INSTITUTE OF DEVELOPING ECONOMIES

IDE DISCUSSION PAPER No. 580

DVD-based Distance-learning Program for University Entrance Exams: RCT Experiments in Rural Bangladesh

Hisaki KONO, Yasuyuki SAWADA and Abu S. SHONCHOY*

Abstract

In contrast to the remarkable progress in developing countries in improving primary education, access to higher education in many countries remains limited, especially in rural areas where the quality of education is inadequate. We evaluate a DVD-based distance-learning program in rural Bangladesh, targeted at students aiming to take university entrance tests. We conducted two experiments: one to evaluate the effect of the distance-learning program and the second to determine the demand and price sensitivity. Our first experiment shows that the DVD-based distance-learning program has a considerable positive effect on the number of students passing entrance exams. This effect does not depend on cognitive scores, but does depend on non-cognitive attributes, indicating the importance of commitment, which is imposed through our program. In the second experiment, we offered a random subsidy to interested participants. The uptake decision is price-sensitive, although the price sensitivity is not correlated with students' past academic performance or their socio-economic status, suggesting that increasing the price should not disproportionately exclude poor students.

*Research Fellow, Development Studies Center, IDE (Abu_Shonchoy@ide.go.jp)

The Institute of Developing Economies (IDE) is a semigovernmental, nonpartisan, nonprofit research institute, founded in 1958. The Institute merged with the Japan External Trade Organization (JETRO) on July 1, 1998. The Institute conducts basic and comprehensive studies on economic and related affairs in all developing countries and regions, including Asia, the Middle East, Africa, Latin America, Oceania, and Eastern Europe.

The views expressed in this publication are those of the author(s). Publication does not imply endorsement by the Institute of Developing Economies of any of the views expressed within.

DVD-based Distance-learning Program for University Entrance Exams: RCT Experiments in Rural Bangladesh[*]

Hisaki Kono
Kyoto University

Yasuyuki Sawada
University of Tokyo

Abu S. Shonchoy
New York University and Institute of Developing Economies, JETRO

June 19, 2016

Abstract

In contrast to the remarkable progress in developing countries in improving basic education, access to higher education in many countries remains limited, especially in rural areas where the supply quality is inadequate. We evaluate a DVD-based distance-learning program in rural Bangladesh, targeted at students aiming to take university entrance tests. We conducted two experiments: one to evaluate the effect of the distance-learning program and the second to determine the demand and price sensitivity. Our first experiment shows that the DVD-based distance-learning program has a considerable positive effect on the probability of students passing entrance exams. This effect does not depend on cognitive scores, but does depend on non-cognitive attributes – especially on self-control abilities – indicating the importance of commitment device availability. In the second experiment, we offered a randomized subsidy to interested participants. The uptake decision is price-sensitive, although the price sensitivity is not correlated with students' past academic performance or their socio-economic status, suggesting that imposing price on such a program may not disproportionately exclude poor students.

JEL Classification: I21; I23

Keywords: Distance Learning, Computer-based teaching, Tertiary education, Bangladesh.

---

1 Introduction

Although many developing countries have achieved remarkable progress in school enrollment and completion rates at primary and secondary levels, little effort has been invested in improving access to tertiary education, especially in rural areas. For instance, the net enrollment rate for primary education in Bangladesh has increased from 62.9% in 2000 to 98.7% in 2013 (ASPR 2014). However, the gross enrollment rate at the tertiary level has been very low, at 12.52% in 2012 (BANBEIS 2012), of which only 16.33% is enrollment in universities. The main reason for this disparity is the low advancement rate of rural students, partly because of difficulty in passing the entrance exams to enroll in subsidized public universities. Rural students generally receive a substantially lower quality of education than their urban counterparts owing to teacher absenteeism, shortage of skilled teachers, and lack of access, both geographically and financially, to supplementary educational aids (Mujeri, 2010). Given the increasing wage return for tertiary education relative to primary (Colclough, Kingdon, and Patrinos, 2010), ensuring fair and equal access to tertiary education for rural students could have a great impact on reducing poverty and inequality.

Studies focusing on the educational effect of various interventions in developing countries are mostly targeted at primary or secondary level (Kremer and Holla, 2009), which are not always applicable to higher levels of education. For example, Banerjee et al. (2007) found that remedial education and computer-based learning improved students' academic performance in India. However, finding remedial tutors for upper-secondary students in rural areas is difficult in most developing countries as the quantity and quality of school teachers required for this level of education are far from sufficient (Banerjee and Duflo, 2006; Chaudhury et al., 2006). Creating effective computer-based learning systems would also be difficult for many countries because it requires people with sufficient knowledge of teaching and programming.

An alternative option for improving the quality of education in rural areas in a more feasible way is through distance learning, which can overcome some of the challenges mentioned above. One cost-effective approach to distance learning is using an off-line platform, such as DVD lectures, which contain pre-recorded lecture delivered by well-respected teachers from the country. These lectures can be copied onto DVDs and distributed to rural students to be watched on laptops or on DVD players. This intervention has two important properties that made it effective and scalable. First, we only need to find a small number of talented teachers whose lectures and teaching styles are effective, which is much less difficult than finding a large number of remedial tutors or creating new computer-based learning systems.

The quality of these lectures is guaranteed, they comply with the current curriculum, and do not suffer from teacher incentive problems, such as absenteeism (Banerjee and Duflo, 2006; Chaudhury et al., 2006). Second, the technological requirement for this intervention is minimal, as only DVD players or other devices, such as laptops or mobile phones, are needed to play the lectures.[1] With the increasing availability of computers and mobile phones in rural areas, DVD lectures may be more affordable and scalable than on-site or online solutions. In addition, students can watch these DVD lectures as many times as they want and adjust the lessons to their own pace, which is helpful for less-able students. We can also use the DVD lectures in the classroom settings by using a projector.

In this paper, we evaluate a DVD lecture program targeted at university entrance preparation for students who have completed upper-secondary school in Bangladesh. University entrance exams in Bangladesh are highly competitive and require dedicated test preparation skills to ensure success. Rural students lack academic and test-preparation skills, and systematically underperform in entrance exams, narrowing their opportunities to receive tertiary education. Most urban students taking university entrance tests go to exam preparation centers, such as prep schools or coaching centers, or hire private tutors. Such services rarely extend to rural areas because of the limited market and the unwillingness of teachers to live in rural areas. In addition, the fees charged by these services are high and often beyond the reach of rural households.

To fill the gap caused by the lack of accessibility to coaching centers in rural areas, we created DVD lectures taught by teachers from a reputable university admission coaching center in Bangladesh. Our implementing partner provided access to these DVD lectures using laptops along with lecture notes, reading materials, and problem solving tutorial classes to interested students in rural Chandpur, a conservative, undeveloped district of Bangladesh.

We evaluated the effect of these DVD lectures employing a Randomized Controlled Trial (RCT) set-up. Specifically, we conducted two experiments: one to evaluate the effect of the distance-learning program and the second to determine the demand and price sensitivity. To preview our findings, our first experiment shows that the DVD-based distance-learning program increased the probability of passing the entrance exams to top-ranked public universities by 15 percentage points, and of passing any public university entrance exams about 17 percentage points. Our results show that the effect of the DVD classes does not depend on cognitive scores, but does depend on non-cognitive attributes – especially on self-control

---

[1]The digital content of the DVDs can also be transferred onto mobile phones by using microSD memory cards.

ability – indicating the importance of commitment devices.

While the DVD lectures are found to be effective in improving the access to the tertiary education, the implementation cost can be high especially in the poor areas where most students do not have access to the device to play the DVDs. In order to provide more people with access to the DVD lectures, the cost sharing with the beneficiary students should be considered. Collecting fees from the students, however, could exclude poor students from the service, if poor students are more price-sensitive in their uptake behavior. To examine this possibility, we performed the second experiment to evaluate the price sensitivity two years after the initial intervention. We found the price sensitivity is not correlated with students' socio-economic status (SES), indicating that imposing price will not disproportionately exclude poor students.[2] We also did not find any evidence that a higher price is systematically correlated with entrance exam success.

Our work is related to literature examining the effect of technology on learning. So far, the evidence is mixed. Although Linden (2008), Barrera-Osorio and Linden (2009), and Angrist and Lavy (2002) found that computers have either no effect or mixed effects on learning outcomes, Banerjee et al. (2007) and Barrow, Markman, and Rouse (2009) found positive effects on learning among school children. However, computer-aided teaching (Lai et al., 2015) and One Laptop One Child programs did not improve learning outcomes for school children in rural China (Mo et al., 2013) and Peru (Beuermann et al., 2015). To the best of our knowledge, the present study is the first to have evaluated a distance-learning program for tertiary education and the findings of this paper are important for guiding policy makers, and international agencies and donors.

The paper is organized as follows. Section 2 talks about the background of the project the details of the intervention and section 3 presents the experimental design. Section 4 reports the empirical results of the effect of the DVD lectures and the uptake decision. Section 5 offers concluding remarks.

2 Background and Intervention

Bangladesh has public, national, and private universities. Public Universities are government-subsidized institutions and are the most prestigious tertiary educational institutions in Bangladesh. National University is the central governing authority for all the affiliated

---

[2]Cohen and Dupas (2010) investigate the uptake behavior of bed nets, finding no significant heterogeneity in the price sensitivity due to the health risk.

private and public colleges offering bachelor's and master's courses in Bangladesh. These colleges are located in almost all sub-districts of Bangladesh, unlike public universities, which are located mainly in large cities. In contrast, private universities are the most expensive institutions located in the major cities. Currently there are 29 public universities, 51 private universities, and 1490 colleges (both government and private) affiliated with the National University in Bangladesh. The Bangladesh Bureau of Educational Information & Statistics (2012) reports that of those who are enrolled in tertiary education after twelve years of schooling, only 16.44% are enrolled in universities (either public or private) and 79.21% are enrolled in national university-affiliated collages.

Entering a public university is often the first choice for those who have completed higher secondary qualifications because of the low cost, high prestige, and future job prospects. As a result, admission to these universities becomes extremely competitive, requiring students of specialized test-taking skills to pass the entrance exams. For example, Dhaka University, the top-ranked university in Bangladesh, received 244,937 applications in 2014 against a total capacity of 6540, making the applicant-to-seat ratio about 37. Similar competition is also being faced by other major public universities in Bangladesh, as depicted in Table 1, where application to seat-ration more than 30 for any general public university in Bangladesh, except for the engineering universities where eligibility for application is restricted for high achieving students only.

In addition, the actual format of entrance examinations for these universities is quite demanding. Each university has a different entrance exam system and the number of tests students need to take also depends on the choice of subjects (e.g., science, social science, arts, commerce) and the school that the specialization belongs to (for example, in science, typical specializations are physics, chemistry, and biology). Moreover, the examination formats for these tests across universities are different. For example, Dhaka University entrance exam for commerce discipline asks a student to solve 120 questions in 60 minutes, which requires months of dedicated practice. In addition, the required scores for passing the entrance exams vary based on the subject and school. Similar entrance examination format has also been followed by other competitive public universities. In contrast, admission to national university-affiliated colleges is less competitive, and, on average, about half of applicants pass the entrance exam. Admission to private universities is also not so competitive because of their high tuitions.

To enter public universities, urban students typically attend prep schools, locally known as coaching centers, which specialize in preparing students for the entrance exams. However,

Table 1: Number of applicants and seats in major public and national universities in 2014

Name of the University	Number of Applicants	Number of Seats	Applicant-seat Ratio
Dhaka University (DU)	244,937	6,540	37
Chittagong University (CU)	146,295	3,985	37
Rajshahi University (RU)	168,224	3,310	51
Jagannath University (JAU)	186,764	2,760	68
Jahangirnagar University (JU)	219,151	2,110	104
Islamic University (IU)	74,529	1,465	51
SUST ♮	49,442	1,400	35
Begum Rokeya University (BRU)	71,079	1,260	56
BUET ♯	9,111	1,000	9
Bangladesh Agricultural University (BAU)	9,575	1,000	10
Khulna University (KU)	39,793	979	41
Comilla University (COU)	36,341	700	52
National University (NU)	413,454	172,582	2

Note: Based on secondary sources of data.
♮ SUST stands for Shahjalal University of Engineering and Technology.
♯ BUET stands for Bangladesh University of Engineering and Technology.

these coaching centers rarely extend their branches to rural areas, and even in the occasional cases that they do, the quality of teaching in these branches is not adequate or comparable to their main centers in the cities. Hence, well-off families send their children to nearby major cities to attend popular, famous coaching centers to prepare properly for university entrance exams.

Our initial focus group discussion with students recently admitted to university reveal the importance of these quality coaching centers for admission success. About 81.34% of the students of Dhaka University whom we interviewed had either attended coaching centers or hired individual tutors for preparation. Rural poor families typically cannot afford to send their children to cities to attend these coaching centers, which are costly. For example, the lowest fee for attending a coaching center is 7000 BDT, and transport and accommodation in an urban location for a minimum of 3 months costs nearly 30,000 BDT on an average (a total of 37,000 BDT, which is about 477 USD)[3]. This is around four times as high as the 1.25 USD a day poverty line. Although various test-solving books for university entrance exams are readily available from bookstores, the contents of these books are not sufficient

---

[3]We used the conversion rate of 1 USD = 77.56 BDT as of 15 May 2014

to achieve the required skills.

To make coaching center lectures accessible to rural poor students, e-Education Bangladesh,[4] our counterpart organization, has run an offline distance-learning program using DVD lectures since 2010. They identified the most popular coaching center teachers in their partner organization, University Coaching Center (UCC), for subjects like commerce, accounting, and English. With permission, they filmed the lectures of these experienced educators and made DVD copies. Following the prep school model of Bangladesh, e-Education Bangladesh made the duration of their distance-learning program 2.5 months, which included laptop DVD classes with lecture notes and reading materials provided by UCC.

Yet, there are two potential concerns about DVD lectures. The first one is the lack of direct interaction with lecturers. Because DVD lectures are pre-recorded, students cannot ask the teachers questions directly. Second, the lack of interpersonal contact could reduce the students' involvement and commitment to the classes. If DVD lectures can be watched at any time, present-biased students might procrastinate by continuously delaying their scheduled DVD classes. Hence, the effectiveness of a DVD based distance-learning program depends on how the program organizer approaches these obstacles. Our counterpart tackled these two problems by imposing a strict schedule with regular problem solving classes taken by tutors who are university students who return home regularly at weekends. These tutors facilitated students' learning by holding question and answer sessions. Moreover e-Education Bangladesh imposed a strict attendance requirement of the students with a potential large penalty. For example, if a student is absent for three consecutive classes without prior notice for a legitimate reason such as illness, he or she is not allowed to continue[5]

3 Experimental Procedures and Survey Design

The study site is in Chandpur District of Chittagong Division, located 217 km away from Dhaka. Chandpur is an undeveloped district of Bangladesh where the literacy rate is 50.3% (Bangladesh Bureau of Statistics Population Census 2001), ranked among the lowest in Bangladesh. Agriculture is the main economic activity in this region. Poverty of Chandpur is mainly driven by its geographical condition. The district is located next to the Meghna

---

[4]e-Education was introduced by Atsuyoshi Saisho (Japan) and Abdul Matin Sheikh (BakBon Foundation, Bangladesh), with the collaboration of the UCC, a leading university admission coaching center in Bangladesh.

[5]Due to the budget limitation, we could not conduct an experiment which evaluate how important the strict scheduling and the role of the tutors were, which is left for future research.

River, which causes frequent seasonal flooding and river erosion is damaging the property and assets of the residents. River transportation is the main mode of transportation for Chandpur to the rest of the country. The inner road network of Chandpur is inadequate and poorly maintained, making the rural areas of Chandpur isolated.

e-Education Bangladesh has four sub-district centers in Chandpur, namely Baburhat, Chandpur Sadar, Faridganj, and Haimchar, with different enrollment capacities.[6] Each center has one classroom with laptops for watching the DVD lectures managed by a center administrator. The administrator announces the timetable for the DVD lectures, takes the attendance record, and notes learning problems and questions, which are addressed in the solving classes. To check the learning progress, monthly tests are conducted. Two tutors, who are Dhaka University students, provide a tutoring service for the students in these four centers over the weekend. Tutors are also available for urgent problems over the phone. Because our counterpart specializes in Dhaka University admission coaching for commerce, all the DVD lectures and educational aids are designed for this entrance exam. In Bangladesh, typically a student prepares for Dhaka University first, because Dhaka University holds its entrance exams before the other public universities. Indeed, intensive preparation for Dhaka University provides students with test-taking skills, which is also useful for other universities' entrance exams.

3.1 Experiment I: Effect of DVD-based Distance-learning

To investigate the effect of the DVD-based distance-learning program on university entrance exam success, we performed the first experiment in 2012. To encourage potential students to join our program, we advertised at various Higher Secondary Educational Institutions (HSCI) in Chandpur from March to May 2012, when students were preparing for or taking the Higher Secondary Certificate (HSC) exams. After the completion of the HSC, we started accepting applications for our DVD-based distance-learning program at the four centers. We announced that we only accept students with a grade point average (GPA) score for the Secondary School Certificate (SSC) exam of no less than 3.88 out of 5.00 because students with lower SSC and HSC GPAs are not eligible for taking the entrance exams for Dhaka University[7].

---

[6]The enrollment capacities are Baburhat, 42 seats; Chandpur Sadar, 80 seats; Faridganj, 30 seats; and Haimchar, 30 seats.

[7]Major public universities base their application eligibility rules on the SSC and HSC GPAs. For example, Dhaka University only allows students with the average of the SSC and HSC GPAs of no less than 4.00 to sit the entrance exam. Because the HSC GPAs were not available when we received the applications, we

In total we received applications from 245 eligible students. In accordance with the advise of local HSCI teachers who helped advertise our program, we enrolled their best 67 students with an SSC GPA of more than 4.9. Since these students were admitted to the program without selection, we excluded their data from our analysis . Among the remaining 178 students, whose SSC GPAs ranged from 3.88 to 4.9, we conducted randomization at the individual student level, with stratification based on gender and SSC GPAs. The treatment probability for each student varied depending on two factors. First, since the capacity of each center was fixed, the ratio of the applicants relative to the capacity differed across centers. The number of eligible applicants for the Chandpur Sadar center was 78 compared with the capacity of 35 after subtracting the guaranteed positions of students with SSC GPAs greater than 4.9. The Haimchar center received 26 applications compared with their capacity of 18 after subtracting the guaranteed seats. Second, female students and students with SSC GPAs above the median were prioritized, with a 1.25-fold higher chance of admission owing to our implementing partner's policy. To control for these different treatment probabilities, we use a weighting method, as explained later in this section.

The randomly selected treatment students were provided with free access to the full package, which includes the DVD lectures, lecture notes, and problem-solving tutorial classes. For the control group, we provided only the lecture notes to control for the effect of the access to other available textbooks and reference books. Since regular academic classes at HSCI were suspended before the HSC exams, students did not meet each other regularly. However, it is still possible for some students in the treatment group to interact with control students in the same village. If we assume that this spill-over effect is positive, then our estimated impact would be conservative one.

We conducted the baseline survey before the intervention in June 2012 and the follow-up survey in March 2013 when all the major public universities completed their entrance exams. In the baseline survey, we collected detailed personal and family information from students and measured their IQ scores by using Raven's Progressive Matrices. We also collected measures of non-cognitive skills such as present bias and grit.[8] We elicit the present-biasness from the hypothetical questions (Ashraf, Karlan, and Yin, 2006). We also measure grit, which is defined as passion and perseverance for long-term goals, by using the Duckworth eight-item

---

only used the SSC GPAs to determine eligibility. Given that the SSC and HSC GPAs are highly correlated, students with a SSC GPA of less than 3.88 would have little chance of being eligible to apply for Dhaka University.

[8]The importance of non-cognitive ability is well documented by Almlund et al. (2011), Chetty et al. (2011), and Heckman, Pinto, and Savelyev (2013). Unlike cognitive ability, which is almost fixed before primary school, non-cognitive ability can be improved or changed throughout life.

grit scale (Duckworth et al., 2007). In fact, Eskreis-Winkler et al. (2014) showed that grit predicts high school graduation and job retention better than IQ score. Students with present biasness and low grit scores tended to procrastinate and fail in continuing to watch the DVD lectures and study. If students procrastinated, then the DVD lectures would have had a smaller effect on them; however, if the strict disciplinary framework imposed by e-education works, then they would experience the additional benefit of sticking to the schedule. To complement the present bias and grit measure, we also adopted the conscientiousness measure in McKenzie's Big Five Psychological traits, which captures self-discipline, diligence, and a focus on achievement.[9] In the follow-up survey, we collected information about their entrance exam results and other related information about university exams. Among our sample students, three students (two in the treatment group and one in the control group) failed the HSC exam and became ineligible for our program. Five students, all of whom were in the treatment group, could not be reached for the follow-up survey, and was not used in the analysis.[10]

As mentioned above, the treatment probability differed across individuals. In particular, the small number of female applicants who had SSC GPAs above the median had a treatment probability of nearly 1. To ensure the common support holds between the treatment and control group, we excluded students from the analysis who had a treatment probability of more than 0.9, following the standard procedure of the propensity score methods,[11] leaving us with 160 students for the analysis. The summary statistics of this sample of the first experiment is reported in Table 2. The SES score reported in the table was computed by the factor analysis based on housing conditions, source of drinking water, sanitary conditions, access to electricity, and self-reported SES. The IQ score, grit measure, and conscientiousness measure are standardized. The average students sat for 2.7 entrance exams and on-an-average 11% of the sample students passed the public university entrance exams, and 9%

---

[9]Psychology categorizes personal traits into five categories, called the Big Five: extraversion (energy, positive emotions, assertiveness, sociability), openness to experience (intellectual curiosity, creativity, appreciation of art, preference for novelty and variety), conscientiousness (self-discipline, organization, diligence, dutifully, focus on achievement), agreeableness (compassion and cooperation rather than suspicion and antagonism towards others, trust, helpfulness), and neuroticism (tendency to experience unpleasant emotions easily, such as anger, anxiety, depression, and vulnerability).

[10]We checked the consistency of our regressions by imputing zero or not successful for the university entrance exam for these attrited students and found similar results as reported in the paper. We also checked for sample selection issue for these attrited students and could not find any evidence of systematic drop-out or attrition from the sample.

[11]Crump et al. (2009) recommend that all units with estimated propensity scores outside the range [0.1, 0.9] should be discarded to ensure the overlap. Because there were no units with a treatment probability of less than 0.1, we only discarded the units with a treatment probability of more than 0.9

passed the first-tier public university entrance exams,[12] whereas 85% of the students passed some university entrance exams (including public, private, or national universities).

Table 2: Summary statistics od the first experiment

	count	mean	sd	min	max
DVD	160	0.53	0.50	0.00	1.00
SES score	160	-0.01	0.77	-0.84	1.28
Female	160	0.34	0.47	0.00	1.00
SSC GPA	160	4.44	0.28	3.88	4.88
IQ score	160	0.00	1.00	-3.31	2.58
Present bias	160	0.23	0.42	0.00	1.00
Grit	160	-0.00	1.00	-2.69	1.87
Conscientiousness	160	0.00	1.00	-3.38	1.77
# of exams taken	160	2.71	1.40	0.00	8.00
Pass public university exam	160	0.11	0.32	0.00	1.00
Pass 1st-tier public university exam	160	0.09	0.29	0.00	1.00
Pass national university exam	160	0.82	0.38	0.00	1.00
Pass any university exam	160	0.85	0.36	0.00	1.00

3.2 Experiment II: Demand for DVD-based Distance-learning

The second experiment investigates the price sensitivity and demand for our DVD-based distance-learning program. If the uptake rate of students from poor families is more price-sensitive, then imposing a participation fee will disproportionately exclude such students, who are the main target of this intervention. Hence, in this experiment, we measure the heterogeneities in the price sensitivity and take-up rate between students from poor and better-off families.

To ensure that our target population understood the program, we performed this experiment in 2014, two years after the first experiment in the same location.[13] During the marketing campaign for the second experiment, we announced that the program was no longer free; however, each student who registered within 3 days of a set period would have the chance to be randomly selected for a subsidy. The minimum subsidy was 25% and the maximum was 75%. We informed each student that the full cost of this program was 3600

---

[12]First-tier public universities in Bangladesh are Dhaka University, Jahangirnagar University, Chittagong University, Rajshahi University, Hazrat Shahjalal University of Science and Technology, and Khulna University

[13]Our counterpart organization ran the same program in 2013 as well. In 2014, our DVD-based distance-learning program was well recognized by the rural students and HSCI teachers.

BDT (about 48 US$), which is still well below the cost of available alternatives such as attending at a coaching center in Dhaka.

One potential mechanisms which could make the poor students more price sensitive is the credit constraint. If people face difficulty in putting money aside from other family members and relatives, dividing the payment amount into several installment could alleviate the problem as in most micro-credit programs (Armendáriz and Morduch, 2010). Hence we also randomly offer to allow students to pay the fee in two equal monthly installments at the individual student level.

We received a total of 244 registrations within 3 days of the set period. We conducted a short survey for the registered students when they submitted their registration forms. The subsidy amount and payment options were randomized at the student level, stratified based on the SES scores calculated in the same way as done for the first experiment. The treatment probability did not vary across students in this experiment, with setting the probabilities of receiving 25% discount, 50% discount, and 75% discount are 0.3, 0.3, and 0.4, respectively. The full price of the program was 3600 BDT (about 48 US$); therefore, the 25% discount corresponds to a fee of 2700 BDT (about 36 US$), the 50% discount corresponds to a fee of 1800 BDT (about 24 US$), and the 75% discount corresponds to a fee of 900 BDT (about 12 US$). The payment options were randomized independent of the subsidy amount, with equal probability of two options: upfront full payment and two equal monthly installments.

After we informed the students of the subsidy and payment option they had been assigned, students were given a week to discuss it with their parents. Those who accepted the offer came to our centers and filled in the admission form with the payment (either full payment or the first installment). The summary statistics of our sample in the second experiment are reported in Table 3. Of the students that showed interest by registering for the program, about 75% of them actually joined by paying the required amount. For those who finally joined the program, the average attendance rate in the program was 79% and only 5% of them succeeded in the public university entrance exams.

Since we could only observe the information on the students who registered within 3 days of the set registration period, our sample could be a selected sample. To understand the potential difference of our sample from the general population of college students who will sit for the university entrance exams, we conducted a short sample survey in the HSCI located in the project site. The summary statistics of the surveyed students and the students with intention to study in any university are reported in Appendix Table 1. Compared to these students, the students in our price experiment earned higher SSC GPA and tend to

Table 3: Summary statistics of the second experiment

	count	mean	sd	min	max
Uptake	244	0.83	0.38	0.00	1.00
25% discount offer	244	0.27	0.45	0.00	1.00
50% discount offer	244	0.30	0.46	0.00	1.00
75% discount offer	244	0.43	0.50	0.00	1.00
Installment	244	0.44	0.50	0.00	1.00
SES score	244	0.00	0.79	-1.32	1.45
SSC GPA	244	4.44	0.44	3.19	5.00
Female	244	0.43	0.50	0.00	1.00
Subject devision: Commerce	244	0.66	0.48	0.00	1.00
Attendance rate	183	0.79	0.13	0.31	0.95
Pass public university exam	183	0.05	0.23	0.00	1.00

have chosen commerce as their discipline of study.[14] Moreover, we see our sample has more male students, reflecting the fact that female students tend to proceed to local colleges affiliated in the National University as their parents are reluctant to have their daughters study outside their home districts, due to issues like conservativeness, purdah restrictions and lack of residential facilities in some public universities. On the other hand, the SES of the students in our experiment was quite similar to that of the students with intention to study in any universities. Since our main focus on the heterogeneity of price sensitivity between poor and better-off students, this similarity could imply the validity of our results.

3.3   Empirical Strategy and Balance Test

As mentioned above, the treatment probability varied across students in the first experiment. To adjust this different treatment probability, we apply the inverse probability weighting (IPW), which is developed by Robins, Rotnitzky, and Zhao (1995) to address sample selection problem. While the IPW use the inverse of the sampling probability as the weighting, we use the inverse of the treatment probability as the weighting. As we know the exact treatment probability for each individual from our experimental setting, there is no need to estimate the treatment probability or to adjust the standard errors.

Let w be the treatment indicator, and $p(\mathbf{X}) = E[w = 1|\mathbf{X}]$ be the treatment probability where $\mathbf{X}$ is the vector of variables affecting the treatment probability. Different treatment probability implies that for $\mathbf{X} \neq \mathbf{X}'$, $p(\mathbf{X}) \neq p(\mathbf{X}')$ and $E[\mathbf{X}|w = 1] \neq E[\mathbf{X}|w = 0]$. Let

---

[14]Since the contents of DVD-lectures provided by our counterpart organization is primarily designed for the Dhaka University entrance exams for commerce.

$y = y_0 + w(y_1 - y_0)$, where y_1 is the outcome with treatment and y_0 the outcome without treatment. Then

$$
\begin{aligned}
E\left[\frac{wy}{p(\mathbf{X})}\middle| \mathbf{X}\right] &= E\left[\frac{wy_1}{p(\mathbf{X})}\middle| \mathbf{X}\right] = E\left[\frac{E[wy_1|\mathbf{X}, w]}{p(\mathbf{X})}\middle| \mathbf{X}\right] \\
&= E\left[\frac{wE[y_1|\mathbf{X}]}{p(\mathbf{X})}\middle| \mathbf{X}\right] = E\left[\frac{w}{p(\mathbf{X})}\middle| \mathbf{X}\right] E[y_1|\mathbf{X}] = E[y_1|\mathbf{X}]
\end{aligned}
$$

Similarly,

$$
E\left[\frac{(1-w)y}{1-p(\mathbf{X})}\middle| \mathbf{X}\right] = E[y_0|\mathbf{X}]
$$

Hence, the IPW procedure can produce consistent estimators. We report the balancing test result after IPW-adjusting the treatment probability in Table 4 for which we simply regress each of treatment indicator variables on observed characteristics of students. The coefficients on the treatment indicators are not significantly different from zero in most cases, indicating that the randomization was successful. One exception is that the significant difference in the SSC GPA between the up-front payment group and monthly installment payment group: Students with higher GPA tend to have been assigned in the installment payment group. To mitigate potential biases, we include the SSC GPA in the regressions. We also report the F-statistics and associated p-values in the parentheses testing the joint hypothesis that the coefficients of all the regressors are zero.[15]

In our regression analysis, we control for the variables affecting the treatment probability as well as for the variables listed in Tables 4, making our empirical specification similar to the doubly robust estimators, which combine propensity score weighting and regression adjustment. The doubly robust estimator is consistent if either of the propensity score specification or regression specification is correct. Because we know the propensity score exactly, our estimator will generate consistent estimates.

4   Result

4.1   Experiment I: Impact of DVD Lectures

The estimated impact of DVD-lecture of the first experiment is shown in Table 5. We employ the probit model with robust standard errors clustered at the branch level and report the

---

[15]Variables used for the balancing test were partially different between the first and second experiments, as the baseline questionnaire in the second experiment was substantially shorter than the first experiment.

Table 4: Balance test

	(1)	(2)	(3)	(4)
	Experiment 1	Experiment 2		
	DVD	25% discount offer	50% discount offer	Installment
SES score	-0.032	0.010	0.006	-0.022
	(0.057)	(0.032)	(0.033)	(0.035)
SSC GPA	0.025	-0.025	-0.011	0.087***
	(0.043)	(0.029)	(0.030)	(0.032)
Female	0.022	0.003	-0.002	-0.039
	(0.091)	(0.061)	(0.063)	(0.067)
IQ score	0.003			
	(0.042)			
Present bias	0.062			
	(0.106)			
Grit	0.058			
	(0.049)			
Conscientiousness	-0.055			
	(0.050)			
Subject division: Commerce		-0.089	-0.022	0.014
		(0.064)	(0.066)	(0.071)
Observations	160	244	244	244
F statistic	0.381	0.607	0.056	1.955
	(0.913)	(0.658)	(0.994)	(0.102)

The dependent variable is an indicator variable for each treatment.
Robust standard errors are reported in parentheses.
Asterisks indicate statistical significance: * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

estimated average marginal effects. The branch fixed effect is included in all the estimations. Control variables include student's gender, SES score, SSC Exam GPA, and standardized IQ score. Columns (1) and (2) estimate the effect of the DVD lectures on the probability of passing any public university entrance exams and first-tier public university entrance exams, respectively. The DVD lectures increase the probability of passing the public university entrance exams by about 17 percentage points, which is significantly different from zero at the 5% level. For first-tier public universities, the effect is an increase of about 15 percentage points, which is also statistically significant at the 1% level. Our intervention also increased the probability of passing the national university entrance exams by 28.5 percentage points, which is significant at the 1% level, as reported in column (3).

However, one can reasonably show a concern that the positive effect of the DVD lectures could be driven by students becoming more motivated to study at a university and taking more university entrance exams to raise their probability of success. The result in column (4), obtained by the negative binomial model on number of taken exams, consider this possibility. Although it is only significant at the 10% level, the DVD lectures increased the number of exams taken by 0.28 percentage points. To take this effect into account, in columns (5) and (6) we include the number of exams taken as the control variable. The estimated coefficients on the DVD lectures are similar to the results in columns (1) and (2). Hence, we can conclude that the increased probability of passing the entrance exams is not due to the increased number of university entrance exams but due to the DVD lectures.

Table 5: Impact of the DVD lectures

	(1) Pub_any	(2) Pub_1st	(3) NU	(4) # exams	(5) Pub_any	(6) Pub_1st
DVD=1	0.167**	0.154***	0.278***	0.280*	0.158**	0.149***
	(0.072)	(0.051)	(0.014)	(0.163)	(0.072)	(0.053)
Female	-0.071	-0.083***	0.067	-1.002***	-0.031	-0.063***
	(0.048)	(0.011)	(0.102)	(0.258)	(0.058)	(0.006)
# of exams taken					0.037***	0.017
					(0.014)	(0.012)
Other controls	Yes	Yes	Yes	Yes	Yes	Yes
Observations	160	160	160	160	160	160
Mean_Control	0.026	0.013	0.671	2.592	0.026	0.013

Standard errors in parentheses
Asterisks indicate statistical significance: * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

In Table 6, we investigate the impact heterogeneity of the DVD lectures with respect

to gender, cognitive ability, and economic conditions. Because of the small sample size and the low rate of passing in the public university entrance exams, identifying such impact heterogeneity depending on a small number of observations is difficult and sensitive, hence the following results should be interpreted with caution.

The results in Table 5 shows that female students were less likely to pass the entrance exams of the first tier public universities and took a smaller number of entrance exams; therefore, we are interested in finding whether the DVD lectures contributed to narrowing the gender gap. Columns (1) and (2) of Table 6 report the results with the interaction term for the DVD lectures and female students. For the effect on passing any public university exam (column (1)), we found no evidence of impact heterogeneity for female students, as indicated by the insignificant coefficient for the interaction term. However, for the first-tier public universities, there is a strong impact heterogeneity–DVD lectures substantially increased the success rate of passing for female students. This is a compelling finding, because female students under-performed in the first-tier entrance exams (column (2), Table 5) and this DVD-based educational aid significantly increased their success. During our focus group discussion with female students, we learned that female students were told by their parents that they will be allowed to leave the district for higher studies only if they pass the admission exams of the first-tier universities. This binding constraint demotivated many female students however worked in-favor of our intervention as female students substantially benefitted from the program. Although we treat this result with caution as the number of female students who passed the first-tier public universities was relatively small.[16]

The following columns investigate whether the effectiveness of the DVD lectures depends on the students' cognitive ability and economic conditions to determine whether this program is also suitable for low-performing and poor students. We standardized these variables, and hence the coefficient on the DVD lectures is similar to those reported in Table 5. The results in columns (3) and (4) show that the effect of the DVD lectures does not depend on the students' cognitive ability, measured by the IQ score. Even if we use the interaction term with the SSC Exam GPA instead of the IQ score, the results are comparable.[17] These results imply the wide applicability of the program. We also did not find any evidence on impact heterogeneity depending on the economic conditions, as indicated by the insignificant coefficients for the interaction term in columns (5) and (6).

---

[16]Only three female students passed the entrance exams for the first-tier public universities. The possibility that the DVD lectures could reduce the gender gap should be examined in future research with a much larger sample size.

[17]The results are available upon request from the corresponding author.

Table 6: Effectiveness of the DVD lectures: cognitive ability and SES score

	(1) Pub_any	(2) Pub_1st	(3) Pub_any	(4) Pub_1st	(5) Pub_any	(6) Pub_1st
DVD=1	0.216**	0.133***	0.168**	0.157***	0.192**	0.156***
	(0.097)	(0.051)	(0.072)	(0.051)	(0.077)	(0.049)
SES score	0.004	-0.006	0.003	-0.006	0.073	0.001
	(0.035)	(0.008)	(0.035)	(0.009)	(0.075)	(0.019)
Female	0.034	-0.542***	-0.073*	-0.084***	-0.073*	-0.083***
	(0.122)	(0.090)	(0.042)	(0.011)	(0.038)	(0.011)
IQ score	-0.009	-0.001	-0.058	0.016***	-0.008	-0.001
	(0.018)	(0.011)	(0.053)	(0.006)	(0.017)	(0.011)
DVD× female=1	-0.118	0.572***				
	(0.082)	(0.066)				
DVD× IQ score			0.070	-0.020		
			(0.061)	(0.015)		
DVD× SES score					-0.091	-0.008
					(0.058)	(0.013)
Other controls	Yes	Yes	Yes	Yes	Yes	Yes
Observations	160	160	160	160	160	160
Mean_Control	0.026	0.013	0.026	0.013	0.026	0.013

Standard errors in parentheses

Asterisks indicate statistical significance: * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Next, we investigate how effectively the DVD lectures worked for the students with non-cognitive capability issues such as present bias, willpower, and self-discipline. The results are reported in Table 7. Columns (1) and (2) report the results including the interaction term of the DVD lectures and the present bias indicator. As expected, students with present bias are less likely to pass the public university entrance exams. However, these type of students also benefited the most from our DVD lecture program. The impact of the DVD lectures was concentrated on students who are present biased, as a consequence the impact on students who are not present bias was insignificant. Our program incorporates a strict disciplinary framework requiring students to attend classes regularly. This indicates the importance of scheduling and commitment in improving the students' academic success. We found a similar effect for the first-tier public universities entrance exam, showing the consistency of our finding.

In columns (3) and (4), we include the interaction term of the DVD lecture with the grit measure. Although students with a higher grit measure are more likely to pass the entrance exams, the impact of the DVD lectures is small for these students. This implies that students with a higher grit measure continue studying hard without the scheduling and commitment

Table 7: Effectiveness of the DVD lectures and non-cognitive ability

	(1) Pub_any	(2) Pub_1st	(3) Pub_any	(4) Pub_1st	(5) Pub_any	(6) Pub_1st	(7) Pub_any	(8) Pub_1st
DVD=1	0.079	0.069	0.172***	0.155***	0.087	0.072	0.200***	0.168***
	(0.087)	(0.063)	(0.065)	(0.048)	(0.082)	(0.061)	(0.050)	(0.040)
Present bias	-0.567***	-0.408***			-0.653***	-0.430***		
	(0.097)	(0.111)			(0.067)	(0.113)		
DVD× Present bias	0.731***	0.560***			0.819***	0.585***		
	(0.138)	(0.114)			(0.099)	(0.116)		
Grit			0.079***	0.040***	0.083***	0.043***		
			(0.029)	(0.006)	(0.025)	(0.008)		
DVD× grit			-0.091***	-0.039**	-0.102***	-0.051***		
			(0.035)	(0.019)	(0.031)	(0.012)		
Conscientiousness							0.125***	0.073***
							(0.041)	(0.020)
DVD× Conscientious							-0.093***	-0.053***
							(0.031)	(0.016)
Other controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	160	160	160	160	160	160	160	160
Mean_Control	0.026	0.013	0.026	0.013	0.026	0.013	0.026	0.013

Standard errors in parentheses
Asterisks indicate statistical significance: * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

imposed by the program and they experience a smaller impact, which is consistent with the discussion of the present bias earlier. When we include both the interaction terms of the present bias and the grit measure in columns (5) and (6), then these terms became significant at the 1% level with similar signs. In columns (7) and (8), we include the interaction term of the DVD lectures with the conscientiousness measure. This result also indicates that students who are less self-disciplined and less hard-working benefited more from the DVD lectures, probably owing to the scheduling and commitment imposed by the program.

This heterogeneous impact implies the importance of commitment, which should be focused more in the program design. This result, combined with tutors, could make the interpretation of the results complicated. Because the tutors also provided encouragement and advice for the students, the estimated impact captures a combined effect of the DVD lectures, strict scheduling, and encouragement. Furthermore, if the tutors are important in creating the positive impact, then the expansion of DVD lectures will be limited. Separating the impact of the DVD lectures themselves and the other components are left for future research.

4.2 Experiment II: Demand for DVD Learning

Next, we turn to the analysis of the price sensitivity of the DVD lectures. We randomized the price discount and the availability of payment in monthly installments at the student level. The reference category for the price discount was set as the 25% discount group. Because the 50% and 75% discount offers correspond to 2/3 and 1/3 price of the 25% discount offer, respectively, we refer to the 50% and 75% discount offers as the 2/3 price treatment and 1/3 price treatment, respectively, for easier interpretation. We denote the base category (25% discount) by $P = 1$, the 2/3 price offer by $P = 2/3$, and the 1/3 price offer by $P = 1/3$. We estimate the following probit model with robust standard errors,[18]

$$\Pr(y_i = 1 | \mathbf{X}_i) = \Phi[\beta_0 + \beta_{p2} I\{P_i = 2/3\} + \beta_{p1} I\{P_i = 1/3\} + \beta_I MI_i + \mathbf{X}_i \boldsymbol{\delta}], \quad (1)$$

and additionally with including the interaction terms,

$$\begin{aligned}
\Pr(y_i = 1 | \mathbf{X}_i) &= \Phi\left[\beta_0 + \beta_{p2} I\{P_i = 2/3\} + \beta_{p1} I\{P_i = 1/3\} + \beta_I MI_i\right. \\
&\quad \left. + \beta_{p2,I}(I\{P_i = 2/3\} \times MI_i) + \beta_{p1,I}(I\{P_i = 1/3\} \times MI_i) + \mathbf{X}_i^c \boldsymbol{\delta}\right], \quad (2)
\end{aligned}$$

where y_i is an indicator of taking up the DVD lectures, Φ is the cumulative normal distribution function, $I\{\cdot\}$ is the indicator function, MI_i is an indicator of the monthly installment payment treatment, the covariates $\mathbf{X}_i^c$ include SES score, student's gender, SSC Exam GPA, and an indicator of the subject division being commerce, and we let $\mathbf{X}_i = (P_i, MI_i, \mathbf{X}_i^c)$. We report the average marginal effects of the treatment variables in Table 8.

As equation (2) includes the interaction terms of the treatment variables, we should be aware what the linear combination of the estimated coefficients capture. Note that

$$\begin{aligned}
\Pr(y_i = 1 | P_i = 2/3, MI_i = 1, \mathbf{X}_i^c) - \Pr(y_i = 1 | P_i = 1, MI_i = 1, \mathbf{X}_i^c) &= \Delta\Phi(\beta_{p2} + \beta_{p2,I}), \\
\Pr(y_i = 1 | P_i = 1/3, MI_i = 1, \mathbf{X}_i^c) - \Pr(y_i = 1 | P_i = 1, MI_i = 1, \mathbf{X}_i^c) &= \Delta\Phi(\beta_{p1} + \beta_{p1,I}), \\
\Pr(y_i = 1 | P_i = 2/3, MI_i = 1, \mathbf{X}_i^c) - \Pr(y_i = 1 | P_i = 2/3, MI_i = 0, \mathbf{X}_i^c) &= \Delta\Phi(\beta_I + \beta_{p2,I}), \\
\Pr(y_i = 1 | P_i = 1/3, MI_i = 1, \mathbf{X}_i^c) - \Pr(y_i = 1 | P_i = 1/3, MI_i = 0, \mathbf{X}_i^c) &= \Delta\Phi(\beta_I + \beta_{p1,I}), \\
\Pr(y_i = 1 | P_i = 2/3, MI_i = 1, \mathbf{X}_i^c) - \Pr(y_i = 1 | P_i = 1, MI_i = 1, \mathbf{X}_i^c) &= \Delta\Phi(\beta_{p2} + \beta_I + \beta_{p2,I}), \\
\Pr(y_i = 1 | P_i = 1/3, MI_i = 1, \mathbf{X}_i^c) - \Pr(y_i = 1 | P_i = 1, MI_i = 1, \mathbf{X}_i^c) &= \Delta\Phi(\beta_{p1} + \beta_I + \beta_{p1,I}).
\end{aligned}$$

---

[18]We did not cluster the standard errors at the branch level because we did not know which branch a student who did not take the offer would have in enrolled if they had taken the offer.

Hence $\beta_{p2} + \beta_{p2,I}$ and $\beta_{p1} + \beta_{p1,I}$ capture the price sensitivity in the monthly installment treatment, while $\beta_I + \beta_{p2,I}$ and $\beta_I + \beta_{p1,I}$ capture the impact of allowing the installment payment when the price was 2/3 and 1/3, respectively. $\beta_{p2} + \beta_I + \beta_{p2,I}$ and $\beta_{p1} + \beta_I + \beta_{p1,I}$ reflect the combined effect of the price discount and installment payment option. Also note that the test for $\beta_{p2} = \beta_{p1}$ investigates the difference in uptake rate between the 1/3 price offer and 2/3 price offer in upfront payment treatment, while the test for $\beta_{p2} + \beta_{p2,I} = \beta_{p1} + \beta_{p1,I}$ examines the difference between the 1/3 price offer and 2/3 price offer in the installment payment treatment.

Column (1) shows the estimation result of the base specification (1). The result indicates that the uptake decision is price-sensitive. While the 2/3 price offer did not affect the uptake rate significantly, the 1/3 price offer increased the uptake rate by 16.2 percentage points, which is significant at the 5% level. We obtain more nuanced results when we include the interaction terms of the price discount and installment treatment variables as shown in column (2). It turns out that students were price-sensitive only when they were offered the monthly installment. While β_{p2} and β_{p1} are insignificant, $\beta_{p2} + \beta_{p2,I}$ and $\beta_{p1} + \beta_{p1,I}$ are positive and statistically significant at the 5% and 1% levels, respectively. However, this price sensitivity result seems to be driven by the substantially low uptake rate in the group of the installment payment with $P = 1$, which is reflected in the negative value of β_I. There is no rational reason that the option to pay in the monthly installment reduces the uptake rate. The estimates of $\beta_I + \beta_{p2,I}$ and $\beta_I + \beta_{p1,I}$ indicate no significant impact of allowing the installment payment when $P = 2/3$ and $P = 1/3$. Further, failure in rejecting the tests of $\beta_{p2} + \beta_I + \beta_{p2,I} = 0$ and $\beta_{p1} + \beta_I + \beta_{p1,I} = 0$ suggests that the uptake rate in the group of $P = 2/3$ or $P = 1/3$ with monthly installment payment option is not statistically different from the reference group. Hence it is likely that for some reasons the uptake rate in the group of the installment payment with $P = 1$ happened to be low, and we avoid concluding whether the uptake decision was price sensitive or not, with more focus on the difference in the price sensitivity between poor students and better-off students.[19]

---

[19]Note that when we split the sample by gender or SES score as in columns (3) and (4) in Table 8 and columns (1) and (2) in Appendix Table 2, we observe the similar pattern, implying that the low uptake rate of this group with installment payment and $P = 1$ was not caused by a specific group. Given that the SSC GPA is not well balanced between the upfront payment group and installment payment group, one would concern that the difference in SSC GPA caused this nuanced results though the SSC GPA is included in all the regression. The results do not change when we include the squared and cubic terms of the SSC GPA to allow for more flexible form of dependence of uptake decision on the SSC GPA, as reported in Columns (1) and (2) in Appendix Table 2. We also split the sample into the low SSC GPA group (below and equal to median) and high SSC GPA group (above median) in Columns (3) and (4) in Appendix Table 2, because the imbalance of SSC GPA could affect the price elasticity estimation if the high SSC GPA group and low SSC GPA group have different price sensitivity. It turns out that the students with low SSC

Table 8: Uptake decision

	(1) All	(2) All	(3) Low SES	(4) High SES	(5) Up-front payment	(6) Installment
β_{p2}: 2/3 price	0.087	-0.082	-0.041	-0.137	-0.063	0.282**
	(0.076)	(0.093)	(0.111)	(0.150)	(0.102)	(0.111)
β_{p1}: 1/3 price	0.162**	0.017	0.022	0.026	0.018	0.318***
	(0.069)	(0.084)	(0.093)	(0.144)	(0.089)	(0.100)
β_I: Installment	0.028	-0.183*	-0.193	-0.189		
	(0.054)	(0.094)	(0.126)	(0.149)		
$\beta_{p2,I}$: 2/3 price × Installment		0.239***	0.236***	0.258***		
		(0.063)	(0.072)	(0.098)		
$\beta_{p1,I}$: 1/3 price × Installment		0.228***	0.227***	0.217		
		(0.075)	(0.080)	(0.145)		
2/3 price × SES score					-0.074	-0.109
					(0.080)	(0.091)
1/3 price × SES score					0.040	0.017
					(0.078)	(0.078)
Other controls	Yes	Yes	Yes	Yes	Yes	Yes
Observations	244	244	133	111	137	107
Mean_Control	0.771	0.771	0.783	0.750	0.783	0.750
$\beta_{p2} + \beta_{p2,I} = 0$		0.033	0.031	0.316		
$\beta_{p1} + \beta_{p1,I} = 0$		0.000	0.003	0.017		
$\beta_I + \beta_{p2,I} = 0$		0.438	0.641	0.550		
$\beta_I + \beta_{p1,I} = 0$		0.503	0.704	0.786		
$\beta_{p2} + \beta_I + \beta_{p2,I} = 0$		0.829	0.991	0.749		
$\beta_{p1} + \beta_I + \beta_{p1,I} = 0$		0.575	0.681	0.746		
$\beta_{p2} = \beta_{p1}$		0.224	0.540	0.199		
$\beta_{p2} + \beta_{p2,I} = \beta_{p1} + \beta_{p1,I}$		0.206	0.520	0.304		

(note) Standard errors are reported in parentheses.
The dependent variable is an indicator variable which takes one if a person takes the program and zero otherwise. Asterisks indicate statistical significance: * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.
$\beta_{p2} + \beta_{p2,I}$ and $\beta_{p1} + \beta_{p1,I}$ captures the impact of 2/3 price and 1/3 price offer on uptake rate in the monthly installment treatment. $\beta_I + \beta_{p2,I}$ and $\beta_I + \beta_{p1,I}$ captures the impact of allowing the installment payment when the price was 2/3 and 1/3, respectively. $\beta_{p2} + \beta_I + \beta_{p2,I}$ and $\beta_{p1} + \beta_I + \beta_{p1,I}$ reflect the combined effect of the price discount and installment payment option. The test for $\beta_{p2} = \beta_{p1}$ investigates the difference in uptake rate between the 1/3 price offer and 2/3 price offer in upfront payment treatment. The test for $\beta_{p2} + \beta_{p2,I} = \beta_{p1} + \beta_{p1,I}$ examines the difference between the 1/3 price offer and 2/3 price offer in the installment payment treatment.

If poor students are more price sensitive, then requiring cost sharing could exclude poor students from the service, contradicting the original purpose of the service of providing the access to rural students who cannot afford to attend the coaching centers. In columns (3) and (4) of Table 8, we estimate the uptake pattern separately for students with an SES score below or equal to the median and students with an SES score above the median, respectively. The results indicate that the price responsiveness is comparable between these two groups. The differences in the estimated coefficients never become significant.[20] The results in columns (5) and (6), where we split the sample into the upfront payment group and installment payment group and include the interaction terms of the discount variables and SES score, confirm that the price responsiveness does not vary depending on the SES score. These results imply that requiring cost sharing will not disproportionally exclude poor students.

Finally, we investigate whether a lower price attracts more students who are less serious and less likely to pass the exam, and reduces the incentive to study hard owing to smaller sunk costs. Because our sample size is small, we could not implement the additional experiment to distinguish the selection effect and incentive effect as in Ashraf, Berry, and Shapiro (2010). Instead, in Table 8 we investigate the total effect of the selection and incentive effect by examining whether students who took up our distance-learning program at a higher price recorded a higher attendance rate and were more likely to be admitted to public universities. Note that these empirical analyses can be interpreted as the one to estimate the intention-to-treatment (ITT) effect. Columns (1) and (2) examine the total effect of selection on attendance. The coefficients never become significant, indicating that the price level did not affect the composition of the students. For the students who attended the DVD lectures, we additionally collected the information on IQ score, grit, and the psychological Big Five. In columns (3) and (4), we include these variables as well as the SES GPA, SSC GPA, and the female dummy as regressors to control these observable variables. If the results change substantially from those in columns (1) and (2), and the coefficient for the 1/3 price dummy is close to zero, it indicates that the price level affected students' incentive to study. The

---

GPA are more responsive to the price difference. Remember that our results imply that students were more price-responsive under the installment payment option, and it was the high SSC GPA students who were more likely in the installment payment group. Hence the imbalance in the SSC GPA will not explain the greater price sensitivity in the installment payment group. We do not report the results with the interaction terms of the price discount and installment variables since our interest here is to examine if the imbalance in the SSC GPA between the upfront and installment payment groups causes the bias in the estimated price elasticity, but the results are available upon request.

[20]t statistics are easily calculated from the table as the standard error of the difference in the coefficients from the different sample, say β^1 and β^2, is calculated as $SE(\hat{\beta}^1 - \hat{\beta}^2) = \sqrt{[SE(\hat{\beta}^1)]^2 + [SE(\hat{\beta}^2)]^2}$.

estimated coefficients are similar to those in columns (1) and (2), indicating the absence of the incentive effect or sunk cost effect, which is consistent with the lack of sunk cost effect in water purification tablet use Ashraf, Berry, and Shapiro (2010). We also conduct a similar exercise for the admission to the public universities, which is reported in columns (5) to (8), finding similar results.

Table 9: Selection and university admission

	(1) % attend	(2) % attend	(3) % attend	(4) % attend	(5) Pub admit	(6) Pub admit	(7) Pub admit	(8) Pub admit
β_{p2}: 2/3 price	0.012	0.015	0.016	0.026	0.012	0.031	-0.001	0.019
	(0.023)	(0.032)	(0.025)	(0.036)	(0.045)	(0.061)	(0.042)	(0.055)
β_{p1}: 1/3 price	-0.038	-0.036	-0.035	-0.020	0.009	0.019	0.005	0.030
	(0.025)	(0.035)	(0.025)	(0.036)	(0.042)	(0.054)	(0.041)	(0.059)
β_I: Installment	0.003	0.008	-0.011	0.014	-0.011	0.015	-0.017	0.027
	(0.019)	(0.037)	(0.018)	(0.041)	(0.034)	(0.070)	(0.034)	(0.069)
$\beta_{p2,I}$: 2/3 price $\times$ Installment		-0.008		-0.026		-0.046		-0.050
		(0.047)		(0.052)		(0.092)		(0.082)
$\beta_{p1,I}$: 1/3 price $\times$ Installment		-0.006		-0.037		-0.026		-0.063
		(0.051)		(0.053)		(0.088)		(0.091)
Control	No	No	Yes	Yes	No	No	Yes	Yes
Observations	183	183	183	183	183	183	183	183
Mean_Control	0.807	0.807	0.807	0.807	0.037	0.037	0.037	0.037
$\beta_{p2} + \beta_{p2,I} = 0$		0.831		0.995		0.834		0.618
$\beta_{p1} + \beta_{p1,I} = 0$		0.250		0.116		0.920		0.607
$\beta_I + \beta_{p2,I} = 0$		0.984		0.671		0.621		0.675
$\beta_I + \beta_{p1,I} = 0$		0.943		0.450		0.827		0.524
$\beta_{p2} = \beta_{p1}$		0.070		0.081		0.850		0.832
$\beta_{p2} + \beta_{p2,I} = \beta_{p1} + \beta_{p1,I}$		0.137		0.083		0.886		0.987

Asterisks indicate statistical significance: Standard errors in parentheses
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

5 Concluding Remarks

We investigated the impact and uptake pattern of a promising education intervention for students who have completed secondary education in Bangladesh. DVD lectures are feasible and expandable, and have a large effect on increasing the probability of passing university entrance exams. The results indicate that students suffering from present-bias and lack of self-discipline & grit benefited more, highlighting the importance of the scheduling and commitment imposed by the program. The price sensitivity of the uptake decision does not depend on the socio-economic conditions of the students; hence, cost sharing will not exclude poor students disproportionately from this program. There is also no evidence that the price

affected the composition of the students or the students' incentive to study. These results suggest that the price can be adjusted without alternating targeting policy to the poor, or resulting in selection and incentive effects on the enrolled students' performance.

The DVD-based distance-learning program could contribute to solving the problem of the disparity between rural and urban education and help students to acquire skills that could lead to better income opportunities that may reduce poverty. DVD-based lectures could be suitable for many countries, as they could be implemented once the best teachers to give lectures have been identified. Although poor infrastructure, such as lack of electrification and limited access to computers, is still a major obstacle to the widespread adoption of such interventions in developing countries, the combined efforts of governments and aid agencies could address these problems as a priority, which may help to achieve economic growth.

One concern with our current DVD program package is its high cost. Because this program provides a tutoring service and strict monitoring of the students' attendance, the running cost is high. The DVD lectures we evaluate are still at a prototype stage. Ideally, DVD lectures should be provided without additional human resources. However, if the DVD lectures alone are provided to students there are two main concerns: lack of direct interaction with lecturers and lack of commitment to attend lectures on schedule. Full-scale DVD lectures should address these two problems by, for example, incorporating the FAQs into the lectures and a punishment mechanism if students procrastinate in watching the DVDs. The program we evaluated depends on volunteer university students working as tutors, and the DVD center administrators imposing strict scheduling. Hence, the estimated impact includes the effect of tutors and strict scheduling, in addition to the individual effect of the DVD lectures.

Another concern is a version of the general equilibrium effect. Since the capacity of the universities is limited, the increased success probability of the treated students will decrease success probability of non-treatment students. If the replaced students were from the villages with similar background, then the DVD lectures aiming at improving access to tertiary education in rural areas would just benefit the treated students at the cost of the other students in other rural areas. Hence, we should also consider fundamental policy issues such as expansion of the supply-side capacity of the universities in accordance with the improvement of the learning conditions in rural areas. Otherwise, any intervention helping students pass the university entrance exams will only cause the rat race.

Recent literature also shows that how the program is implemented is as important as what

the program is (Bold et al., 2013).[21] In the program we evaluated, we monitored the students'
use of the DVD lectures closely, although the effect could be different if we implemented the
project with a different design. The detailed design of the project implementation should be
examined carefully in future research.

---

[21]Linden (2008) found that introducing computerized learning improved academic performance, although
it did not work well when it was used to replace the teacher in the normal school day. Some educational
literature comparing podcasting with traditional lectures also reported mixed results. Recently, Beuermann
et al. (2015) found that the One Laptop per Child Program (OLPC) in Peru had no significant effect on
students' attendance and time use, indicating that just providing the technology does not improve students'
performance, and how the students use the technology is important.

References

Almlund, Mathilde, Angela Lee Duckworth, James J. Heckman, and Tim D. Kautz. 2011. *Personality Psychology and Economics*, *Handbook of the Economics of Education*, vol. 4, chap. 1. Elsevier, 1–181.

Angrist, Joshua and Victor Lavy. 2002. "New Evidence on Classroom Computers and Pupil Learning." *Economic Journal* 112 (482):735–765.

Armendáriz, Beatriz and Jonathan Morduch. 2010. *The economics of microfinance*. MIT press.

Ashraf, Nava, James Berry, and Jesse M. Shapiro. 2010. "Can Higher Prices Stimulate Product Use? Evidence from a Field Experiment in Zambia." *American Economic Review* 100 (5):2383–2413.

Ashraf, Nava, Dean Karlan, and Wesley Yin. 2006. "Tying Odysseus to the Mast: Evidence from a commitment savings product in the Philippines." *Quarterly Journal of Economics* 121 (2):635–672.

Banerjee, Abhijit and Esther Duflo. 2006. "Addressing Absence." *Journal of Economic Perspectives* 20 (1):117–132.

Banerjee, Abhijit V., Shawn Cole, Esther Duflo, and Leigh Linden. 2007. "Remedying Education: Evidence from Two Randomized Experiments in India." *The Quarterly Journal of Economics* 122 (3):1235–1264.

Barrera-Osorio, Felipe and Leigh L. Linden. 2009. "The use and misuse of computers in education : evidence from a randomized experiment in Colombia." Policy Research Working Paper Series 4836, The World Bank.

Barrow, Lisa, Lisa Markman, and Cecilia Elena Rouse. 2009. "Technology's Edge: The Educational Benefits of Computer-Aided Instruction." *American Economic Journal: Economic Policy* 1 (1):52–74.

Beuermann, Diether W., Julian Cristia, Santiago Cueto, Ofer Malamud, and Yyannu Cruz-Aguayo. 2015. "One Laptop per Child at Home: Short-Term Impacts from a Randomized Experiment in Peru." *American Economic Journal: Applied Economics* 7 (2):53–80.

Bold, Tessa, Mwangi Kimenyi, Germano Mwabu, Alice Ng'ang'a, and Justin Sandefur. 2013. "Scaling-up What Works: Experimental Evidence on External Validity in Kenyan Education." CSAE Working Paper Series 2013-04, Centre for the Study of African Economies, University of Oxford.

Chaudhury, Nazmul, Jeffrey Hammer, Michael Kremer, Karthik Muralidharan, and F Halsey Rogers. 2006. "Missing in Action: Teacher and Health Worker Absence in Developing Countries." *Journal of Economic Perspectives* 20 (1):91–116.

Chetty, Raj, John N. Friedman, Nathaniel Hilger, Emmanuel Saez, Diane Whitmore Schanzenbach, and Danny Yagan. 2011. "How Does Your Kindergarten Classroom Affect Your Earnings? Evidence from Project Star." *The Quarterly Journal of Economics* 126 (4):1593–1660.

Cohen, Jessica and Pascaline Dupas. 2010. "Free Distribution or Cost-Sharing? Evidence from a Randomized Malaria Prevention Experiment." *Quarterly Journal of Economics* 125 (1):1–45.

Colclough, Christopher, Geeta Kingdon, and Harry Patrinos. 2010. "The Changing Pattern of Wage Returns to Education and its Implications." *Development Policy Review* 28 (6):733–747.

Crump, Richard K., V. Joseph Hotz, Guido W. Imbens, and Oscar A. Mitnik. 2009. "Dealing with limited overlap in estimation of average treatment effects." *Biometrika* 96 (1):187–199.

Duckworth, Angela L, Christopher Peterson, Michael D Matthews, and Dennis R Kelly. 2007. "Grit: perseverance and passion for long-term goals." *Journal of personality and social psychology* 92 (6):1087.

Eskreis-Winkler, Lauren, Elizabeth P. Shulman, Scott A. Beal, and Angela L. Duckworth. 2014. "The grit effect: predicting retention in the military, the workplace, school and marriage." *Frontiers in Personality Science and Individual Differences* 5 (36):1–12.

Heckman, James, Rodrigo Pinto, and Peter Savelyev. 2013. "Understanding the Mechanisms through Which an Influential Early Childhood Program Boosted Adult Outcomes." *American Economic Review* 103 (6):2052–86.

Kremer, Michael and Alaka Holla. 2009. "Improving Education in the Developing World: What Have We Learned from Randomized Evaluations?" *Annual Review of Economics* 1 (1):513–545.

Lai, Fang, Linxiu Zhang, Qinghe Qu, Xiao Hu, Yaojiang Shi, Matthew Boswell, and Scott Rozelle. 2015. "Teaching the Language of Wider Communication, Minority Students, and Overall Educational Performance: Evidence from a Randomized Experiment in Qinghai Province, China." *Economic Development and Cultural Change* 63 (4):753 – 776.

Linden, Leigh L. 2008. "Complement or Substitute? The Effect of Technology on Student Achievement in India."

Mo, Di, Johan Swinnen, Linxiu Zhang, Hongmei Yi, Qinghe Qu, Matthew Boswell, and Scott Rozelle. 2013. "Can One-to-One Computing Narrow the Digital Divide and the Educational Gap in China? The Case of Beijing Migrant Schools." *World Development* 46 (C):14–29.

Mujeri, Mustafa K. 2010. "The rights-based approach to education in Bangladesh." *Bangladesh Development Studies* 33 (1):139–203.

Robins, James M., Andrea Rotnitzky, and Lue Ping Zhao. 1995. "Analysis of semiparametric regression models for repeated outcomes in the presence of missing data." *Journal of the American Statistical Association* 90 (429):106–121.

A   Appendix Tables

Appendix Table 1: Characteristics of Students in Targeted HSC Institutes

Grade 12 students					
	count	mean	sd	min	max
SSC GPA	2157	4.11	0.57	3.00	5.00
SES score	2157	-0.03	0.68	-1.20	1.45
Female	2157	0.52	0.50	0.00	1.00
Commerce	2157	0.53	0.50	0.00	1.00

Grade 12 students with intention to study in universities					
	count	mean	sd	min	max
SSC GPA	1710	4.14	0.57	3.00	5.00
SES score	1710	-0.01	0.69	-1.20	1.45
Female	1710	0.51	0.50	0.00	1.00
Commerce	1710	0.53	0.50	0.00	1.00

	(1)	(2)	(3) Add $(\text{SSC GPA})^2$ $(\text{SSC GPA})^3$	(4) Add $(\text{SSC GPA})^2$ $(\text{SSC GPA})^3$	(5)	(6)
	Male	Female			Low GPA	High GPA
β_{p2}: 2/3 price	0.015	-0.188	0.082	-0.092	0.171*	0.009
	(0.128)	(0.141)	(0.076)	(0.091)	(0.103)	(0.111)
β_{p1}: 1/3 price	0.069	-0.036	0.158**	0.008	0.231**	0.096
	(0.115)	(0.122)	(0.070)	(0.084)	(0.098)	(0.094)
β_I: Installment	-0.198*	-0.141	0.035	-0.184*	0.051	0.029
	(0.120)	(0.148)	(0.055)	(0.095)	(0.083)	(0.074)
$\beta_{p2,I}$: 2/3 price $\times$ Installment	0.143	0.335***		0.243***		
	(0.110)	(0.070)		(0.062)		
$\beta_{p1,I}$: 1/3 price $\times$ Installment	0.194**	0.244*		0.231***		
	(0.098)	(0.129)		(0.075)		
Observations	140	104	244	244	124	120
Mean_Control	0.789	0.750	0.750	0.750	0.650	0.933
$\beta_{p2} + \beta_{p2,I} = 0$	0.096	0.221		0.037		
$\beta_{p1} + \beta_{p1,I} = 0$	0.002	0.052		0.000		
$\beta_I + \beta_{p2,I} = 0$	0.571	0.112		0.415		
$\beta_I + \beta_{p1,I} = 0$	0.963	0.320		0.484		
$\beta_{p2} + \beta_I + \beta_{p2,I} = 0$	0.788	0.979		0.787		
$\beta_{p1} + \beta_I + \beta_{p1,I} = 0$	0.656	0.671		0.618		
$\beta_{p2} = \beta_{p1}$	0.599	0.250		0.227		
$\beta_{p2} + \beta_{p2,I} = \beta_{p1} + \beta_{p1,I}$	0.240	0.621		0.207		

Standard errors are reported in parentheses.

Asterisks indicate statistical significance: * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

$\beta_{p2} + \beta_{p2,I}$ and $\beta_{p1} + \beta_{p1,I}$ captures the impact of 2/3 price and 1/3 price offer on uptake rate in the monthly installment treatment. $\beta_I + \beta_{p2,I}$ and $\beta_I + \beta_{p1,I}$ captures the impact of allowing the installment payment when the price was 2/3 and 1/3, respectively. $\beta_{p2} + \beta_I + \beta_{p2,I}$ and $\beta_{p1} + \beta_I + \beta_{p1,I}$ reflect the combined effect of the price discount and installment payment option. The test for $\beta_{p2} = \beta_{p1}$ investigates the difference in uptake rate between the 1/3 price offer and 2/3 price offer in upfront payment treatment. The test for $\beta_{p2} + \beta_{p2,I} = \beta_{p1} + \beta_{p1,I}$ examines the difference between the 1/3 price offer and 2/3 price offer in the installment payment treatment.