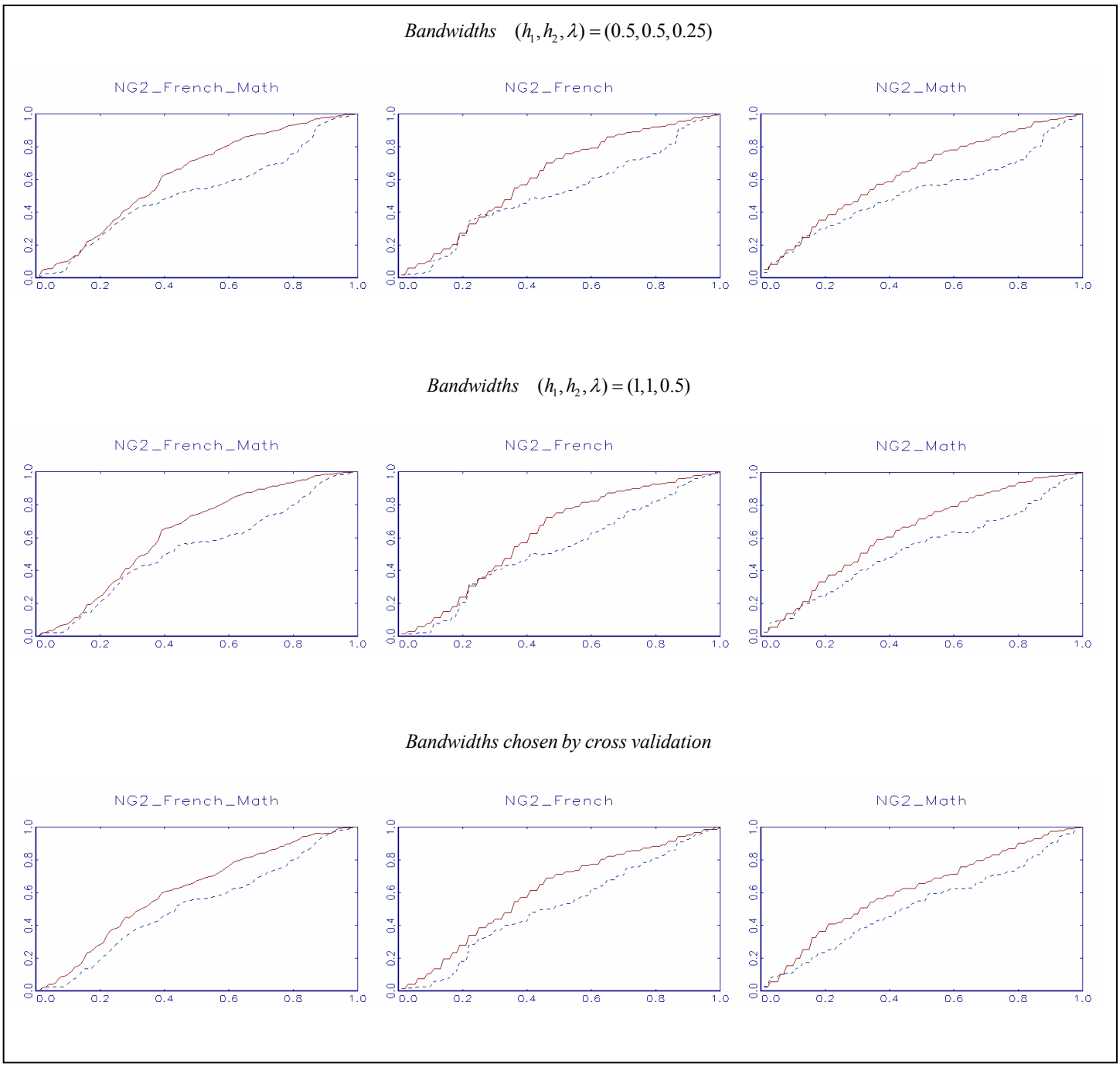
Note: Distribution functions of potential outcomes, solid line $\hat{F}_{y^1}$, dashed line $\hat{F}_{y^0}$. (Horizontal distance is quantile treatment effect.)

Figure 2: Potential outcomes for Mali 5th grade (Xset 1)



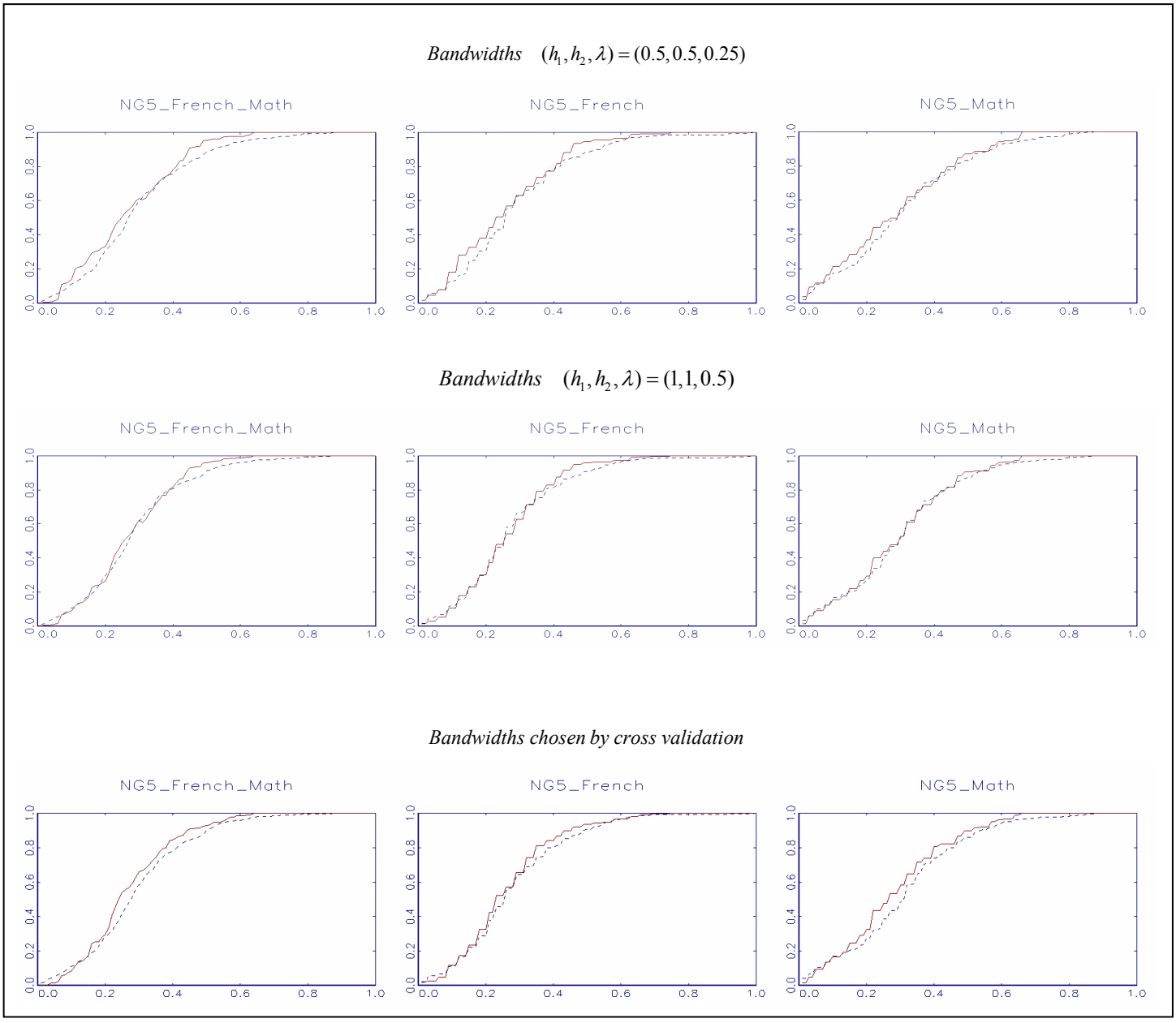
Note: Distribution functions of potential outcomes, solid line $\hat{F}_{Y^1}$, dashed line $\hat{F}_{Y^0}$. (Horizontal distance is quantile treatment effect.)

Figure *3*: Potential outcomes for Niger 2nd grade (Xset 1)



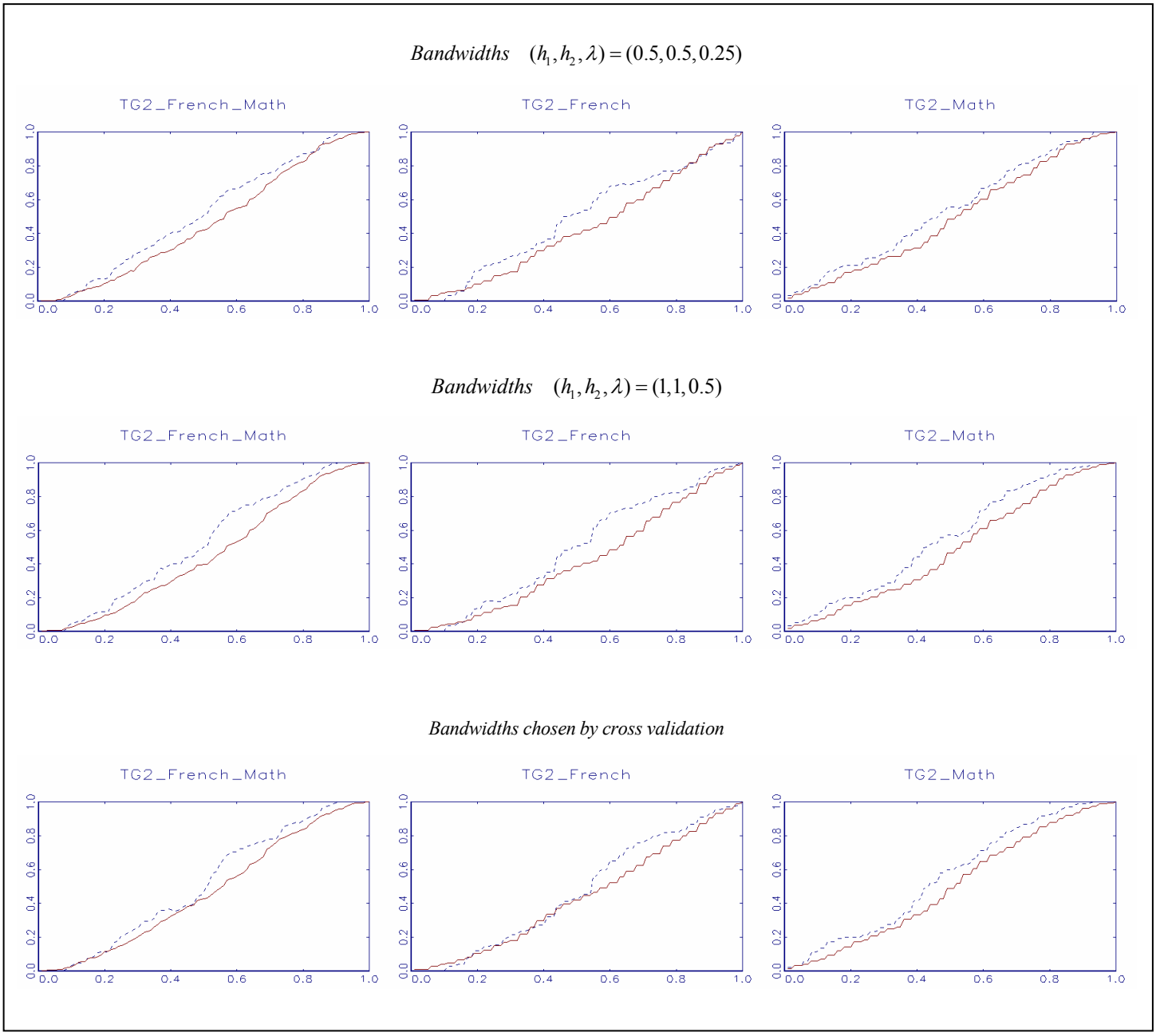
Note: Distribution functions of potential outcomes, solid line $\hat{F}_{Y^1}$, dashed line $\hat{F}_{Y^0}$. (Horizontal distance is quantile treatment effect.)

Figure 4: Potential outcomes for Niger 5th grade (Xset 1)



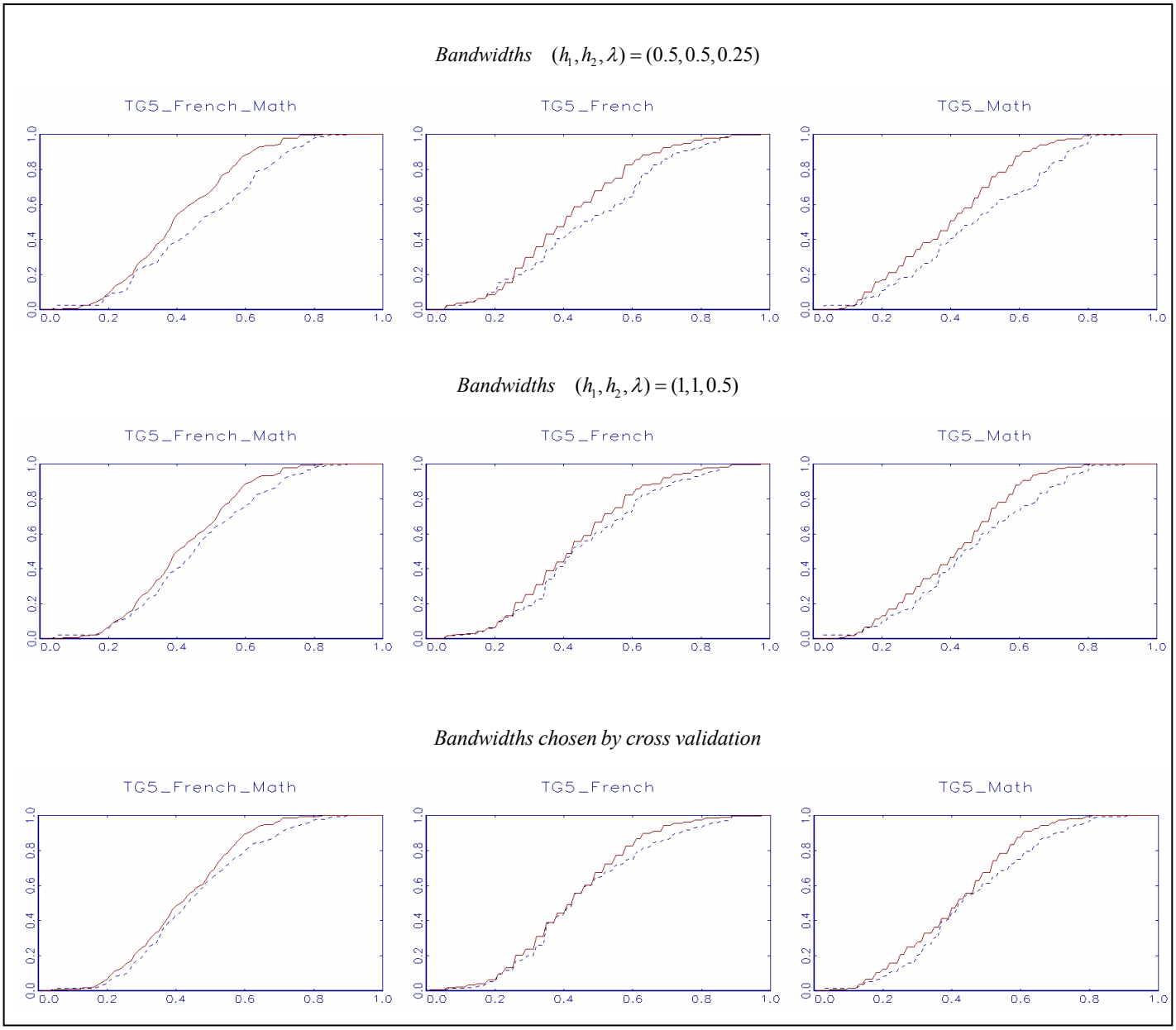
Note: Distribution functions of potential outcomes, solid line $\hat{F}_{Y^1}$, dashed line $\hat{F}_{Y^0}$. (Horizontal distance is quantile treatment effect.)

Figure 5: Potential outcomes for Togo 2nd grade (Xset 1)



Note: Distribution functions of potential outcomes, solid line $\hat{F}_{Y^1}$, dashed line $\hat{F}_{Y^0}$. (Horizontal distance is quantile treatment effect.)

Figure 6: Potential outcomes for Togo 5th grade (Xset 1)



Note: Distribution functions of potential outcomes, solid line $\hat{F}_{Y^1}$, dashed line $\hat{F}_{Y^0}$. (Horizontal distance is quantile treatment effect.)

6. Conclusions

In this paper we analyzed the impact of the 'contract teacher' reforms on educational quality. Traditionally, in most countries, teachers are hired as *civil servants* after a well regulated initial education and training period and with clear career advancements tracks. Due to financial pressure, high schooling demand and other reasons, many African (as well as Latin American and South Asian) countries have experimented with alternative forms to engage new teachers, usually providing only fixed term contracts with lower remuneration and reduced entry requirements. In this paper we provide an overview of these contract teacher reforms in francophone Africa and nonparametrically estimate *quantile treatment effects* for Niger, Togo and Mali. Our empirical analysis is based on data collected by PASEC in several francophone African countries, with the advantage that sampling, data collection, ability testing, interviewing, data cleaning etc. always follow similar procedures, and that, with few exceptions, variables are always coded and defined in the same way.

Our estimations point to two major findings. First it seems that contract teachers do relatively better for low ability than for high ability students. *When positive treatment effects are found, they tend to be more positive at the low to medium quantiles, and when negative effects are observed they tend to be more pronounced at the high ability quantiles.* This pattern is remarkably stable across countries, and most pronounced for Niger 2nd grade and Togo 5th grade. This suggests that relative to traditional civil servant teachers, contract teachers are in a better position to work in a more difficult learning environment and to react to the needs of students with the most serious learning deficiencies. Thereby, they tend to reduce existing inequalities in overall student outcomes.

Second, we observe clear differences in the impact of contract teachers between the three countries. The treatment effects are highly *negative* for *Niger* in the 2nd grade and tend to be very small, and slightly negative, for the 5th grade. In *Togo* we found clearly positive effects for 2nd grade students. For the 5th grade, the effects were very small and negative for low ability but very large and negative for high ability students. Here contract teachers do well in low grades, but clearly fail in the 5th grade for the more advanced students. In contrast, in *Mali*, the treatment effects tend to be positive for both 2nd and 5th grade, particularly in Mathematics.

Hence, when ordering the three countries by their overall effects, we find that effects are *positive in Mali*, somewhat *mixed in Togo* (with positive effects in 2nd and negative effects in 5th grade) and *negative in Niger*. This ordering can be related to the details of the implementation of the contract teacher programme. In Mali and Togo, contract teachers have

been introduced in a less centralized way and, especially in Mali, the system continues to work predominantly through the local communities. This could have led to a closer monitoring and more effective hiring of contract teachers, which may have contributed to this positive outcome. In Niger, apart from the centrally governed overall approach, the very fast hiring of huge numbers of contract teachers relative to a rather limited base of qualified secondary graduates may also have contributed to poor performance.

Hence, a focus on local community and parental involvement in hiring and monitoring contract teachers as well as a gradual rather than immediate reform process seem to be warranted.

Overall, our results thus indicate that the success or failure of contract teacher programmes in terms of student performance depends on a careful implementation of the system. Despite lower pay and adverse working conditions, the incentive effect may be positive, especially if teachers are directly engaged by parents or the local community. In this case they will feel the recognition of their effort and they can also be directly held responsible for their work.

These findings are encouraging, especially if we consider that in terms of purely quantitative objectives such as universal primary education, hiring contract teachers appears to be inevitable. According to the most recent UNESCO estimates, until the year 2015, 60 000 new teaching positions must be created in Niger, 55 000 in Mali and 12 000 in Togo (UNESCO-UIS 2006, p. 41). Taking into account the usual rates of turnover and attrition, it could be estimated that overall about 150 000 teachers will have to be recruited in the three countries. This number is twice as high as the stock of teachers currently on the job.

Our results suggest that the involvement and empowerment of parents and local communities can help to face this challenge. It should be noted, however, that relying on the cooperation of these groups tends to reinforce existing inequalities. If poor communities pay and monitor their teachers while other well to do schools are equipped and managed by public authorities, education policy becomes unacceptably regressive. The new challenge therefore is to achieve a pro-poor distribution of educational expenditure while, at the same time, encouraging local initiative and autonomy.

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Appendix A: Additional information about the contract teacher reforms, labour market conditions and the data set

Table A.1: Additional information on contracts teachers in francophone sub-Saharan Africa (primary education)[1]

Country	Total number of teachers, 2004	EFA staff needs, 2015[2]	Types of contract teachers (local names)[3]	Contract teachers in % of national primary teaching staff, 2003	Recent trends	Contract teacher salaries as compared to salaries for full rank civil servants (details and trends)
Benin	25,600	49,300	Contract teachers	24%		35%
			"Communautaires"	30% (2006)		17% and without any bonuses, since recently mainly paid by the central government budget (in 2006 only about one sixth, i.e. ca. 1,000, paid by parents and local communities)
Burkina Faso	23,400	76,500	Contract teachers	24%		80%
			Community teachers	12%		30-35%
Cameroon	55,300	78,000[d]	"Instituteurs vacataires" (IVAC)	24%	Sharp increase	25% to 40% (=90$ to 140$ per month); in 2006, a process started to integrate experienced IVAC into the civil service
			Community teachers "maîtres de parents"	45%	Decrease	Local arrangements, ca. 30$/month for seven months per year
Chad	16,200	61,200	Community teachers	65%	Permanent increase	Variable, typically 20% to 40%[4]
			Public contract teachers	< 0,5% of teaching staff)	Decrease	
Congo, Rep. of	7,100	26,400	Contract teachers	4%		100%, on nine months per year
			Volunteers	14%		Volunteers 45% to 80% also on nine months
			Community teachers	30%	Increase	Variable, estimates range from 30% to 60%
Guinea	25,400	48,200	Contract teachers	54% (2005)	Increase	55%
			Community teachers	< 2% (2005)[5]	Decrease	33%
Madagascar	64,300	89,600	Contract teachers (various types)	59% (2004)[5]	Increase	30% to 50% for state contract teachers, depending on types, figures are rapidly changing [6]
Mali	26,700	82,200	Contract teachers (various types)	65% (2004)	Overall increase	
Mauritania	9,800	16,900	Temporary staff	ca. 8% (2004)	Decrease	Hourly wages
			retirees	marginal		Bonus added to regular pension
Niger	22,400	82,700	Contract teachers	56% (2004) plus 0,7% acting as teachers during civic service.	Sharp increase	
Senegal	32,000	57,100	Educational volunteers	contract teacher 42% parents' teachers 12%		
Togo	22,200	34,100	Contract teachers	31%	Increasing	40%
			community teachers	33 %		≥16%; typically 25% to 30% for schools run by NGO

[1] This table does not only provide additional details to Table 1 (and 2) of the text, it sometimes also presents more recent information. This is notably the case when the information required for Table 1 is only partially available for the more recent year.

[2] UNESCO-UIS estimates for total requirement of primary teachers to achieve universal primary education in 2015

[3] In our text, "contract teacher" is used as a general term including all kinds of non-civil servant teachers hired on a contractual basis, independently of whether they are engaged by the public administration, the community or other private entities. In the countries, various terms are used distinguishing between these groups. The term "contract teacher" then also refers more narrowly to those teachers engaged or at least paid by public authorities. However, the terms for subgroups are not used in any uniform way across different countries.

[4] In some deprived areas, monthly wage is estimated only around 10$. However, in 2005 a plan was set up as to guarantee, through a state grant a monthly salary of 45$ for community teachers with, and of 25$ for community teachers without pedagogical training. The former represents about half the wage of civil servant auxiliary teachers. The grant is financed through the state's new petroleum receipts.

[5] While officially, the status of most community teachers was changed into (public) contract teachers in 2004, some doubts remain with respect to official statistics. In particular, it has been observed that communities continue to hire their own teachers which are not taken into account.

[6] In early 2007 a five-year plan was launched to hire 13 000 "vacataires" to support the EFA process.

Sources: World Bank (2002, 2004, 2005a, 2005b, 2005c 2006a, 2007), World Bank (Africa Region) and Pôle de Dakar (2007), UNESCO-UIS (2006, p 162).

Table A2: School to work transition and alternative labour market opportunities for teacher candidates

		Mali (1998-2004)	Niger (2000-2002)	Togo (1997-2000)
Annual number of graduates (labour market supply, skilled or semi-skilled)	Lower secondary attainment	19100	7900	11800
	Upper secondary attainment	6100	2200	4200
	Tertiary attainment	4000	1500	1600
Annual job openings (labour market demand, skilled or semi-skilled and unskilled, modern sector)	Professionals (skilled / highly skilled)	670	500	300
	Semi-skilled and unskilled	6500	3000	1700
Ratio tertiary graduates / professional positions		6,0	3,0	5,3
Ratio secondary and tertiary graduates / total modern sector positions		3,9	3,4	9,4

Sources: World Bank (2002, p. 77, 2004, p. 97, 2006a, p. 141).

Table A3: Sample description: averages of student, teacher, and school variables, by country and teacher status

	Mali				Niger				Togo			
	2nd grade		5th grade		2nd grade		5th grade		2nd grade		5th grade	
	D=0	D=1	D=0	D=1	D=0	D=1	D=0	D=1	D=0	D=1	D=0	D=1
School location												
Next city at least one hour away from school location (dummy)	0.1	0.49	0.26	0.42	0.44	0.17	0.26	0.34	0.34	0.48	0.38	0.31
School is located in a small village (dummy)	0	0.12	0.2	0.17	0.1	0.06	0.07	0.08	0.04	0.29	0.04	0.16
School is located in a big village (dummy)	0.1	0.35	0.16	0.29	0.24	0.26	0.19	0.26	0.31	0.23	0.28	0.41
Student variables												
Student's initial test score in French (0-100 % of correct answers)	0.29	0.19	0.33	0.31	0.18	0.16	0.24	0.23	0.39	0.39	0.55	0.41
Student's initial test score in Math (0-100 % of correct answers)	0.44	0.32	0.38	0.36	0.39	0.32	0.27	0.27	0.49	0.49	0.62	0.54
Student is a boy (dummy)	0.46	0.47	0.49	0.41	0.6	0.52	0.53	0.55	0.56	0.53	0.51	0.58
Student's age (7-20 years)	8.4	8.17	12.11	12.14	7.96	8	11.45	11.46	8.11	8.34	10.44	11.81
Student's socio-economic background, indicator 3: family possession of various consumer and investment goods, adjusted to urban/rural differences (0-1)	0.45	0.37	0.49	0.36	0.32	0.3	0.3	0.36	0.33	0.24	0.46	0.24
Student's family possesses a car (dummy)	0.3	0.2	0.3	0.18	0.16	0.19	0.15	0.2	0.26	0.17	0.33	0.18
Student's family possesses a refrigerator (dummy)	0.28	0.23	0.29	0.18	0.21	0.17	0.16	0.25	0.27	0.13	0.36	0.14
Student's family has a flush toilet	0.15	0.14	0.21	0.1	0.25	0.18	0.14	0.2	0.19	0.19	0.27	0.08
Student's family has electricity (dummy)	0.52	0.36	0.47	0.29	0.34	0.33	0.29	0.4	0.42	0.29	0.55	0.23
Student's family has access to tab water (dummy)	0.39	0.28	0.52	0.2	0.29	0.25	0.25	0.34	0.27	0.16	0.37	0.13
Student's family possesses a plough (dummy)	0.26	0.41	0.44	0.56	0.17	0.22	0.2	0.17	0.07	0.11	0.09	0.12
Student's family possesses a radio, TV and/or a video player (0-3)	1.94	1.59	1.99	1.67	1.25	1.23	1.34	1.49	1.23	1	1.82	1.2
Student's family possesses a video player (dummy)	0.3	0.18	0.33	0.2	0.17	0.16	0.14	0.23	0.2	0.09	0.31	0.13
Student's family possesses a radio (dummy)	0.96	0.94	0.97	0.95	0.76	0.77	0.87	0.83	0.69	0.69	0.93	0.81
Student's family possesses TV (dummy)	0.67	0.45	0.65	0.47	0.32	0.31	0.33	0.43	0.34	0.23	0.59	0.27
Student helps with commercial activities, agricultural activities and/or animal husbandry (0-3)	2.21	2.14	1.97	2.43	1.07	0.95	1.2	1.15	0.83	1.16	0.94	1.51
Student helps with field work (dummy)	0.37	0.51	0.45	0.64	0.52	0.46	0.57	0.56	0.35	0.63	0.36	0.74
Student helps with agricultural work and animal husbandry (dummy)	0.4	0.33	0.23	0.38	0.32	0.28	0.31	0.29	0.28	0.37	0.22	0.38

Table A3 cont.

	Mali				Niger				Togo			
	2nd grade		5th grade		2nd grade		5th grade		2nd grade		5th grade	
	D=0	D=1	D=0	D=1	D=0	D=1	D=0	D=1	D=0	D=1	D=0	D=1
Student helps with commercial activities (dummy)	0.32	0.26	0.25	0.32	0.24	0.22	0.33	0.29	0.2	0.16	0.37	0.4
Student has breakfast, lunch and/or dinner (0-3)	2.96	2.95	2.94	2.95	2.86	2.88	2.95	2.89	2.65	2.77	2.81	2.61
Student has breakfast never, sometimes or regularly (0-1)	0.99	0.98	0.97	0.98	0.98	0.99	1	1	0.88	0.9	0.95	0.86
Student has lunch never, sometimes or regularly (0-1)	0.99	0.99	0.98	0.99	0.92	0.93	0.97	0.93	0.88	0.93	0.93	0.87
Student has dinner never, sometimes or regularly (0-1)	0.98	0.98	0.99	0.98	0.95	0.96	0.98	0.97	0.89	0.93	0.93	0.88
Student has a textbook for French, for Math or both (0-2)	0.39	0.29	0.72	0.55	0.36	0.38	0.4	0.41	1	0.48	1.34	0.72
Student gets help with studies at home (dummy)	0.71	0.6	0.75	0.55	0.49	0.52	0.65	0.68	0.6	0.65	0.68	0.55
Student speaks French at home (dummy)	0.09	0.12	0.42	0.22	0.07	0.07	0.04	0.09	0.48	0.41	0.86	0.86
Student is repeating the 5th grade (dummy) e)	0.15	0.2	0.27	0.24	0.08	0.1	0.08	0.11	0.2	0.31	0.16	0.22
Student's number of previous grade repetitions (0-4)	0.18	0.17	0.41	0.47	0.15	0.09	0.23	0.19	0.31	0.5	0.72	1.2
School variables												
Class size	71.41	63.51	58.77	54.33	46	45.68	34.43	36.14	40.46	38.36	32.81	36.83
Share of female students in the class (0-100%)	45.81	46.07	40.89	42.16	44.14	45.15	45.07	44.92	44.54	46.69	48.44	44.69
School's overall number of students (14-2733)	304.28	234.47	251.55	211.24	348.08	368.52	391.95	445.62	511.08	460.43	441.46	512.32
School equipment indicator, low to high (0-14)	5.48	4.85	4.82	4.9	3.78	3.9	3.77	4.31	4.29	3	5.68	3.23
School has access to fresh water (dummy)	0.68	0.74	0.74	0.68	0.67	0.58	0.63	0.63	0.56	0.21	0.51	0.3
Classroom has electricity (dummy)	0.34	0.11	0.25	0.03	0.14	0.15	0.11	0.18	0.27	0.05	0.21	0.05
School has toilets	0.68	0.75	0.73	0.79	0.57	0.48	0.48	0.64	0.75	0.19	0.75	0.39
Parents easily mobilized for school issues (dummy)	0.28	0.51	0.27	0.48	0.57	0.76	0.83	0.56	0.6	0.58	0.42	0.43
Frequent exchange among teachers (dummy)	0.9	0.92	0.91	0.91	0.75	0.84	0.79	0.74	0.96	0.95	0.96	1
Director is male (dummy)	0.78	0.9	0.66	0.84	0.84	0.84	0.9	0.77	0.95	0.92	0.92	0.89
Director's education index, from below primary completion to 3 years of higher education and above (0-6)	3.46	3.08	2.32	3.07	3.98	4.07	3.93	3.88	3.1	3.29	3.2	2.96
Director received some pedagogical training (dummy)	0.8	0.8	1	0.8	0.88	0.9	0.98	0.85	0.16	0.19	0.21	0.25
School participates in a pilot project, exchange program etc. (dummy)	0.32	0.24	0.44	0.3	0.36	0.41	0.43	0.19	0.08	0.35	0.19	0.21

Table A3 cont.

	Mali				Niger				Togo			
	2nd grade		5th grade		2nd grade		5th grade		2nd grade		5th grade	
	D=0	D=1	D=0	D=1	D=0	D=1	D=0	D=1	D=0	D=1	D=0	D=1
Teacher variables												
Teacher is male (dummy)	0.29	0.28	0.51	0.71	0.34	0.06	0.47	0.36	1.36	1.32	1.03	1.05
Teacher's age (21-60 years)	35.01	29.83	36.53	31.93	30.08	27.79	30.07	28.74	34.62	32.52	36.01	34.09
Teacher's education index, from below primary completion to 3 years of higher education and above (0-6)	2.34	1.61	2.34	2.15	4.01	3.72	4.51	4.18	2.86	2.88	3.82	4
Teacher speaks local language (dummy)	0.61	0.73	0.86	0.8	0.9	0.92	0.91	0.93	0.82	0.79	0.75	0.61
School inspected during the last 12 months (dummy)	1	0.79	1	0.81	0.78	0.83	0.86	0.73	0.57	0.69	0.64	0.79
Teacher's job experience (0-40 years)	8.43	3.12	7.04	3.82	4.88	2.44	5.58	2.7	6.2	5.47	7.04	5.87
Class management in double shifts (dummy)	0.59	0.39	0.5	0.39	0.09	0.1	0	0	0	0	0	0
Class management with multi-grade teaching (dummy)	0.09	0.06	0.06	0.15	0	0.07	0.06	0.04	0	0.1	0	0.02
Classroom is equipped with a blackboard and chalk (dummy)	1	0.86	0.91	1	0.87	0.93	0.92	1	0.83	0.76	0.75	0.83

Notes: Range of possible values in parenthesis.
Teacher status: D=0 civil servant, D=1 contract teacher.
Source: PASEC database.

Appendix B: Additional details on the econometric methodology

A nonparametric matching estimator of the potential outcome distribution is

$$\hat{\Pr}(Y^d \le a) = \frac{1}{n}\sum_i \hat{m}_a(X_i, d) \quad , d=0,1 \tag{5}$$

where $\hat{m}_a$ is a nonparametric regression estimator of

$$m_a(x,d) = E[1(Y \le a) \mid X = x, D = d]. \tag{6}$$

Since $m_a(x,d)$ is bounded between zero and one, a local logit specification is used to implement the boundedness restriction in a natural way. Define $Y_j^* = 1(Y_j \le a)$. For estimating $m_a(x,d)$ at a location *x* the local log likelihood is maximized among the $D_j = d$ observations

$$\arg\max_{\beta_{xd}} \sum_j \left\{ Y_j^* \ln g(X_j, \beta_{xd}) + (1 - Y_j^*) \ln(1 - g(X_j, \beta_{xd})) \right\} \cdot 1(D_j = d) \cdot K_j, \tag{7}$$

where

$$g(X_j, \beta_{xd}) = \frac{1}{1 + e^{-X_j' \beta_{xd}}} \tag{8}$$

is the logit function and K_j a kernel weight further described below. The coefficients β_{xd} may be different for any value of *x* and *d,* and $m_a(x,d)$ is then estimated as

$$\hat{m}_a(x,d) = g(x, \hat{\beta}_{xd}). \tag{9}$$

Since the local log likelihood function is concave, the maximizer is found usually within very few iterations.

The kernel weighting function K_j assigns larger weights to observations close to *x*. With X_j being multidimensional and also containing a large number of binary regressors, we follow a suggestion by Racine and Li (2004) to also smooth over the dummy variables to improve precision in small samples, see Racine and Li (2004). A product Gaussian kernel is used for the continuous and ordered discrete variables, whereas the dummy variables enter multiplicatively with a weight of one if this variable is identical in *x* and X_j and a weight of $\lambda<1$ otherwise. Let X_j be a vector of dimension Q where the regressors are ordered such that the first element is a constant, the elements 2,...,Q_1 are continuous and ordered discrete regressors and the last Q_1+1,...,Q elements are dummy variables. The kernel weights are computed as

$$K_j = \prod_{q=2}^{Q_1} \phi\left(\frac{X_{j,q} - x_q}{h}\right) \cdot \prod_{q=Q_1+1}^{Q} \lambda^{1(X_{j,q} \ne x_q)}. \tag{10}$$

If λ=0, only observations X_j that are identical to x with respect to all dummy variables receive positive weights. This corresponds to running separate local regressions within each cell defined by the dummy variables. If λ=1, the dummy variables would not affect the kernel weights but would enter only in the local approximation plane $g(X_j, \beta_{xd})$.

In principle different bandwidth values h or λ could be used for every regressor, which however would require choosing a very large number of smoothing parameters. Instead we distinguish *three* bandwidths: h_1 for the French and Math test scores at the beginning of the school year, h_2 for all the other non-binary regressors and λ for the binary regressors. Before estimation, all the non-binary regressors are rotated such that their sample variance-covariance matrix is the identity matrix. In other words, these transformed regressors all have the same standard deviation and are uncorrelated. This reduces colinearity problems and also ensures that the effective bandwidth is about proportional to the standard deviation of each variable.

For choosing bandwidth values for nonparametric regression, least-squares cross-validation is a frequently used approach. For matching estimators, where the nonparametric regression enters only as a plug-in and is then averaged over, it is well known that some asymptotic undersmoothing is required to reduce the order of the bias term. However, no data-driven bandwidth selectors for matching estimators based on local logit regression seem to be available so far. Therefore, we pursue a rather conservative approach in that we estimate the potential outcome distributions for bandwidth values chosen by leave-one-out least-squares cross-validation[14] and for two sets of fixed bandwidth values: $(h_1, h_2, \lambda) = (0.5, 0.5, 0.25)$ and $(h_1, h_2, \lambda) = (1, 1, 0.5)$. We expect the cross-validation bandwidths to generate a larger bias and will therefore concentrate on the latter two bandwidth choices to examine sensitivity of the estimates to the bandwidth values. Only if the estimates appear to be rather stable, one would be confident to trust in the results.[15]

The precise implementation of the local logit estimator follows Frölich (2006a). For any given bandwidths values it may occur that for some locations x and d the local likelihood estimator is not well defined, e.g. due to local near-colinearity or perfect prediction. This happens

[14] The bandwidths were chosen by leave-one-out least-squares cross-validation separately for the *D=0* and the *D=1* subsample, and separately for each country, grade and Xset. The list of all different bandwidth values is available from the authors upon request. They were computed for the joint achievement variable French and Math first and then also used for each of the subjects separately.

[15] This procedure seems also be justified by the finding that many data-driven bandwidth selectors converge only very slowly to the true optimal bandwidth. Hence, although being consistent, the bandwidth values chosen for a particular sample might be very variable and one would still like to examine sensitivity of the estimates to alternative bandwidth choices.

particularly for small bandwidth values and in regions of sparse data. When this happened, the bandwidths are locally, proportionally increased, repeatedly until a valid estimate is obtained. If the repeated local increases of the bandwidth values did not lead to convergence, the regressors causing local near-colinearity were dropped locally.

Appendix C: Robustness analysis, additional estimation results

The following tables and graphs show the estimated distribution functions and quantile treatment effects for the larger Xsets 2 and 3, respectively. For the 5th grade in Niger additional results are shown for an Xset 3a, in which the five variables *socioeconomic status*, *media*, *child labour*, *small village* and *active involvement of parents* have been dropped. These variables induce serious local multicolinearity problems which lead to a conspicuous kink at the higher quantiles in the estimated distribution functions for Niger 5th grade with Xset 3. To avoid this pattern of the estimates, which is more likely to be an artefact of high correlation of regressors than a true feature of the potential outcomes, we dropped these variables to examine the robustness of the estimates.

Table C.1: Quantile treatment effects (Xset 2)

	Mali 2nd		Mali 5th		Niger 2nd		Niger 5th		Togo 2nd		Togo 5th	
	French	Math	French	Math	French	Math	French	Math	French	Math	French	Math
bandwidt 0.25												
τ=0.1	-2.8	4.1	0.4	-0.1	-4.9	0.4	-0.2	-0.4	-6.5	-7.1	-5.4	-1.4
τ=0.2	1.4	3.5	2.8	0.7	-2.5	4.2	-3.2	-2.6	0.2	-6.1	3.2	-1.9
τ=0.3	3.5	3.3	-2.5	3.6	-0.1	0.4	-8.2	-7.6	5.1	2.1	0.5	-0.3
τ=0.4	2.2	5.1	-0.1	5.7	2.0	-7.2	-0.9	-6.5	7.7	5.5	-3.2	-2.3
τ=0.5	-14.0	6.1	-3.2	3.5	-5.1	-15.1	-3.0	-4.9	3.3	*11.4*	**-11.0**	-7.1
τ=0.6	-13.3	3.0	-3.0	7.8	**-21.0**	**-25.6**	-0.2	1.9	-1.3	5.1	**-15.1**	**-13.6**
τ=0.7	-11.6	4.9	-2.3	4.3	**-26.2**	**-21.8**	3.2	1.8	-1.5	10.0	**-16.6**	**-15.4**
τ=0.8	-13.1	-0.3	2.2	4.6	**-11.1**	**-17.1**	5.6	4.8	-1.8	8.4	-9.5	**-13.1**
τ=0.9	-8.3	-18.2	2.1	5.1	-4.9	-9.4	13.7	-5.3	-2.5	9.5	-8.3	**-10.3**
bandwidth 0.5												
τ=0.1	-2.4	4.5	0.7	3.0	-2.3	2.8	-2.6	-1.7	-0.1	-4.6	2.3	0.1
τ=0.2	1.6	3.5	2.9	2.1	-4.1	1.7	-5.5	-6.2	7.4	-2.2	3.3	2.4
τ=0.3	3.7	3.1	-2.3	4.9	0.3	-2.6	-0.9	-8.2	8.4	5.5	-2.4	-0.2
τ=0.4	2.2	5.2	-0.1	5.9	0.3	-8.6	-1.6	-4.6	**13.5**	7.7	-0.5	-0.1
τ=0.5	-16.2	5.9	-3.2	3.6	-5.5	-17.4	-0.2	0.2	5.3	*11.6*	-7.7	-5.2
τ=0.6	-13.5	2.7	-2.9	7.8	**-24.0**	**-17.9**	0.4	2.0	-1.2	**13.4**	-8.6	-6.3
τ=0.7	-13.1	2.1	-2.4	4.2	**-27.1**	**-26.5**	3.1	0.5	-3.7	*12.9*	**-10.5**	**-13.3**
τ=0.8	-13.8	-1.8	-0.1	1.9	**-22.0**	**-20.1**	-0.3	0.6	-4.4	7.9	**-10.7**	**-14.9**
τ=0.9	-11.0	-20.0	1.8	1.9	-7.8	-15.1	16.6	-2.1	-2.9	6.8	-6.7	**-10.6**
bandwidth cv												
τ=0.1	-2.4	5.1	3.1	4.5	-5.7	-0.1	0.0	-0.3	2.3	3.0	0.3	-1.4
τ=0.2	1.5	5.0	3.2	2.2	-3.1	-1.7	-0.5	-6.3	*11.0*	2.0	-5.2	-2.9
τ=0.3	3.4	4.5	-2.3	4.8	-3.0	-8.1	-2.3	-5.0	10.8	9.7	-2.6	-4.4
τ=0.4	2.0	5.1	-0.2	5.8	0.1	-9.9	0.0	-0.4	*11.0*	9.9	-3.9	-2.8
τ=0.5	-16.7	5.8	-3.5	3.3	-4.4	-8.0	2.9	2.9	3.0	7.7	-7.5	-6.8
τ=0.6	-13.3	2.6	-3.1	7.6	**-19.0**	-10.4	5.6	1.6	-0.9	9.7	-8.5	-6.8
τ=0.7	-11.5	1.7	-2.4	3.8	**-19.6**	*-16.2*	3.4	0.1	-3.6	10.1	-8.9	-7.2
τ=0.8	-13.1	-2.0	-0.3	1.8	**-19.1**	*-15.8*	1.6	0.1	-4.8	3.3	-7.2	-9.2
τ=0.9	-10.7	-19.6	1.7	0.2	-9.6	-12.6	-3.5	-4.8	-0.6	2.4	-6.3	**-13.1**

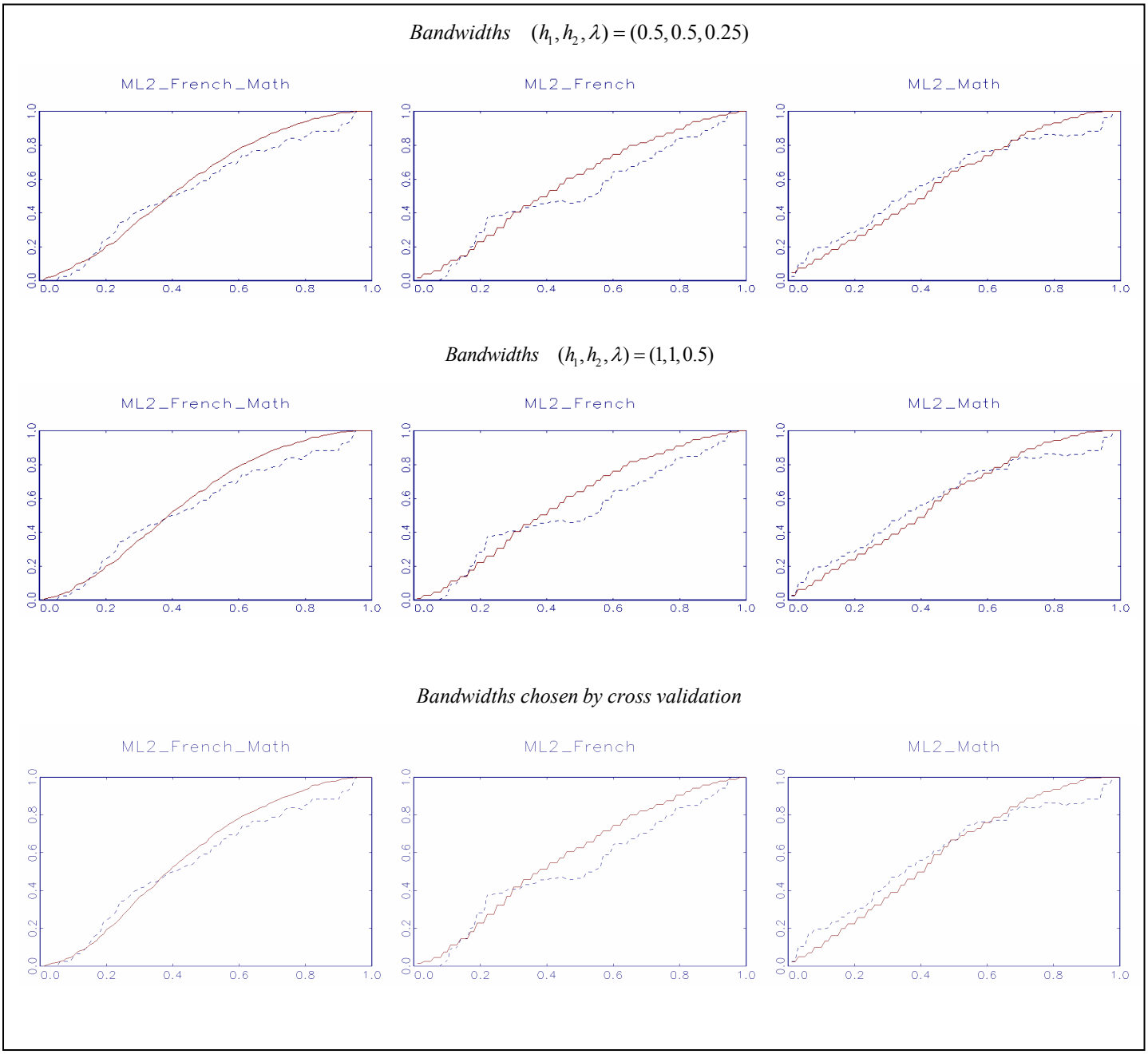
Note: Percentage points treatment effects, significant at 10% are marked in *italics*, significant at 5% are marked in **bold**, significant at 1% are marked in **bold underlined**.

Table C.2: Quantile treatment effects (Xset 3)

	Mali 2nd		Mali 5th		Niger 2nd		Niger 5th		Niger 5th **Xset 3a**		Togo 2nd		Togo 5th	
	French	Math	French	Math	French	Math	French	Math	French	Math	French	Math	French	Math
bandwidt 0.25														
τ=0.1	-3.6	4.8	-6.0	-8.1	-3.7	0.3	-0.6	-0.6	-0.3	-6.1	-5.1	-7.3	-6.3	-1.9
τ=0.2	-1.8	9.9	-5.6	-1.7	-3.0	2.9	-5.7	-6.6	-2.9	-9.7	-2.3	-3.0	-0.1	-3.6
τ=0.3	0.1	8.4	-8.5	-4.9	-0.3	4.8	-6.0	*-12.2*	-6.0	*-11.3*	-3.3	3.0	-5.5	-3.0
τ=0.4	-2.5	8.2	-8.7	-2.4	-0.3	-4.1	-0.2	*-11.1*	-4.5	-9.0	-0.1	4.6	-6.2	-6.2
τ=0.5	-0.3	8.1	-6.1	-6.7	-5.1	-12.0	0.4	-1.7	-2.9	-4.5	8.2	2.0	-8.2	-9.6
τ=0.6	1.7	5.6	-3.0	-3.7	**-24.2**	**-26.2**	5.6	2.0	2.3	1.1	8.0	1.9	**-14.4**	-8.7
τ=0.7	4.8	*11.4*	0.1	-0.4	**-27.0**	**-22.6**	19.4	7.9	0.6	1.7	6.6	7.7	**-11.2**	**-14.6**
τ=0.8	8.1	**14.8**	8.6	2.1	**-17.3**	**-16.4**	25.9	1.7	0.1	-2.7	2.9	*13.0*	**-14.5**	**-12.1**
τ=0.9	6.3	7.5	**12.5**	7.4	-5.8	-9.5	13.6	-11.4	5.7	-7.3	-0.5	10.0	-5.2	-9.9
bandwidth 0.5														
τ=0.1	-3.3	7.3	-5.6	-4.7	-2.0	0.6	-1.3	-2.0	-0.4	-6.8	-0.1	-5.2	0.0	-0.3
τ=0.2	-1.8	*10.1*	-5.3	-0.3	-4.1	1.7	-3.7	-9.7	-3.3	*-10.4*	0.5	1.6	0.0	-0.3
τ=0.3	0.1	8.4	-8.3	-3.4	-3.2	0.5	-3.0	*-10.4*	-3.5	-9.1	-0.7	4.5	-0.7	-0.3
τ=0.4	-2.6	8.2	-8.6	-2.2	-3.4	-7.9	0.4	-2.3	-4.2	-9.1	2.7	6.3	-0.7	-3.0
τ=0.5	-0.5	8.2	-6.1	-6.6	-5.5	**-17.4**	0.9	0.7	-2.7	-6.9	9.4	2.1	-6.0	-8.1
τ=0.6	1.4	5.5	-3.0	-3.9	**-26.6**	**-28.6**	9.2	5.7	-2.2	1.5	6.5	2.0	**-11.2**	-9.9
τ=0.7	3.1	*10.2*	0.1	-0.6	**-27.3**	**-26.2**	28.0	10.3	0.3	2.4	3.3	9.7	-8.1	**-12.4**
τ=0.8	7.5	**14.4**	8.7	1.6	**-21.7**	**-22.6**	28.6	6.6	0.0	-1.3	0.3	*12.7*	-9.0	**-15.1**
τ=0.9	6.0	5.8	**14.3**	5.1	-8.1	-12.8	14.4	-3.8	7.8	-4.2	-2.9	7.1	-5.7	**-13.1**
bandwidth cv														
τ=0.1	-3.2	7.4	-3.2	-3.6	-5.5	-0.1	-3.3	0.1	-0.1	-5.0	0.6	0.4	-1.6	-0.3
τ=0.2	-0.4	*11.2*	-5.0	-0.3	-3.0	-0.1	-6.4	*-11.3*	-2.9	-7.5	0.6	-0.7	-5.7	-4.5
τ=0.3	0.2	9.7	-6.0	-3.7	-5.1	-0.3	-8.7	-4.4	-2.6	-9.6	-5.7	2.3	-3.0	-5.0
τ=0.4	-2.5	8.0	-6.4	-2.0	0.5	4.4	-1.5	-2.2	0.2	-7.8	-2.4	-0.2	-6.1	-4.3
τ=0.5	-0.6	7.9	-6.0	-6.6	2.8	1.8	6.0	0.6	0.2	0.5	7.8	-3.4	-5.0	-2.2
τ=0.6	1.9	4.9	-0.8	-3.8	-5.1	-3.1	6.1	5.3	2.4	1.2	6.1	-10.3	**-11.3**	-6.8
τ=0.7	4.7	6.8	0.4	-0.8	*-15.4*	-8.7	7.7	2.2	-2.4	0.0	0.9	2.7	**-10.8**	**-12.1**
τ=0.8	8.1	**12.8**	6.5	1.9	*-11.2*	-11.7	5.3	2.0	-2.4	-0.4	0.0	5.2	**-11.0**	**-12.5**
τ=0.9	6.3	5.4	**14.1**	1.8	-3.8	-10.0	23.3	0.0	-3.8	-9.5	-0.7	6.4	**-11.5**	**-17.5**

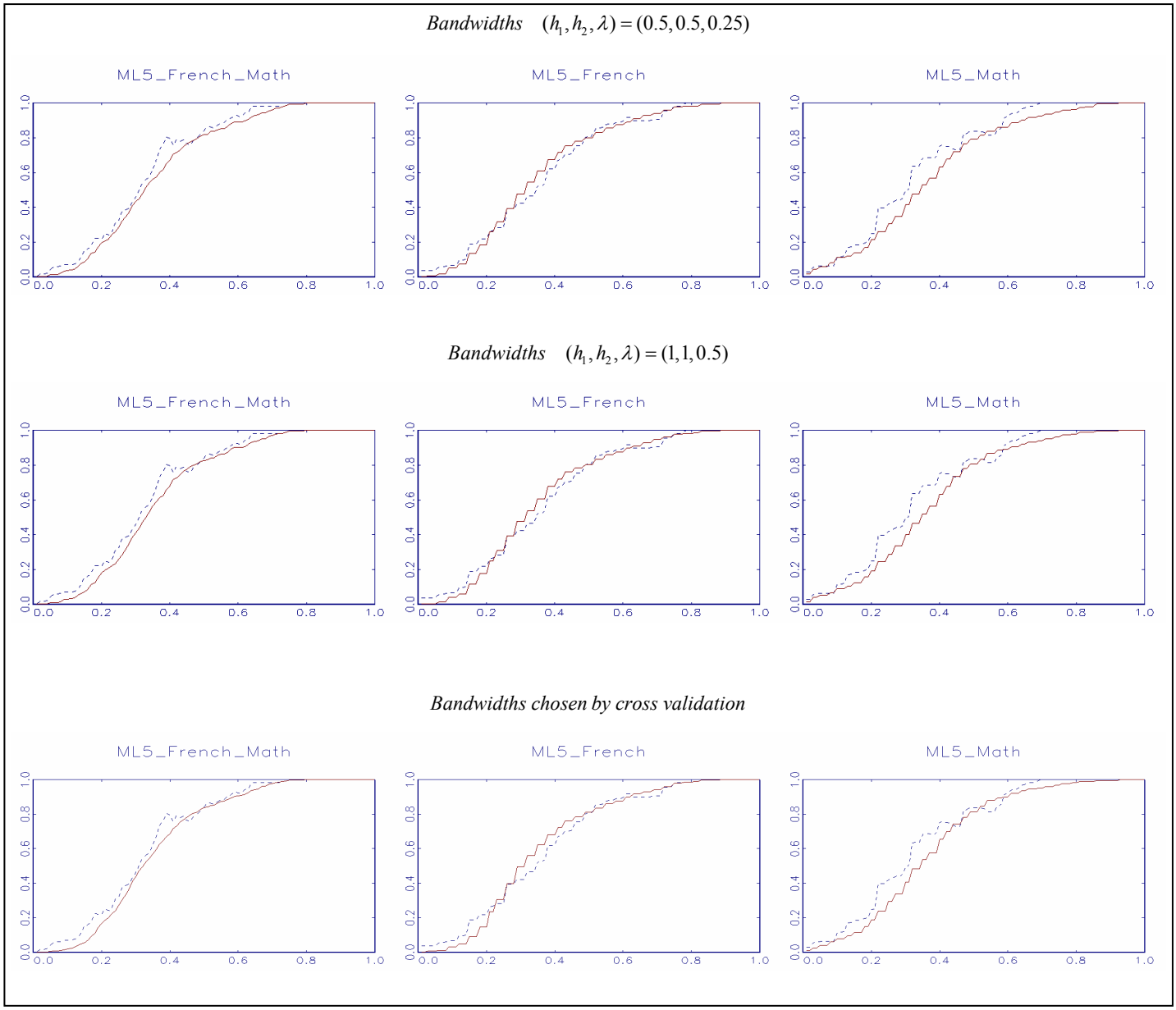
Note: Percentage points treatment effects, significant at 10% are marked in *italics*, significant at 5% are marked in **bold**, significant at 1% are marked in **bold underlined**.

Figure C1: Potential outcomes for Mali 2nd grade (Xset 2)



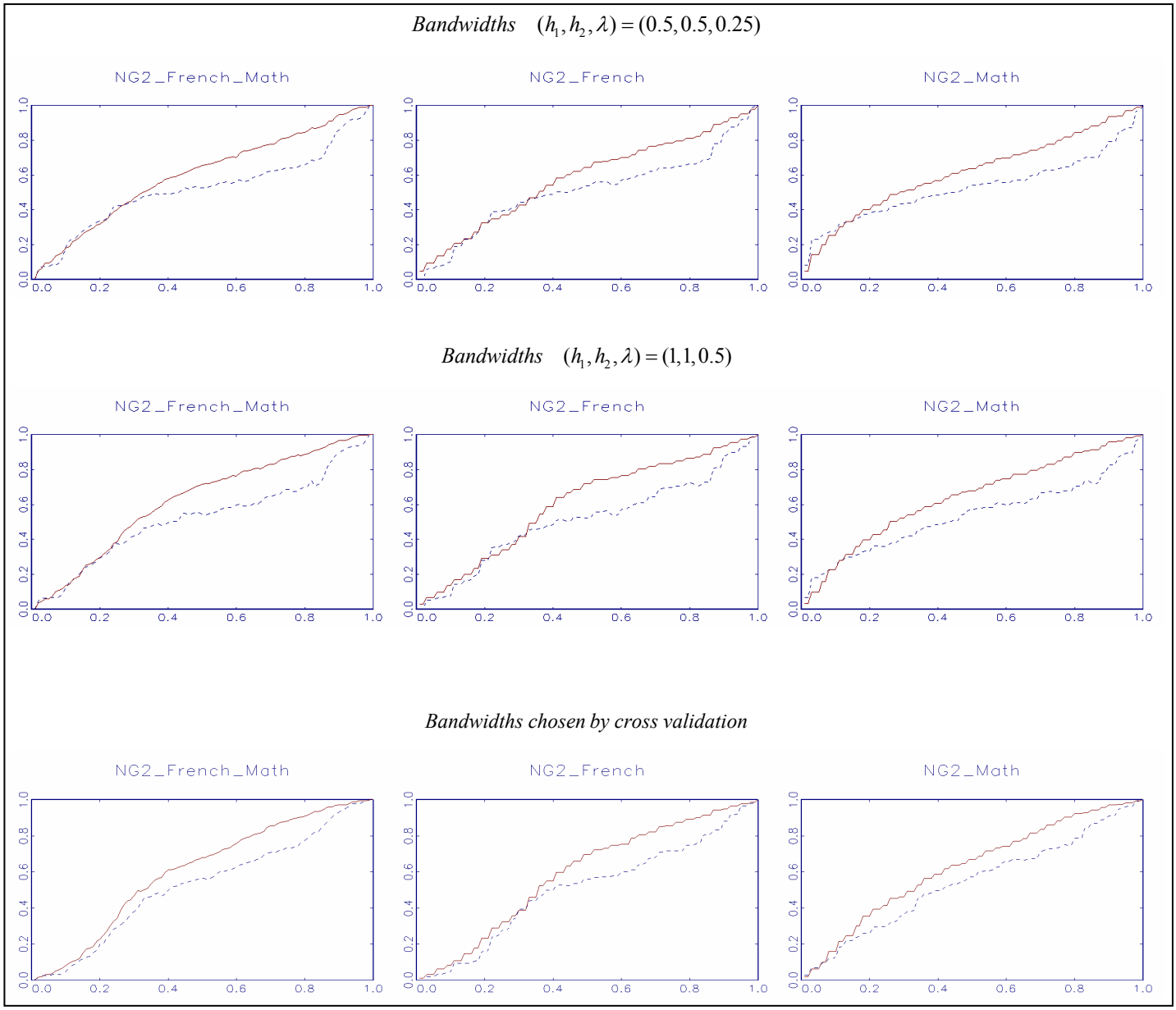
Note: Distribution functions of potential outcomes, solid line $\hat{F}_{Y^1}$, dashed line $\hat{F}_{Y^0}$. (Horizontal distance is quantile treatment effect.)

Figure C2: Potential outcomes for Mali 5th grade (Xset 2)



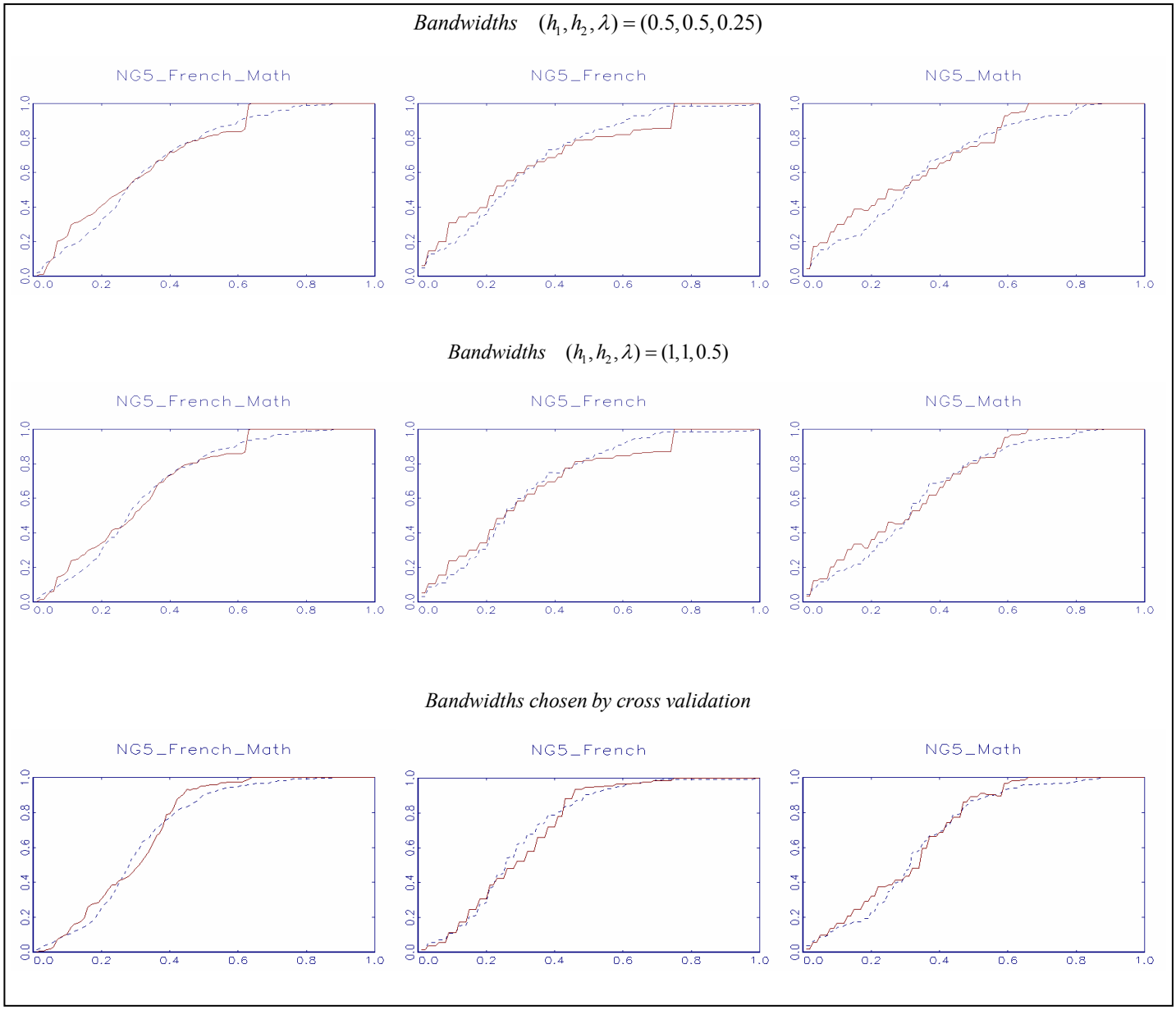
Note: Distribution functions of potential outcomes, solid line $\hat{F}_{Y^1}$, dashed line $\hat{F}_{Y^0}$. (Horizontal distance is quantile treatment effect.)

Figure C3: Potential outcomes for Niger 2nd grade (Xset 2)



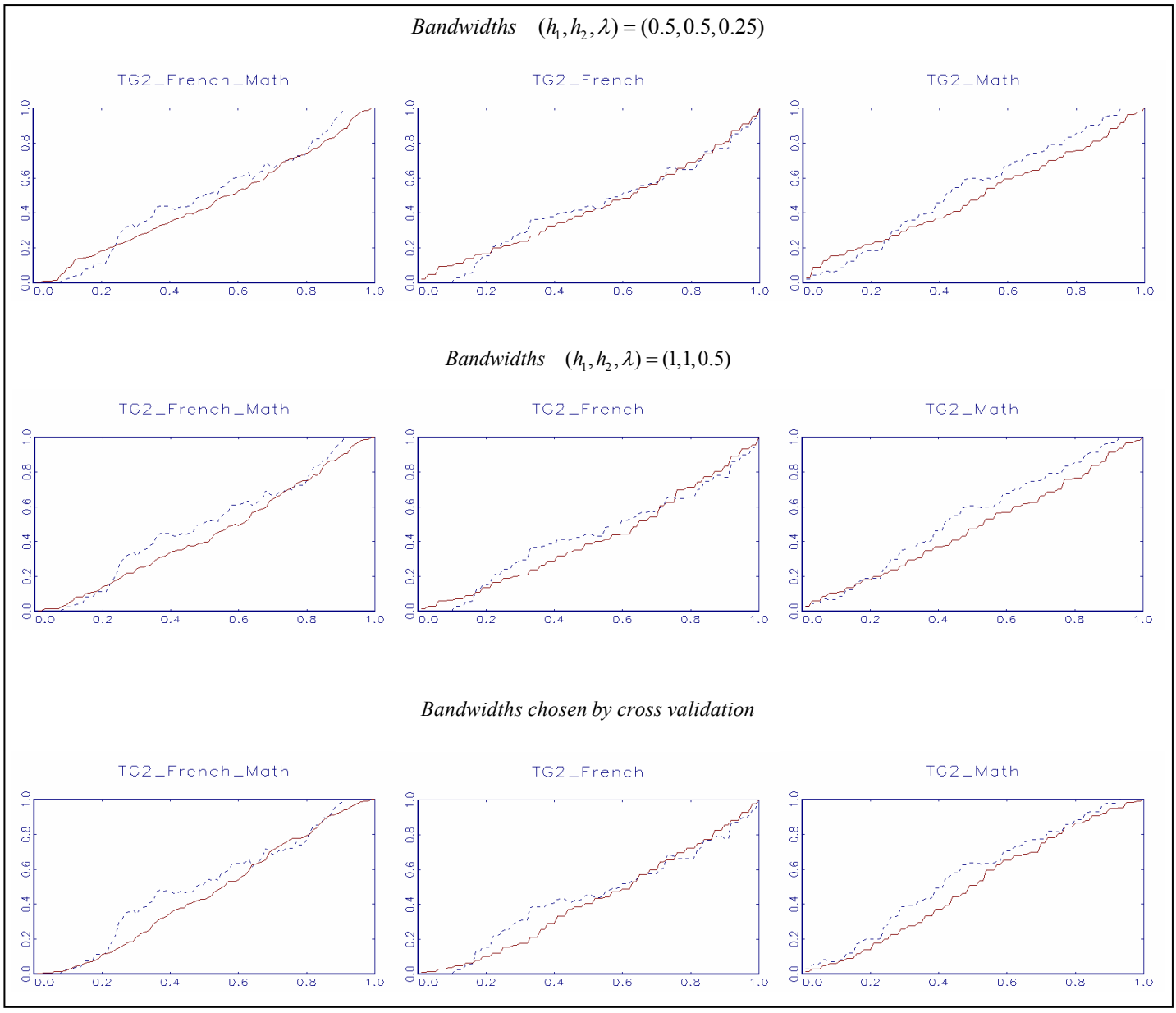
Note: Distribution functions of potential outcomes, solid line $\hat{F}_{Y^1}$, dashed line $\hat{F}_{Y^0}$. (Horizontal distance is quantile treatment effect.)

Figure C4: Potential outcomes for Niger 5th grade (Xset 2)



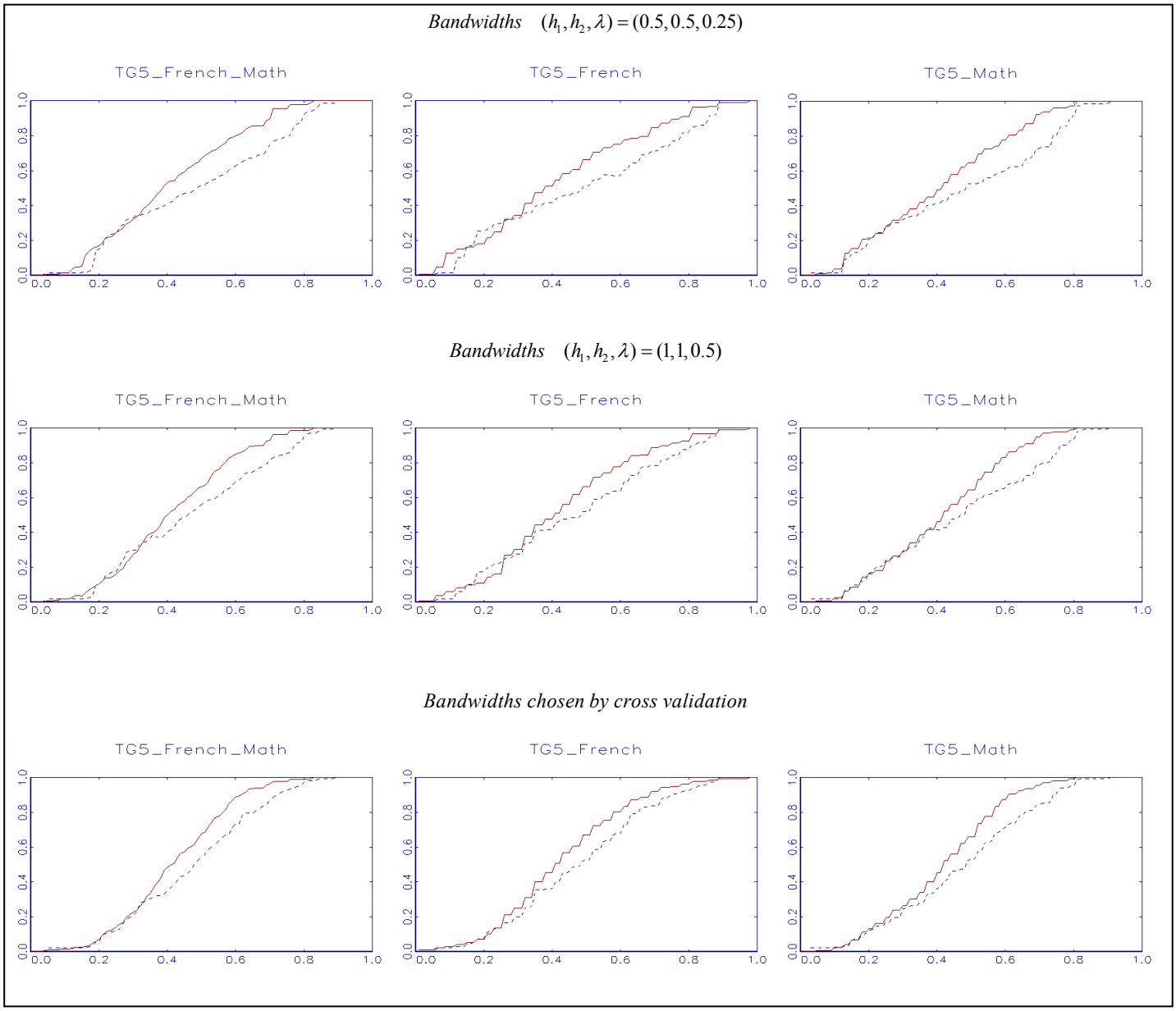
Note: Distribution functions of potential outcomes, solid line $\hat{F}_{Y^1}$, dashed line $\hat{F}_{Y^0}$. (Horizontal distance is quantile treatment effect.)

Figure C5: Potential outcomes for Togo 2nd grade (Xset 2)



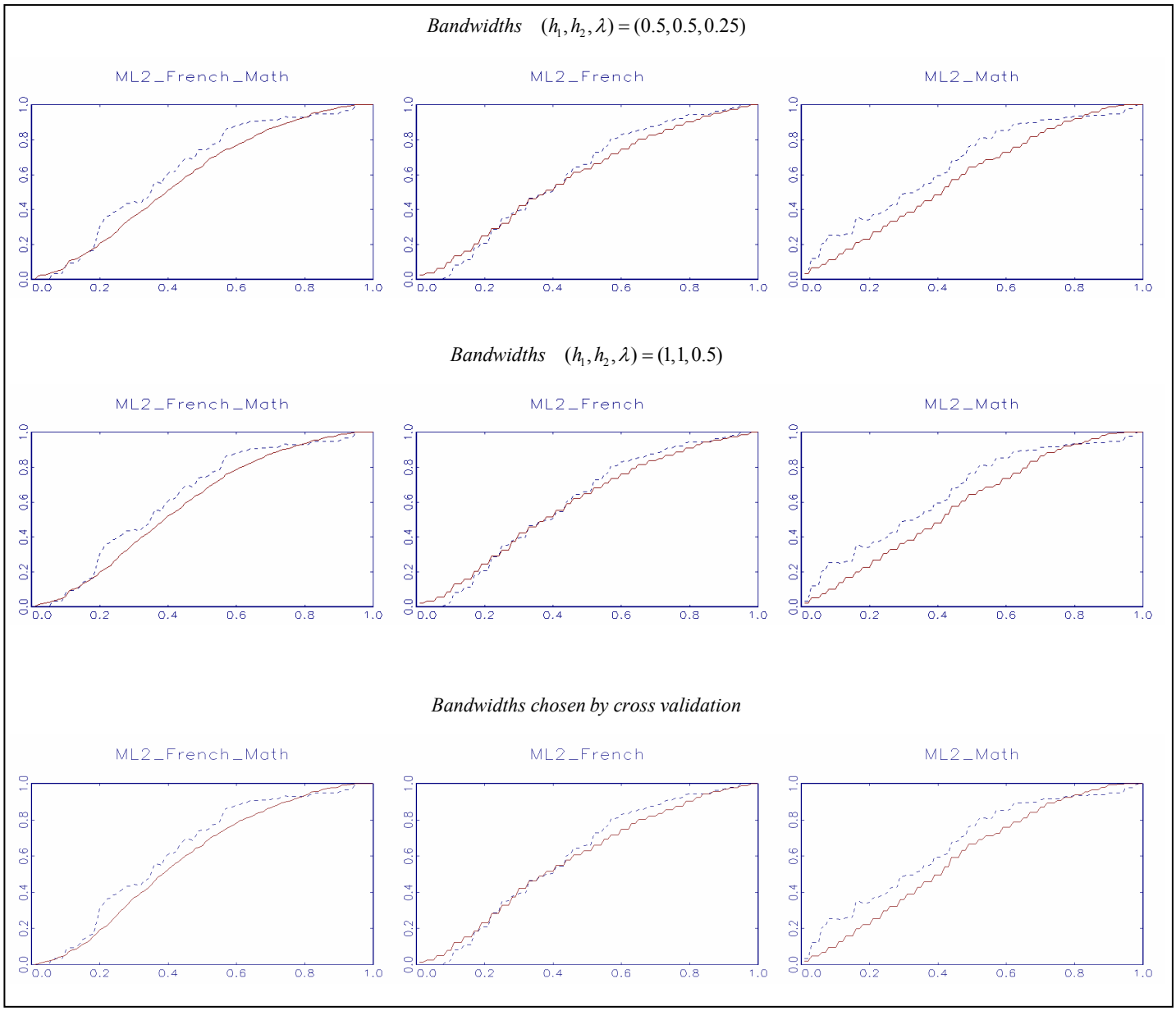
Note: Distribution functions of potential outcomes, solid line $\hat{F}_{Y^1}$, dashed line $\hat{F}_{Y^0}$. (Horizontal distance is quantile treatment effect.)

Figure C6: Potential outcomes for Togo 5th grade (Xset 2)



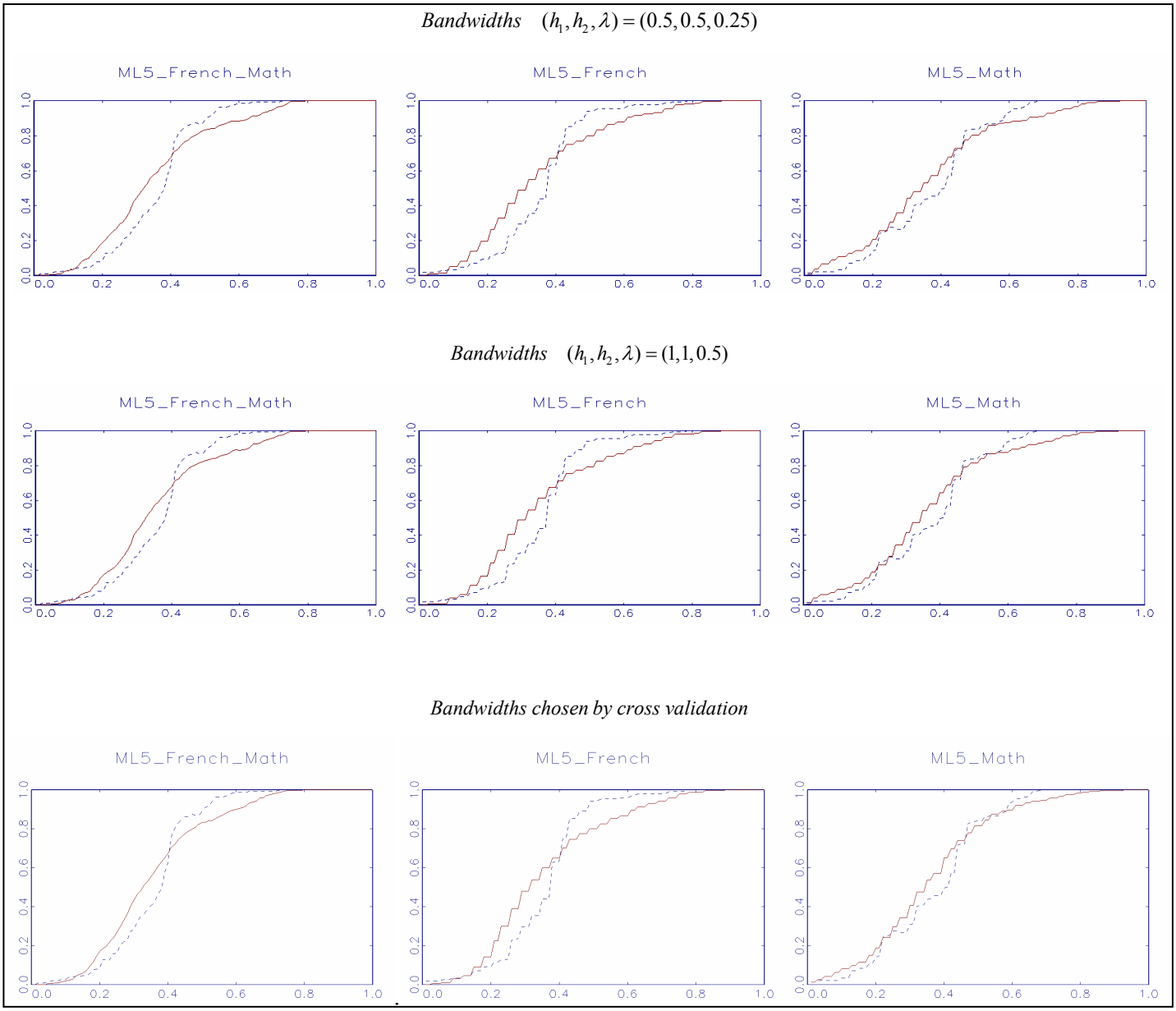
Note: Distribution functions of potential outcomes, solid line $\hat{F}_{Y^1}$, dashed line $\hat{F}_{Y^0}$. (Horizontal distance is quantile treatment effect.)

Figure C7: Potential outcomes for Mali 2nd grade (Xset 3)



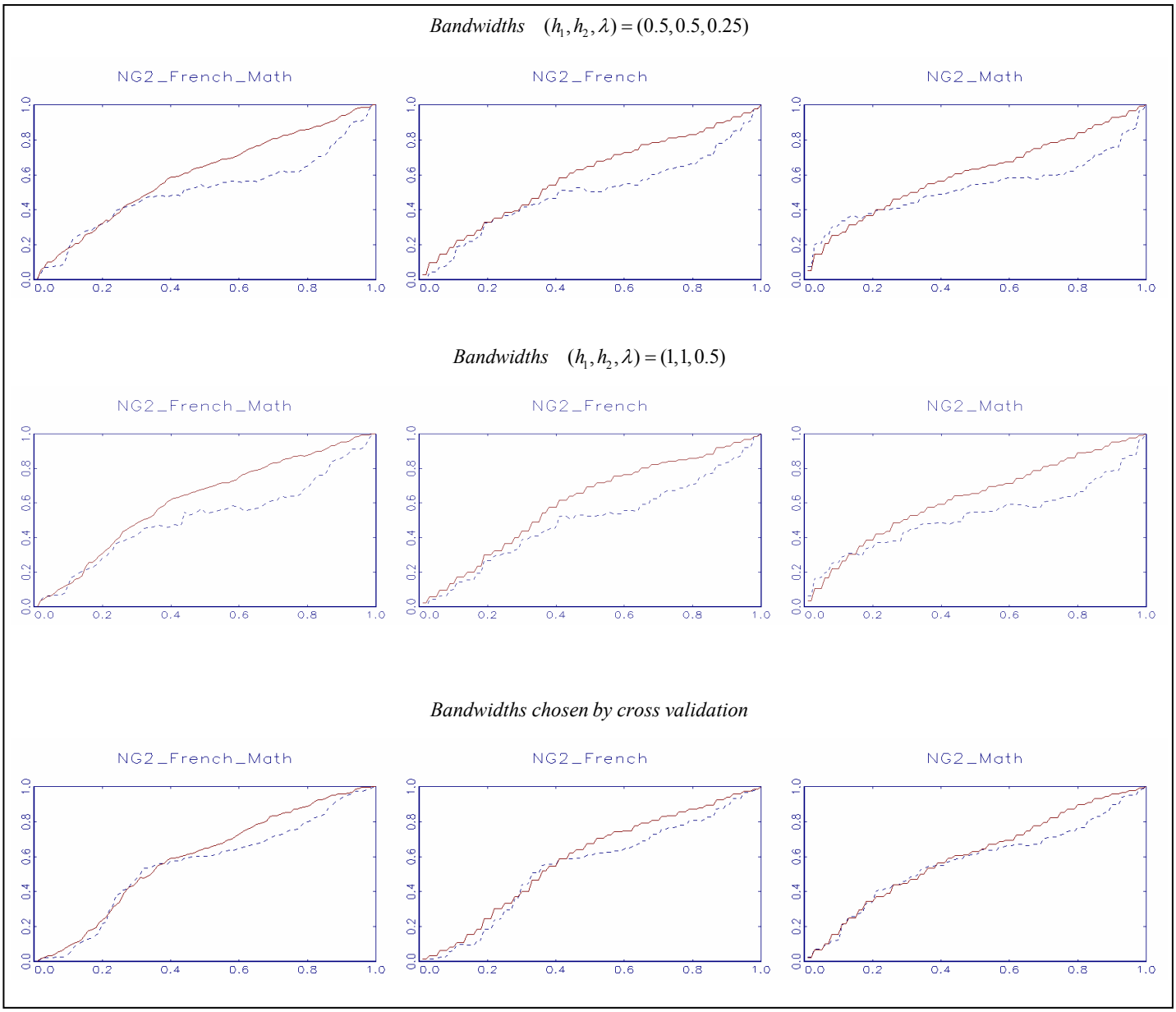
Note: Distribution functions of potential outcomes, solid line $\hat{F}_{y^1}$, dashed line $\hat{F}_{y^0}$. (Horizontal distance is quantile treatment effect.)

Figure C8: Potential outcomes for Mali 5th grade (Xset 3)



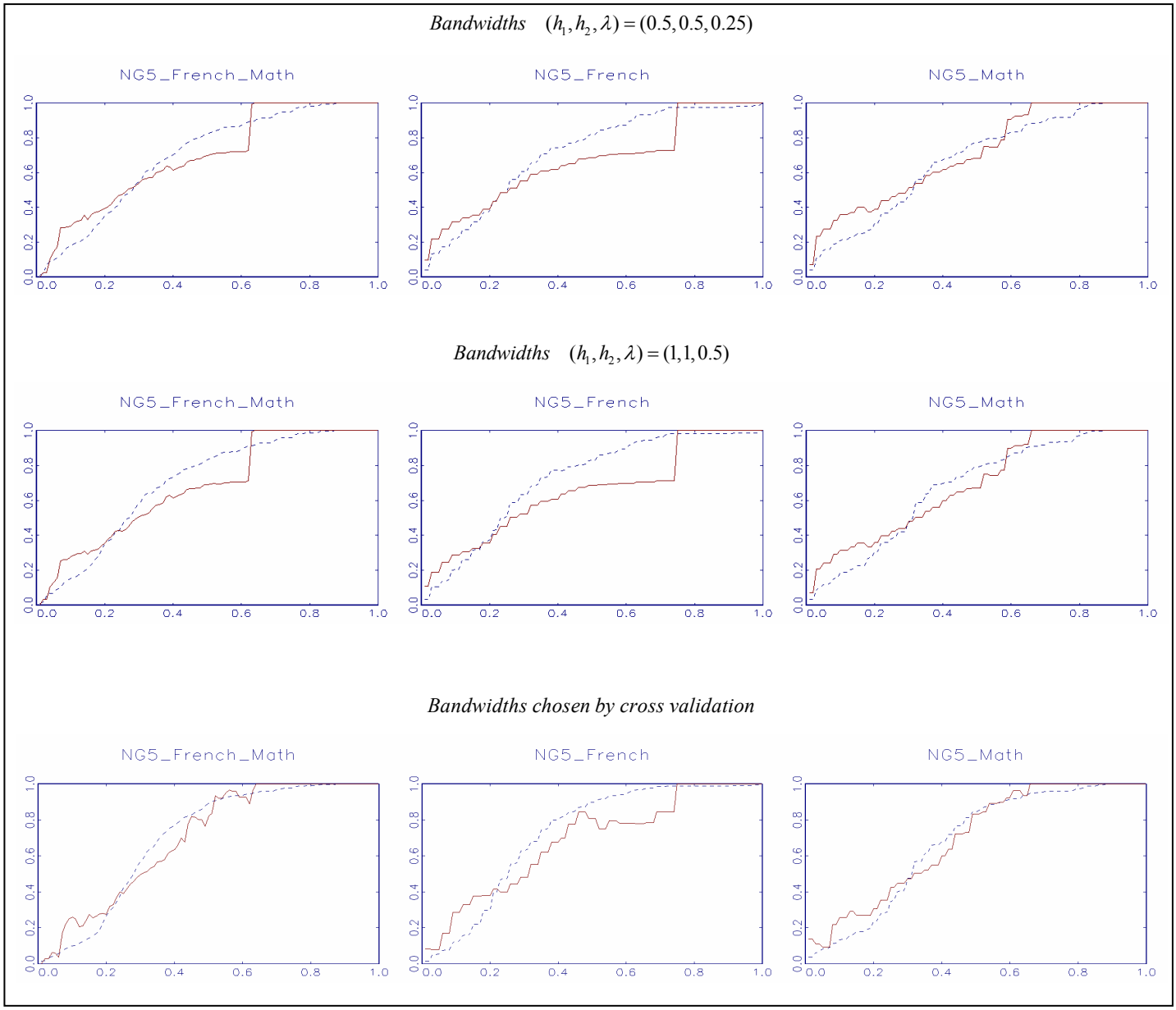
Note: Distribution functions of potential outcomes, solid line $\hat{F}_{Y^1}$, dashed line $\hat{F}_{Y^0}$. (Horizontal distance is quantile treatment effect.)

Figure C9: Potential outcomes for Niger 2nd grade (Xset 3)



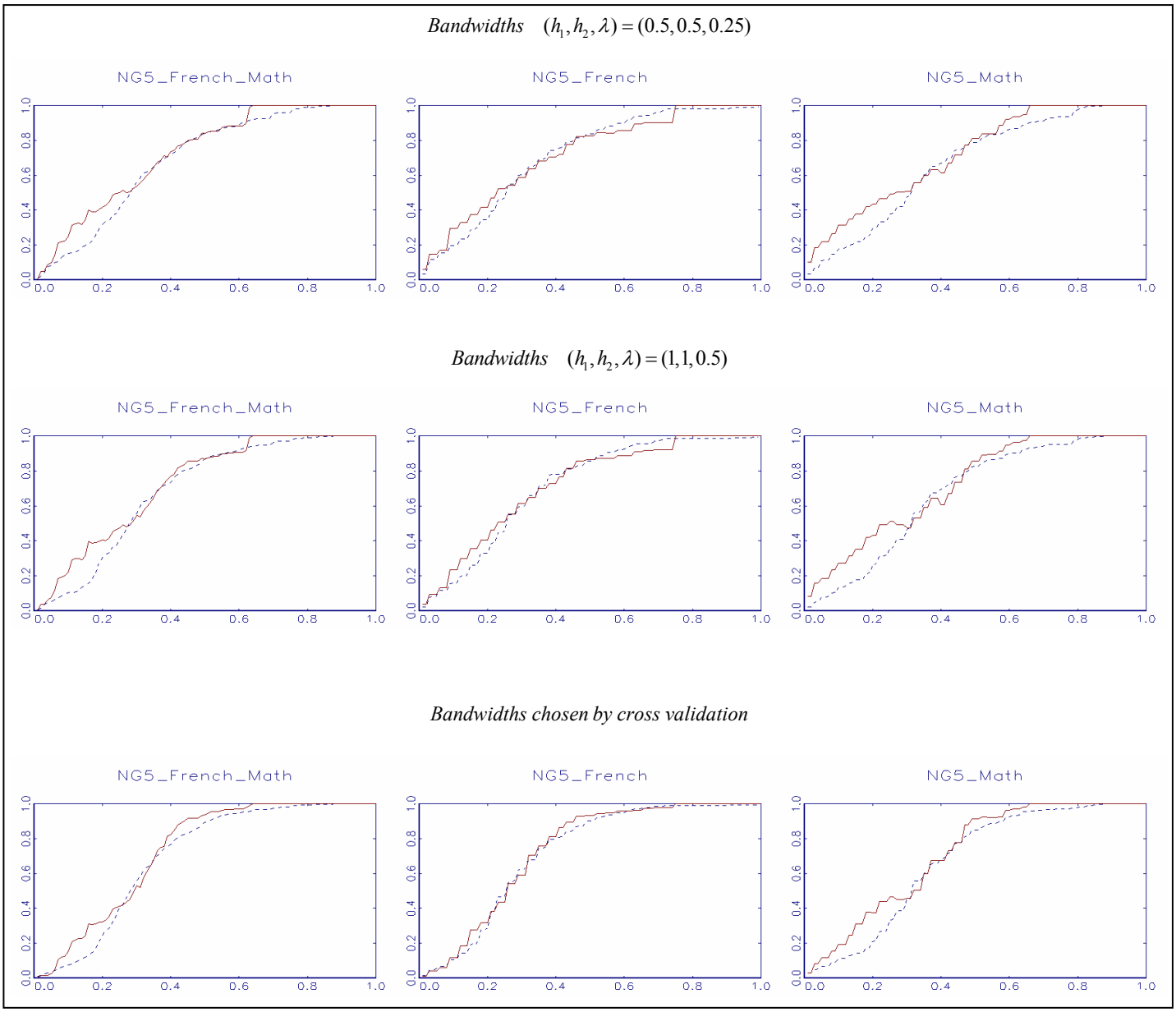
Note: Distribution functions of potential outcomes, solid line $\hat{F}_{Y^1}$, dashed line $\hat{F}_{Y^0}$. (Horizontal distance is quantile treatment effect.)

Figure C10: Potential outcomes for Niger 5th grade (Xset 3)



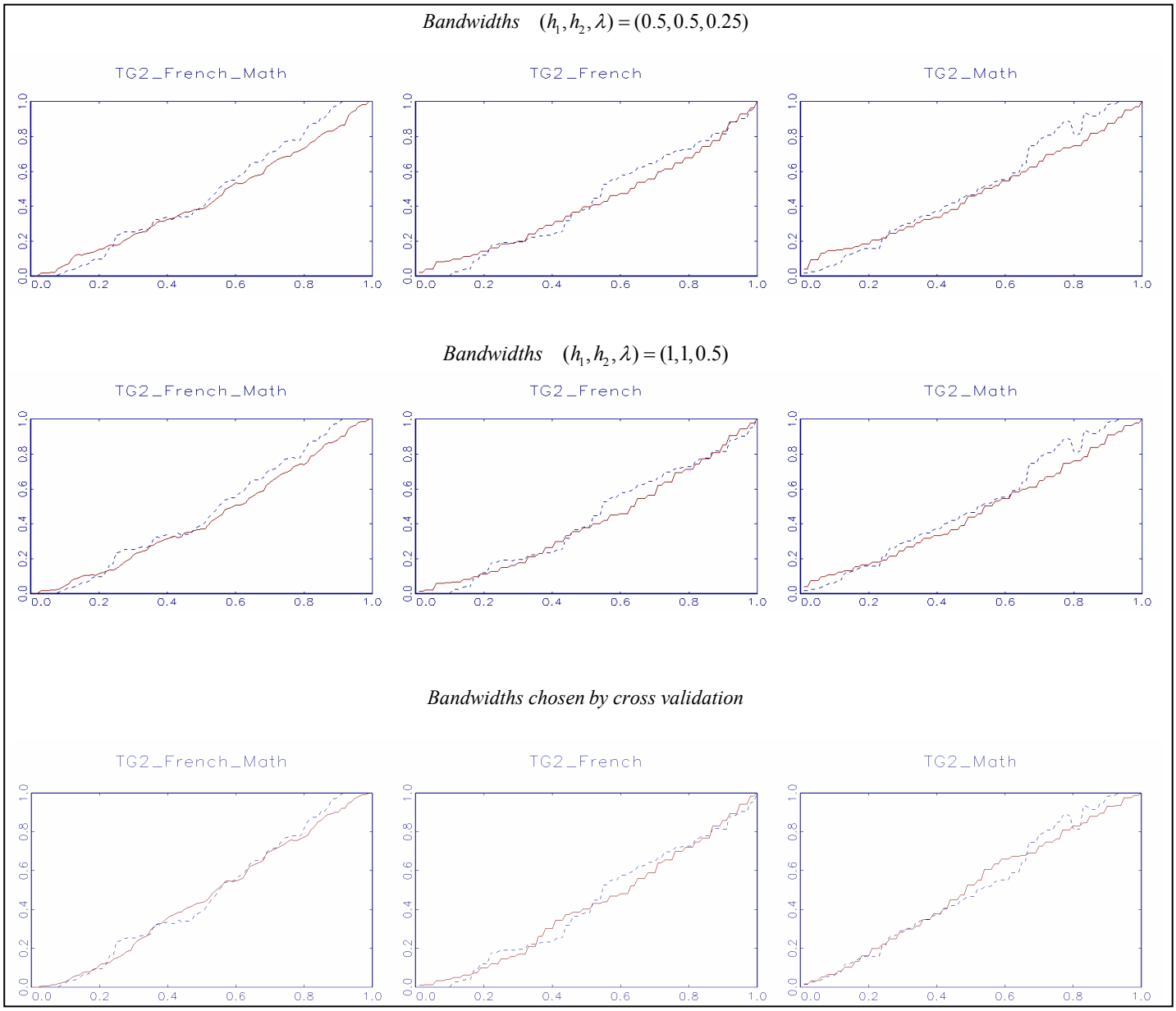
Note: Distribution functions of potential outcomes, solid line $\hat{F}_{Y^1}$, dashed line $\hat{F}_{Y^0}$. (Horizontal distance is quantile treatment effect.)

Figure C11: Potential outcomes for Niger 5th grade (Xset 3a)



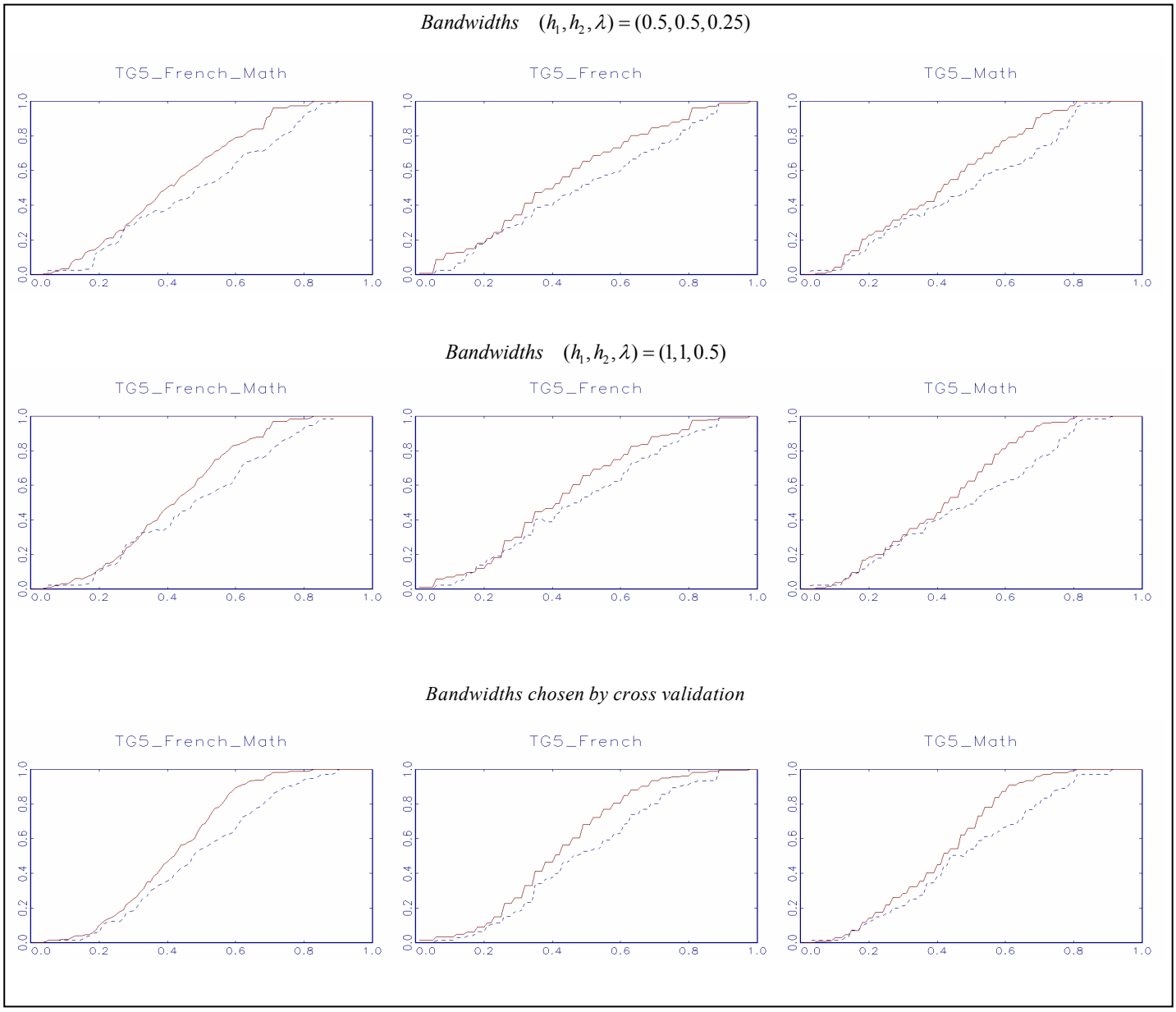
Note: Distribution functions of potential outcomes, solid line $\hat{F}_{Y^1}$, dashed line $\hat{F}_{Y^0}$. (Horizontal distance is quantile treatment effect.)

Figure C12: Potential outcomes for Togo 2nd grade (Xset 3)



Note: Distribution functions of potential outcomes, solid line $\hat{F}_{Y^1}$, dashed line $\hat{F}_{Y^0}$. (Horizontal distance is quantile treatment effect.)

Figure C13: Potential outcomes for Togo 5th grade (Xset 3)

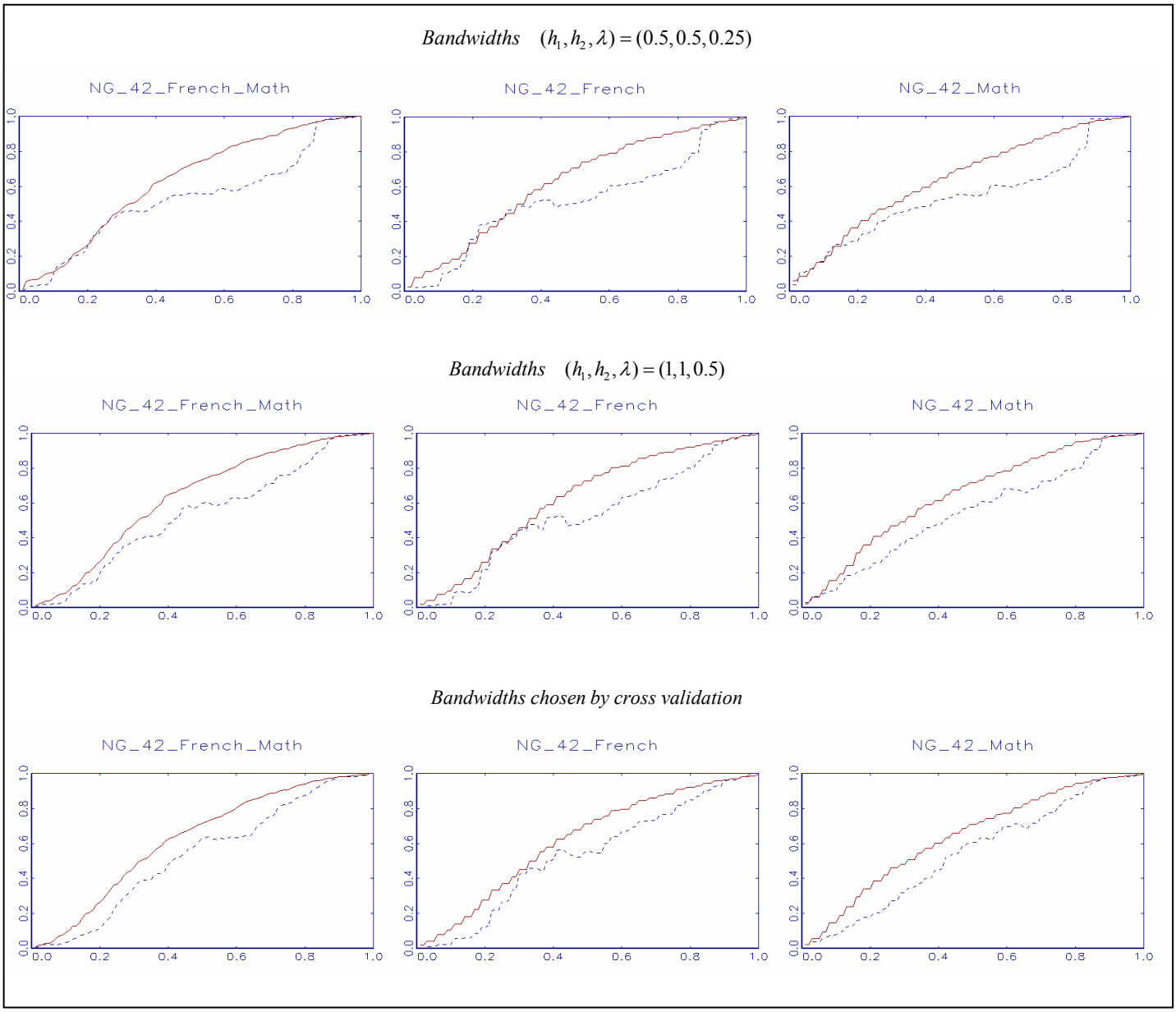


Note: Distribution functions of potential outcomes, solid line $\hat{F}_{y^1}$, dashed line $\hat{F}_{y^0}$. (Horizontal distance is quantile treatment effect.)

Appendix D: Robustness to the sample definition based on job experience

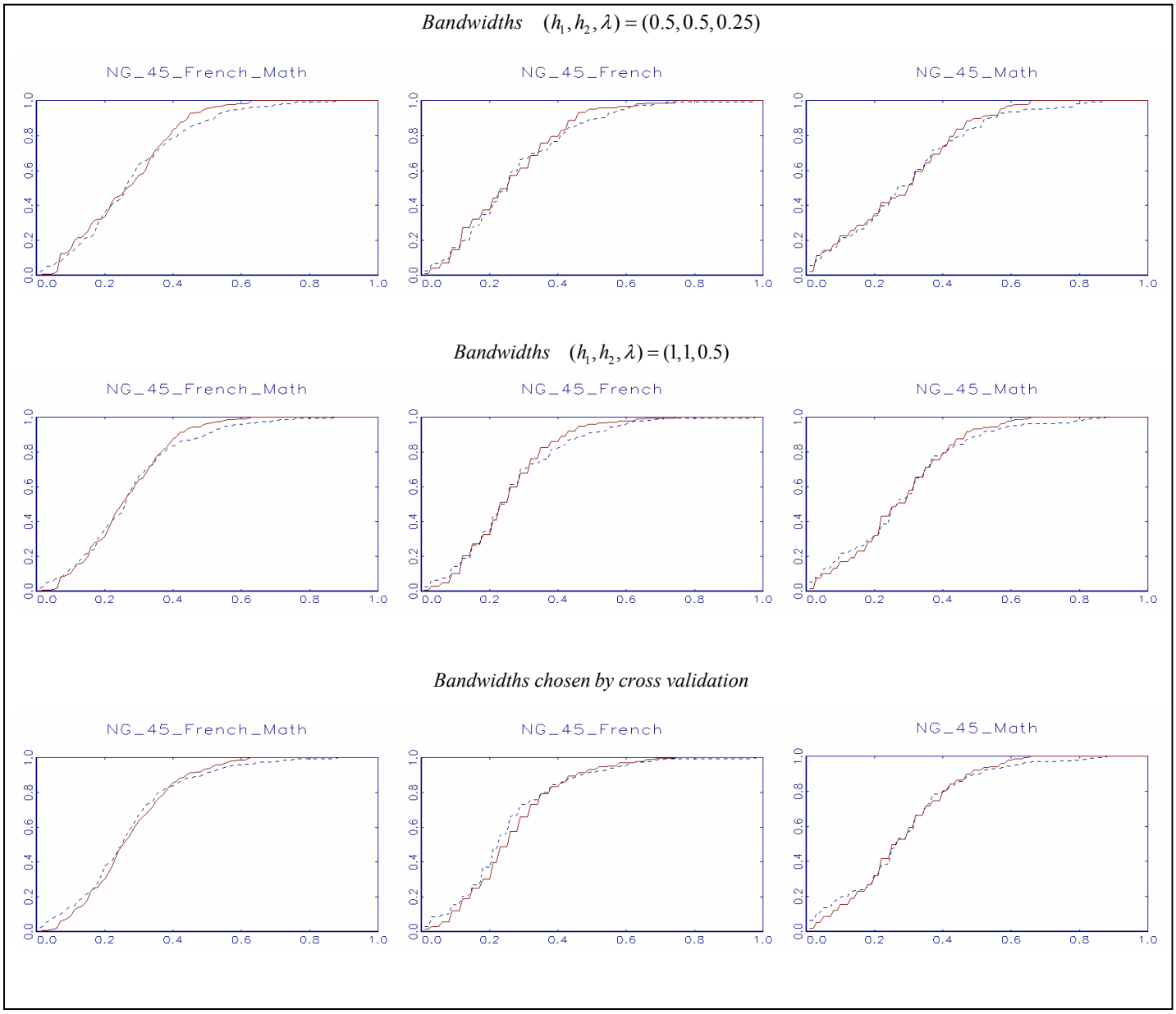
The following graphs show the estimated potential distribution functions for Niger when the sample is restricted to include only teacher with at most 4 years of job experience. The results are very similar to those of the earlier analysis.

Figure D1: Potential outcomes for Niger 2nd grade (Xset 1)



Note: Distribution functions of potential outcomes, solid line $\hat{F}_{Y^1}$, dashed line $\hat{F}_{Y^0}$. (Horizontal distance is quantile treatment effect.)

Figure D2: Potential outcomes for Niger 5th grade (Xset 1)



Note: Distribution functions of potential outcomes, solid line $\hat{F}_{Y^1}$, dashed line $\hat{F}_{Y^0}$. (Horizontal distance is quantile treatment effect.)