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Abstract: Gender parity in education—an important global development goal—has been primarily measured through school enrollment, and the gender parity in education quality has received limited attention until recently. We address this issue by highlighting the intrahousehold allocation of education expenditure. We extend the hurdle model into a three-part model to enable decomposition of households' education decisions into enrollment, total education expenditure, and share of the total education expenditure on the core component, or items relating to the quality of education such as private tutoring. We apply this model to four rounds of nationally representative household surveys from Bangladesh, a country that offers a unique setting in South Asia with the Female Stipend Programs (FSPs), a nationwide gender-targeted conditional cash transfer program. We demonstrate a strong profemale bias in the enrollment decision but contrasting promale bias in the other two decisions, conditional on enrollment. We argue that this contradirectional gender gap is unique to Bangladesh and that it can be explained partly by the FSPs. Both the three-part model and a separate analysis of double-difference model show that the FSPs promoted girls' secondary school enrollment. However, the FSPs did not narrow the gender gap in the intrahousehold allocation of educational resources. Consistently, we find a gender gap in on-time completion of secondary school. Our findings collectively highlight the complex interplay of intrahousehold decisions and underscore the importance of minding the gender gap in the quality of education and implementing complementary policies to address it in developing countries.

Keywords: Conditional cash transfer, Quality of education, Hurdle model, Female stipend program, Bangladesh

1. Introduction

The last several decades have witnessed significant progress around the globe in various aspects of education, particularly for girls who have been historically disadvantaged. Most notably, the previous global targets of universal primary education and gender equality in all levels of education under the Millennium Development Goals (MDGs) were broadly attained by 2015, based on quantity indicators such as enrollment (United Nations, 2015). However, if access to education is narrowly defined as enrollment, vast differences in educational quality, resource inputs, and measurable outcomes would be concealed (Lewin, 2007). UNESCO (2014) argues that the neglect of learning outcomes in the MDGs also diminished attention to education quality and that this issue, together with a failure to reach the marginalized, has contributed to a learning crisis that needs urgent attention. With increased recognition of the importance of the quality of education, the policy focus in the developing world has rightly shifted from quantity to quality, as epitomized by the fourth Sustainable Development Goal—quality education. Against this backdrop, we demonstrate that a significant gender gap may persist in the intrahousehold allocation of educational resources even if gender-targeted stipend programs are introduced and gender parity in enrollment is achieved. While our analysis is based on data from Bangladesh, this finding has a global implication since current education policies implemented in developing countries are often unable to adequately address the gender gap in the quality of education and learning achievements.

One of our primary contributions is methodological, where we bring the way households spend money on education into the analysis. Even though it has largely been neglected in the literature, the way financial resources are spent on education is important for understanding the gender gap in education, since the total education expenditure can mask an important gap that may affect the quality of education that girls and boys receive. To see the relevance of this point, consider a household with a boy and a girl in which an equal amount is spent on their education. Suppose further that the education expenditure for the boy is mostly utilized to pay for private tutoring, whereas that for the girl is mostly used to buy more or better uniforms. The gender gap in the pattern of education expenditure would result in a gender difference in the quality of education.

One empirical challenge in addressing this issue is the interdependence in various intrahousehold education decisions. To tackle this challenge, we propose an extension of the hurdle model—which was first used by Kingdon (2005) to analyze gender bias in enrollment and total education expenditure—by including the third decision on how the total educational expenditure is utilized. Specifically, this three-part model consists of the following three decisions made by the household: (1) enrollment, (2) total education expenditure conditional on enrollment, and 3) share of the total education expenditure on the "core" component—which includes items that would directly affect the child's education quality (such as private tutoring) as elaborated in Section 4. The third decision on the core share is important, because higher education expenditure would not translate into higher education quality when it is spent mostly on the "peripheral component"—which includes items that are not in the "core" component (such as uniforms). We estimate this three-part model by maximum likelihood estimation using four rounds of nationally representative household surveys in Bangladesh.

Bangladesh provides an excellent and policy relevant context to study the gender gap in intrahousehold educational expenditure differentiating between the core and peripheral components given the presence of gender-targeted CCTs. Despite being predominantly patriarchal, Bangladesh has achieved remarkable progress in bringing girls and boys to school. The recent progress is especially pronounced in education statistics at the secondary level. The gross secondary school enrollment rate for girls [boys] increased from 14 [27] percent in 1990 to 72 [66] percent in 2016. This noteworthy progress has been supported by several interventions implemented by government and nongovernmental organizations (see Ahmed et al. (2007) for a review). In particular, interventions targeted at promoting girls' education have helped eliminate or even reverse the gender gap in some measures of education in Bangladesh (Ahmed et al., 2007; Chowdhury et al., 2002; Shafiq, 2009). At the secondary level, the Female Stipend Programs (FSPs)—conditional cash transfer (CCT) programs that provide girls with a stipend and tuition fee waiver—have been notably credited for narrowing the gender gap in enrollment (Asadullah and Chaudhury, 2009; Behrman, 2015; Khandker et al., 2003; Mahmud, 2003). The FSPs are also found to increase the years of schooling for younger siblings through positive spillovers (Begum et al., 2017), as well as to delay marriage and childbearing (Hahn et al., 2018).

The distinction between quantity and quality is important because policies to increase quantity outcome measures do not necessarily lead to an improvement in the education quality or learning achievements (Asadullah et al., 2019). To highlight this, take CCT programs as an example. These programs give cash to eligible households, if their children can fulfill certain conditions such as satisfactory school attendance. Therefore, CCT programs can simultaneously relax the budget constraint and lower the opportunity cost of education. Following the success of the pioneering CCT program, *Progresa* in Mexico, similar programs have been replicated around the world to help the disadvantaged groups (see Fiszbein and Schady, 2009 for a review). In South Asia, studies in the Punjab province of Pakistan (Chaudhury and Parajuli, 2010) and in seven states of India (Sekher and Ram, 2015) suggest that gender-targeted CCT programs can narrow the gender gap in enrollment.

However, gender parity in education needs to be viewed from a broader perspective, using a host of indicators in addition to enrollment. Girls may fall behind boys in learning achievements, even when gender parity in school enrollment is achieved. In various places, the supply of education services has failed to keep pace with the massive increase in school attendance and enrollment with the introduction of CCT programs. This, in turn, has resulted in overcrowded classrooms—lowering the quality of school education (Kattan, 2006). Alam et al. (2011) document that a gender-targeted CCT program in the Punjab province of Pakistan may have contributed to a gender gap in learning as households responded to this program by sending boys to private schools. However, existing studies mostly neglected the (potentially negative) impact of gender-targeted CCTs on intrahousehold resource allocation and the quality of education children receive. This is a particularly serious problem for economically and socially disadvantaged households, since they are least likely to be able to help children by hiring private tutors or by teaching them at home. Consequently, children may not learn much despite going to school (Saha and Saha, 2018). Supply side factors—such as low female-male ratio among teachers, gender bias among educators (Lavy and Sand, 2018), and lack of gender-appropriate school curriculum and facilities (e.g., gender-segregated toilets)—may also hinder quality learning experience for girls. These supply-side factors are relevant and have been studied at length in the literature. In comparison, the demand-side constraints that would potentially limit the effectiveness of education policies and programs are relatively understudied. Hence, we focus on the gender gap from the demand side by highlighting the allocation of education expenditure within the household.

With less household education expenditure spent on girls' education, it is not surprising that girls are lagging behind boys in various educational outcomes in the secondary and higher levels of education. Girls have been underperforming boys in the Secondary School Certificate (SSC) examination as discussed subsequently. Further, girls also face higher rates of dropout and grade repetition than boys (Schurmann, 2009), and these points remain true even in recent education statistics. For example, the secondary school completion rate for girls and boys were respectively 58 percent and 67 percent in 2017, up from 34 percent and 43 percent in 2008.

Our estimates of the three-part model show a clear profemale bias in the enrollment decision in Bangladesh. However, the decisions about total education expenditure and core expense share—conditional on enrollment—are significantly promale in the recent three survey rounds in Bangladesh. For example, we find that girls were 10 percentage points more likely to be enrolled in secondary school than boys in 2010. Nevertheless, conditional on enrollment, the total education expenditure and the core component expenditure for girls in 2010 are estimated to be lower than those for boys by 520 BDT and 542 BDT— which are about 7 and 10 percent of the total education expenditure and core expenditure on the boys, respectively.[1]

Our finding of *contradirectional* gender gap—profemale bias in enrollment decision and promale bias in the other two education decisions in the three-part model—is not found anywhere else. Hence, the uniqueness of the contradirectional gender gap found in this study is noteworthy. To better understand the contradirectional gender gap in Bangladesh, particularly in comparison to

[1] In 2010, the average official exchange rate was about 1 USD = 70 BDT (Bangladesh taka).

other South Asian countries, we explore the relevance of the FSPs, because a comparable nationwide gender-targeted CCT program did not exist in other South Asian countries during our study period.[2]

We find some evidence that the FSPs help explain the contradirectionality of the gender gap. Specifically, by taking advantage of the variations in the FSP coverage and adopting a double-difference estimation, we find that the FSPs helped increase girls' enrollment relative to boys'. We also integrate the double-difference strategy into the three-part model to understand the broader impact of FSPs by taking the status of FSP receipt and treatment intensity as sources of identification. We find that the FSPs were not successful in narrowing the gender gap in education expenditure and core share, conditional on enrollment, despite increasing girls' school enrollment more than boys'. This result indicates the presence of a gender gap in the quality of education that school children receive. Therefore, while CCT programs like the FSPs can be effective in bringing girls to school and help improve or even reverse the gender gap in quantity indicators of education, they may be ineffective in narrowing the gaps in education quality and learning achievements, partly because the gender gap persists in the amount and kind of educational resources made available at home. Hence, policy-makers would also need to consider implementing complementary policies—such as gender-targeted school quality improvement programs or vouchers for free remedial education—to improve the quality of education for girls and to narrow the gender gap in education quality. Our finding also adds to a broader debate on gender-related changes in Bangladesh and South Asia.

The rest of this paper is organized as follows. We review related studies and discuss our paper's relevance and contributions to the body of existing studies in Section 2. We introduce the three-part model in Section 3, followed by the data description and key summary statistics in Section 4. In Section 5, we document the contradirectional gender gap using the three-part model. We then investigate the relevance of the FSPs in the following three sections. We first demonstrate that the FSPs had a positive impact on the quantity measures of education using double-difference estimation in Section 6. We then use the three-part model to show that the FSPs did not mitigate—and in fact worsened if anything—the promale bias in the conditional education expenditure and core share decisions in Section 7. Consistent with this, girls who have graduated from primary school are less likely to graduate from secondary school on time when they are from a division with more intensive coverage of FSPs as elaborated in Section 8. Summary and discussions of the findings are provided in Section 9.

2. Relevance and Contributions to Literature

This study contributes to the literature on intrahousehold allocation of resources for human capital investment in developing countries. Previous studies highlighted a gender bias whereby parents systematically invest more resources in sons' education (Deaton, 1989; Li and Tsang, 2003; Kaul, 2018). Employing a hurdle model, Kingdon, 2005 finds a promale bias in the enrollment decision but no gender bias in education expenditure among enrolled children in rural India. Azam and Kingdon (2013) revisit this study with more comprehensive data from India and found the presence of promale bias in education expenditure. Using more recent data, Datta and Kingdon (2019) find that promale bias in enrollment and conditional education expenditure decisions is more prevalent at higher levels of education. Besides India, the hurdle model has also been applied to Malaysia (Kenayathulla, 2016), Pakistan (Aslam and Kingdon, 2008), Paraguay (Masterson, 2012), and Sri Lanka (Himaz, 2010), among others. The main results of these studies using a hurdle model are summarized in Table 15 in Appendix F.

Table 15 shows that the promale bias is far from ubiquitous: Masterson (2012) finds a promale bias in rural areas but a profemale bias in urban areas in Paraguay. In Malaysia, no gender gap was found (Kenayathulla, 2016), whereas a profemale bias in education expenditure conditional on enrollment was detected in Sri Lanka (Himaz, 2010). Wongmonta and Glewwe (2017) also find a gender gap in favor of females in Thailand, though this study is not based on a hurdle model. Table 15 also shows that the directions of gender biases in enrollment and conditional education expenditure decisions are never contradirectional (i.e., if one of them is significantly profemale [promale], then the other is never significantly promale [profemale]).

Therefore, the contradirectional gender bias documented in this paper is new. It is notable that the contradirectional gender bias in Bangladesh contrasts with a clear (codirectional) promale bias in other South Asian countries such as India and Pakistan. It is also remarkable that this bias has been clearly present since 2000 both in urban and rural areas. As elaborated later, the evidence for the presence of contradirectional bias is robust.

This paper also makes a methodological contribution by extending the hurdle model to include a third equation for the core share in the total education expenditure as discussed earlier. This additional equation enables us to detect gender bias in the way education expenditure is used. Moreover, we allow for correlations in the unobservable error terms across different decisions, which enables more efficient estimation than equation-by-equation estimation typically used in the literature. Furthermore, the three-part model developed in this paper is integrated with a double-difference approach to estimate broader impacts of FSPs on gender gap.

This paper also contributes to the literature on the impact of CCT programs. These programs are found to be effective in promoting school enrollment for the targeted population (Khandker et al., 2003; Mahmud, 2003; Glewwe and Kassouf, 2012; Behrman et al., 2009), though they may not help to improve education quality as shown in Mexico (Behrman et al., 2009), Bangladesh (Khandker et al., 2003), and Brazil (Glewwe and Kassouf, 2012). The impact of CCT programs on test scores, as a measure of educational performance, is weak at best (García and Saavedra, 2017). While there are some studies that examine the impact of CCT programs on the pattern of household expenditure (Maluccio and Flores, 2005; Edmonds and Shrestha, 2014), we offer a new angle in this literature by investigating the allocation of educational resources within the household in the presence of a CCT program.[3]

In line with previous studies, we find that CCT programs were effective in bringing girls to schools. However, they did not attract a sufficient amount of complementary investment from households. The gap between enrolled boys and girls in school performance did not narrow as a result. While our analysis is based only on Bangladeshi data, the lack or inadequacy of complementary investment from households may be among the most important reasons why CCT programs did not achieve notable improvements in educational outcomes beyond attendance. Thus, this study offers a cautionary lesson to researchers and policy-makers: simply increasing the enrollment of female students does

[2] Sekher and Ram (2015) and Chaudhury and Parajuli (2010) discussed earlier only cover a part of Pakistan and India, respectively.

[3] Note also that there are a number of studies that have examined the impact of CCT programs on noneducational outcomes such as health and cognitive abilities (Gertler, 2004; Fernald et al., 2008; Orazio et al., 2010; Paxson and Schady, 2010; Macours et al., 2012). While noneducational outcomes are also important, they are beyond the scope of this study.

not automatically narrow the gender gap in the quality of education that children receive.[4]

Finally, our paper also relates to a body of empirical studies on gender gap in education in Bangladesh, particularly those focused on learning outcomes and educational quality. Earlier studies have documented that girls lag behind boys in important skills such as literacy and numeracy, even though the difference is not always significant (Nath et al., 1999; Chowdhury et al., 2003). Our analysis of on-time graduation from secondary school and performance in secondary school certificate examination (Fig. 1 in Appendix F) also indicate that the gap persisted at least until recent years. Our results resonates with Schurmann (2009), who argues without data that it is expensive to let children progress through grades due to the sporadic quality of teaching, because parents need to hire the class teacher as a tutor. This cost affects girls more than that for boys, since households are less willing to hire tutors for girls than for boys. We substantiate this argument using microdata. The empirical finding offered in this paper also adds to a broader debate about changing gender gap in South Asia, as elaborated in Section 9.

3. The three-part model

We extend the hurdle model proposed by Kingdon (2005)—a model consisting of decisions on a child's school enrollment and the amount of education expenditure conditional on enrollment—in two directions. First, we extend the hurdle model to account for the gender difference in the way education expenditure is used, a point that is mostly neglected in the literature. To address this point, we classify education expenditure items into core and peripheral components, where the former directly relates to the quality of education but the latter does not, as detailed in the next section. We then incorporate the core share in the total education expenditure as the third part of the model.

Second, we allow for correlations in unobservable error terms across all equations. This is important because there may be some unobservable characteristics that affect all three decisions simultaneously. Take unobserved innate ability as an example. Smarter children (with high innate intellectual abilities) are arguably more likely to be enrolled in school due to their high expected returns from education. On the one hand, they may require less education expenditure from the household than less smart children, because of a lower need for private tutoring or a higher chance of receiving merit-based scholarships. On the other hand, households may be encouraged to spend more money on education for children with high abilities to learn. Our model enables the data to indicate the sign and size of the correlations among the error terms arising from unobservable characteristics, such as innate ability.

Formally, we consider the following three outcome variables: school enrollment $d \in \{0, 1\}$, education expenditure $y(> 0)$, and core share in education expenditure $s \in [0, 1]$, and our three-part model has the following structure:

$$d = \mathbf{1}(x'_d\beta_d + \epsilon_d > 0) \tag{1}$$

$$\log y = x'_y\beta_y + \epsilon_y \tag{2}$$

$$s = \max(0, \min(1, x'_s\beta_s + \epsilon_s)), \tag{3}$$

where $\mathbf{1}(\cdot)$ is an indicator function, and x, β, and ϵ in each equation are the vector of covariates, its coefficient vector, and the idiosyncratic error term, respectively. The covariates include, among others, a dummy variable for girl to identify the gender effect. The observed share s is related to its latent variable $s^* \equiv x'_s\beta_s + \epsilon_s$, and s is a truncated version of s^* from below at zero and from above at one. It should be noted that the education expenditure (y) and core share (s) are observable if and only if the child is enrolled in school (i.e., $d = 1$).

To allow for the dependency across the three equations, we assume that the error terms ϵ_d, ϵ_y, and ϵ_s have the following trivariate normal distribution:

$$\begin{bmatrix} \epsilon_d \\ \epsilon_y \\ \epsilon_s \end{bmatrix} \sim N\left(\mathbf{0}, \begin{bmatrix} 1 & \rho_{dy}\sigma_y & \rho_{ds}\sigma_s \\ \rho_{dy}\sigma_y & \sigma_y^2 & \rho_{ys}\sigma_y\sigma_s \\ \rho_{ds}\sigma_s & \rho_{ys}\sigma_y\sigma_s & \sigma_s^2 \end{bmatrix}\right), \tag{4}$$

where the variance of ϵ_d can be assumed to be unity without loss of generality.

There are four distinct cases to consider in this setup: 1) the child is not enrolled in school $(d = 0)$, 2) the child is enrolled in school with all education expenditure going to the peripheral component $(d = 1$ and $s = 0)$, 3) the child is enrolled in school with education expenditure going to both the core and peripheral components $(d = 1$ and $0 < s < 1)$, and 4) the child is enrolled in school with all education expenditure going to the core component $(d = 1$ and $s = 1)$.[5]

The sample log-likelihood function $l(\theta)$ can be written as:

$$l(\theta) = \sum_{i=1}^{N} l_i(\theta) = \sum_{i=1}^{N}\Big\{\mathbf{1}[d_i = 0]\cdot l_i^1 + \mathbf{1}[d_i = 1, s_i = 0]\cdot l_i^2 \tag{5}$$

$$+\mathbf{1}[d_i = 1, 0 < s_i < 1]\cdot l_i^3 + \mathbf{1}[d_i = 1, s_i = 1]\cdot l_i^4\Big\}, \tag{6}$$

where l_i^j is the log-likelihood function for child $i \in \{1, \cdots, N\}$ under case $j \in \{1, 2, 3, 4\}$ and θ is a parameter vector that includes all βs, ρs, and σs. The maximum-likelihood (ML) estimator $\hat{\theta}_{ML}$ for the three-part model can be written as $\hat{\theta}_{ML} = \arg\max_\theta l(\theta)$.We relegate the detailed derivation of the log-likelihood function l_i^j for each case to Appendix A.

The primary coefficients of interest are those on the girl dummy in β_d, β_y, and β_s. If these coefficients have positive [negative] signs, they indicate a profemale [promale] bias. An important identification assumption is that the girl dummy is exogenous. While this treatment is common in studies on gender gap, it is potentially problematic as the child's gender may be correlated with unobservable characteristics, such as household's gender preference. As elaborated in Section 5, we attempt to partially address this issue through fixed-effects regressions for some subsamples.

It should be noted here that the size of the coefficient does not necessarily equate with the size of the effect, since the model is nonlinear. Therefore, using the ML estimates, we calculate the marginal effects of being a girl on the probability of enrollment as well as conditional and unconditional levels of the total education expenditure and core expenditure. Because we cannot obtain a simple closed-form solution for the marginal effect due to the correlation across error terms, we need to use numerical integration to calculate marginal effects. The girl effects on d, y, and s are computed as the change in the expected value of the outcome of interest when the value of the girl dummy variable changes from zero to one. The following expressions are used for the conditional and unconditional expectations:

[4] A related point was made in Shonchoy and Rabbani (2015). However, we provide more complete and coherent explanations of this phenomenon with more rounds of survey data.

[5] Cases 2) and 4) are relatively rare in our data, accounting for 0.42 percent and 0.25 percent of all observations across years, respectively.

$$E(d) = P(d=1) = \Phi(x'_d\beta_d) \quad \text{(Expected enrollment)} \tag{7}$$

$$E(y|d=1) = \int_0^\infty yf(y|d=1)dy \quad \text{(Conditional expected education expenditure)} \tag{8}$$

$$E(y) = P(d=1)E(y|d=1) \quad \text{(Unconditional expected education expenditure)} \tag{9}$$

$$E(ys) = \int_0^1 \int_0^\infty ysf(y,s)dyds \quad \text{(Unconditional expected core expenditure)} \tag{10}$$

$$E(ys|d=1) = \frac{E(ys)}{P(d=1)} = \frac{E(ys)}{\Phi(x'_d\beta_d)} \quad \text{(Conditional expected core expenditure)}, \tag{11}$$

where Φ is the cumulative density function (CDF) for a standard normal distribution and f is the probability density function. We use simulations to compute the standard errors for the equations above and evaluate only at the sample means to reduce the computational burden of numerical integrations. The details of the mathematical expressions used for numerical integrations and the simulation method for computing the marginal effects are described in Appendix B.

4. Data

We primarily use the nationally representative Household Expenditure Survey (HES) for the year 1995 and Household Income Expenditure Survey (HIES) for the years 2000, 2005, and 2010, all of which were conducted by the Bangladesh Bureau of Statistics. These datasets provide demographic and socioeconomic characteristics of households and detailed information on education expenditure for each child in a household.[6]

We report the average education expenditure conditional on enrollment for boys and girls and the difference between them for each grade, including both the primary (grades 1–5, officially ages 6–10) and secondary (grades 6–10, officially ages 11–15) levels in Fig. 2 in Appendix F.[7] We note three points from this figure. First, across all survey years, the education expenditure increases with grade, particularly at the secondary level. Second, boys receive a larger investment in education than girls conditional on enrollment. Third, except for the year 1995, the gender gap in education expenditure tends to widen as grades progress, especially at the secondary level.

Therefore, secondary education appears to be particularly important for the analysis of gender gap. It is also worth noting that gender-based education intervention by the government existed at the secondary level but not at the primary level during our study period. The FSPs were targeted only at girls in secondary schools, whereas the Food for Education program, started in 1993, and its successor, the Primary Education Stipend program, started in 2002, were not related to the child's gender. Furthermore, passing the SSC examination, which is held at the end of the secondary education phase, is a major milestone in the Bangladeshi education system.[8] For these reasons, we choose to focus on secondary education.

We include the following basic covariates in each of the three equations (Eqs. (1)–(3)) in all reported three-part regressions: the age and gender of the child, the age and gender of the household head, logarithmic household size, logarithmic expenditure per capita, the number of children in the household, the head's working status and religion, and parental education in years. In addition, we also include the urban dummy to capture the geographical heterogeneity in parental investment in children's education. The choice of these covariates is broadly consistent with existing studies such as those by Kingdon (2005),Aslam and Kingdon (2008), Masterson (2012),Azam and Kingdon (2013).

Some covariates are assumed to affect some but not all outcomes. In Eq. (1), the numbers of secondary schools and madrasas per thousand people in an area of residence are included in the set of covariates as measures of school accessibility in addition to the basic covariates discussed above. We argue that this is reasonable because school accessibility will primarily affect the enrollment decision, particularly in developing countries where school infrastructure is inadequate. On the other hand, it will not heavily affect education expenditure once the type of school that a child attends is controlled for.

To construct the accessibility measures, we compile the number of schools and madrasas at the district or subdivision level (district-level data from Banbeis (1995),Banbeis (2006), and Banbeis (2010) for the years 1995, 2005, and 2010 and subdivision-level data from the Bangladesh Bureau of Statistics (2002) for the year 2000) and divide by the population at that level using the population figures taken from the Population and Housing Census for the year 2001.[9]

In Eq. (2), we add two school-type variables (public and private) as different types of schools may affect tuition, uniform, and other education expenditure items differently.[10]

[6] The top 1 percent of observations with the highest total educational expenditure are dropped as outliers. Further, to apply the three-part model to the data, we choose to drop from our sample around 0.39 percent of children who were enrolled in secondary school with no education expenditure. As a result, the education expenditure for a child in our sample is always positive (i.e., $y > 0$) whenever the child is enrolled in school (i.e., $d = 1$).

[7] Secondary education is sometimes subdivided into junior secondary (grades 6–8, officially ages 11–13) and secondary (grades 9–10, officially ages 14–15) levels in Bangladesh. We do not make this distinction.

[8] Analysis of older age groups, including the higher secondary and tertiary levels, is beyond the scope of this paper, since the analysis gets more complicated for three reasons. First, we are unable to explicitly include early marriage and pregnancy in our analysis because we have only limited information about each child beyond gender and age. Nevertheless, early marriage and pregnancy can result in grade repetition and dropout, particularly for girls at the higher secondary and tertiary levels. The outcomes of younger children are much less likely to be directly impacted by early marriage or pregnancy. The implications of early marriage and pregnancy for the secondary-school age students will be discussed in Section 9. Second, the passing rate of the SSC examination was historically low: below 60 percent for most years before 2007 as Fig. 1 in Appendix F shows. This makes it difficult to see whether a child is not in school because of not being able to pass the SSC or for some other reason. Finally, the proportion of girls in higher education is very small in earlier years, making it difficult to attain reliable estimates.

[9] In 1991, there were 5 divisions, 64 districts, and 486 subdistricts in Bangladesh (Bangladesh Bureau of Statistics, 1994 Table 2.7). While subdivision is not a commonly used unit, the Bangladesh Bureau of Statistics (2002) divides Bangladesh into 22 subdivisions.

[10] The base school type in the regressions reported in Section 5 is all schools other than (secular) public and private secondary schools. This includes NGO schools and madrasas. While the choice of school type is potentially important, we choose not to model it for two reasons. First, public secondary schools are rare in Bangladesh, accounting for less than 5 percent of all secondary schools (Banbeis, 1995; Banbeis, 2006; Banbeis, 2010). Second, there is a significant mismatch in the type distribution of secondary schools between the HIES data and other sources. The proportion of children in public schools in our data is around 20 percent, which is much higher than 5 percent or less reported by Banbeis (1995, 2006, 2010) and Nath et al. (2008). This discrepancy may in part stem from the public nature of private schools in Bangladesh. In 2005 [2010], 97 [95] percent of private school students are from schools under the Monthly Pay Order (MPO) scheme, in which teachers are paid by the government (we do not have relevant data for other years). It should also be noted that our results remain qualitatively similar even when the school-type variables are dropped from the regression.

The logarithmic education expenditure is separately added to control for the education expenditure in the core share equation (Eq. (3)).[11]

The upper part of Table 1 reports some descriptive summary statistics for secondary school enrollment and its covariates for children in the secondary school age group, disaggregated by children's gender from 1995 to 2010. It shows impressive gains in a variety of development indicators between 1995 and 2010, including the enrollment rate, nominal household per capita expenditure, and mother's education. The bottom part of the table provides a breakdown of the school types among children who are enrolled in a secondary school.

There are two important observations to make from Table 1. First, the first row shows that girls are on average more likely to be enrolled in secondary school than boys. The gender difference in enrollment was small and not significantly different from zero in 1995 even at a 10 percent level, but it has become larger and statistically significant since the year 2000. This is consistent with the common observation of the reversal of the gender gap from promale to profemale in school enrollment in Bangladesh in recent years (Asadullah and Chaudhury, 2009; Shafiq, 2009).

Second, Table 1 shows that there are some important differences between boys and girls in their households' demographic characteristics. In particular, girls tend to live in larger households. This is true for all survey rounds, even though the difference in the average household size between boys and girls has been decreasing during our study period and is no longer statistically significant in 2010. In addition, the number of children in the household for girls is significantly greater than that for boys in all survey rounds. These differences create a potential endogeneity concern. We elaborate and address this issue in Section 5 and Appendix C.

To apply the three-part model to data, we categorized the education expenditure items into core and peripheral components. We choose to include expenditures for tuition, private tutoring, and materials (e.g., textbooks, exercise books, and stationery) in the core component. The peripheral component includes all other items, including admission, examination, uniform, meals, transportation, and others, which would only have marginal relevance to the quality of education at best.

Because the choice of items in the core component is not obvious, let us explain the reasons for including tuition, private tutoring, and materials in the core component. First, it is reasonable to include the tuition fee in the core component because it reflects, at least to some extent, the quality of education provided by schools in Bangladesh. If schools face some degree of competition, those schools that consistently provide only low-quality education for high tuition fees will exit the market such that a positive correlation between the quality of education and tuition will emerge. The force of competition is likely to be important in Bangladesh where a large majority of secondary schools are private.[12]

Second, private tutoring is also a key item of the core component. It is widely documented that private tutoring can be an important educational input (Bray, 2003), since it is associated with better learning achievements for the students (Nath, 2012; Asadullah et al., 2021). This is also the case in Bangladesh (Nath, 2008; Hamid et al., 2009), as it is not uncommon in Bangladesh for public school teachers to serve as private tutors for their students. In some cases, teachers may deliberately teach less in the regular classes to gain more income from private tutoring. Thus, there are good reasons to include private tutoring in the core component.

Nevertheless, the spending on private tutoring must be interpreted with caution. On the one hand, private tutoring would raise the overall quality of education that the child receives. On the other hand, if private tutoring is given only to weaker students and boys are generally weaker than girls, the promale bias in the core share shown below may be driven by the relatively weak academic performance of boys. We argue that this latter possibility is unlikely to be important, given that girls have consistently underperformed both in the passing rate and the share of top students in the SSC examination, as shown in Fig. 1 in Appendix F.

Finally, it is also reasonable to include materials in the core component, because reading more textbooks and doing more problems in exercise books also contribute directly to academic performance. However, one could argue that more expensive books are not necessarily of higher quality. Thus, the inclusion of materials in the core component is admittedly disputable. To address this concern, we also repeated the analysis excluding the materials from the core component. It turns out that the results are qualitatively similar. Thus, our results are not driven by the inclusion of the materials in the core component. In sum, our choice of the definition of the core component is reasonable, if not indisputable.

Table 2 reports summary statistics of education expenditure items in nominal terms from the years 1995 to 2010 using a subsample of children who were enrolled in secondary school at the time of the survey. The italicized items below each of the Core and Peripheral rows represent the underlying items in these components, respectively. As the bottom of the table shows, the average total education expenditure increased rapidly between 1995 and 2010. Its annualized average growth rate in this period is 7.3 percent, which is substantially larger than the average annual inflation rate of 5.9 percent in consumer prices based on the World Development Indicators.

Table 2 also shows that the core component accounts for roughly two-thirds of the total education expenditure and boys have a significantly higher core share than girls. Within the core component, private tutoring is the major expenditure item.

Even though a considerable share of children spend nothing on private tutoring during our observation periods, there is an obvious trend of increasing popularity of private tutoring over the years, particularly among higher grades. In 1995, 57 percent of male and 55 percent of female secondary school students reported having spent a positive amount on private tutoring, and these ratios respectively increased to 76 percent and 71 percent in 2010. Further, among those with positive spending on private tutoring, its share in the total education expenditure also went up slightly from 40 percent and 41 percent, respectively, for boys and girls in 1995 to 44 percent and 43 percent in 2010. Taken together, these show increasing dependency on private tutoring and an increasing gender gap in the use of private tutoring, both in the intensive and extensive margins.[13] Hence, parents are willing to invest more in children's, particularly boys', education for higher quality education beyond the basic educational costs like school fees.[14]

However, it should be noted that the expenditure on private tutoring does not include informal tutoring activities. For example, imagine that parents (or other relatives) provide free tutoring at home. In such cases, the market value of their service as private

[11] See Table 16 in Appendix F for additional information on the definition of variables mentioned above and elsewhere in the paper.

[12] In a working paper version (Xu et al., 2019), we find a positive relationship between the average tuition fee and test score at the primary level. This also serves as suggestive evidence that a higher tuition fee reflects a higher quality of education. Xu et al. (2019) also show that there are substantial variations in tuition fees within each of private and public schools.

[13] In absolute terms, the gender gap (G-B) in private tutoring has changed from 74 taka in 1995 to −205 in 2000, −134 in 2005, and −376 in 2010 as Table 2 shows.

[14] Alternative interpretations are also possible here. For example, the increasing popularity of private tutoring may reflect the deteriorating quality of school education because of the overcrowding of classrooms or teacher absenteeism (Banerjee and Duflo, 2006).

Table 1
Summary statistics of basic covariates by gender from 1995 to 2010 (secondary school age group)

	1995				2000				2005				2010			
Variables	**Boy (B)** (1)	**Girl (G)** (2)	**G-B** (3)	**All** (4)	**Boy (B)** (5)	**Girl (G)** (6)	**G-B** (7)	**All** (8)	**Boy (B)** (9)	**Girl (G)** (10)	**G-B** (11)	**All** (12)	**Boy (B)** (13)	**Girl (G)** (14)	**G-B** (15)	**All** (16)
All children aged 11–15																
Enrolled in secondary school	0.355	0.375	0.020	0.365	0.342	0.450	0.108	0.395	0.417	0.513	0.096	0.465	0.483	0.572	0.089	0.526
	(0.479)	(0.484)		(0.481)	(0.475)	(0.498)	***	(0.489)	(0.493)	(0.500)	***	(0.499)	(0.500)	(0.495)	***	(0.499)
Child's age (yrs)	13.032	12.906	−0.126	12.972	13.019	12.918	−0.101	12.970	13.079	13.005	−0.074	13.042	12.999	12.922	−0.077	12.962
	(1.370)	(1.353)	***	(1.363)	(1.400)	(1.347)	***	(1.375)	(1.402)	(1.352)	**	(1.378)	(1.394)	(1.379)	**	(1.388)
HH per capita expenditure	10.529	11.836	1.307	11.146	10.890	11.592	0.702	11.232	14.604	14.955	0.351	14.777	29.195	29.663	0.468	29.420
(thousand BDT/year)	(9.241)	(11.958)	***	(10.630)	(8.080)	(9.302)	***	(8.704)	(11.070)	(12.022)		(11.549)	(22.244)	(24.128)		(23.169)
Household size	6.638	6.802	0.164	6.716	6.403	6.552	0.149	6.476	5.983	6.096	0.113	6.038	5.526	5.599	0.073	5.561
	(2.519)	(2.512)	**	(2.517)	(2.381)	(2.395)	**	(2.389)	(2.240)	(2.162)	*	(2.202)	(2.011)	(1.869)		(1.944)
Father's education (yrs)	3.771	4.021	0.250	3.889	2.891	3.161	0.270	3.023	3.111	3.238	0.127	3.174	2.883	2.990	0.107	2.934
	(4.495)	(4.637)	*	(4.564)	(4.177)	(4.239)	**	(4.209)	(4.236)	(4.256)		(4.246)	(4.223)	(4.305)		(4.263)
Mother's education (yrs)	2.027	2.317	0.290	2.164	1.773	1.974	0.201	1.871	2.287	2.372	0.085	2.329	2.568	2.699	0.131	2.631
	(3.174)	(3.409)	***	(3.290)	(3.161)	(3.246)	**	(3.204)	(3.565)	(3.591)		(3.578)	(3.663)	(3.775)		(3.718)
Number of children	3.649	3.790	0.141	3.716	3.514	3.626	0.112	3.569	3.233	3.331	0.098	3.281	2.932	3.024	0.092	2.976
	(1.861)	(1.909)	***	(1.885)	(1.739)	(1.756)	**	(1.748)	(1.567)	(1.582)	**	(1.575)	(1.440)	(1.442)	**	(1.442)
Urban	0.318	0.371	0.053	0.343	0.320	0.342	0.022	0.331	0.343	0.346	0.003	0.345	0.349	0.343	−0.006	0.346
	(0.466)	(0.483)	***	(0.475)	(0.467)	(0.475)	*	(0.471)	(0.475)	(0.476)		(0.475)	(0.477)	(0.475)		(0.476)
Female head	0.085	0.091	0.006	0.088	0.073	0.079	0.006	0.076	0.094	0.092	−0.002	0.093	0.131	0.138	0.007	0.134
	(0.279)	(0.287)		(0.283)	(0.260)	(0.270)		(0.265)	(0.291)	(0.289)		(0.290)	(0.337)	(0.345)		(0.341)
Head is a wage worker	0.354	0.366	0.012	0.360	0.461	0.480	0.019	0.470	0.448	0.485	0.037	0.466	0.447	0.445	−0.002	0.446
	(0.478)	(0.482)		(0.480)	(0.499)	(0.500)		(0.499)	(0.497)	(0.500)	***	(0.499)	(0.497)	(0.497)		(0.497)
Head's age (yrs)	46.488	46.525	0.037	46.505	47.000	46.854	−0.146	46.929	47.663	47.595	−0.068	47.630	47.167	46.925	−0.242	47.051
	(11.198)	(11.101)		(11.151)	(10.736)	(10.951)		(10.841)	(10.625)	(10.431)		(10.529)	(10.568)	(10.604)		(10.586)
Muslim	0.897	0.891	−0.006	0.894	0.920	0.923	0.003	0.922	0.892	0.895	0.003	0.893	0.899	0.886	−0.013	0.893
	(0.304)	(0.312)		(0.308)	(0.271)	(0.267)		(0.269)	(0.310)	(0.307)		(0.309)	(0.301)	(0.318)	*	(0.309)
Hindu	0.094	0.100	0.006	0.097	0.075	0.070	−0.005	0.072	0.091	0.092	0.001	0.091	0.091	0.104	0.013	0.097
	(0.293)	(0.300)		(0.296)	(0.263)	(0.254)		(0.259)	(0.287)	(0.288)		(0.288)	(0.288)	(0.305)	*	(0.297)
Father's education missing	0.003	0.001	−0.002	0.002	0.147	0.171	0.024	0.159	0.147	0.170	0.023	0.159	0.176	0.196	0.020	0.186
	(0.058)	(0.035)		(0.049)	(0.354)	(0.376)	**	(0.365)	(0.354)	(0.376)	**	(0.365)	(0.381)	(0.397)	**	(0.389)
Mother's education missing	0.003	0.001	−0.002	0.002	0.069	0.082	0.013	0.076	0.062	0.079	0.017	0.070	0.058	0.077	0.019	0.067
	(0.058)	(0.035)		(0.049)	(0.254)	(0.275)	*	(0.264)	(0.240)	(0.270)	***	(0.256)	(0.234)	(0.266)	***	(0.250)
Obs	2,667	2,386		5,053	2,534	2,417		4,951	2,906	2,817		5,723	3,323	3,079		6,402
Enrolled in secondary school children aged 11–15																
Public school	0.17	0.18	0.01	0.18	0.26	0.23	−0.03	0.24	0.25	0.23	−0.02	0.24	0.22	0.21	−0.01	0.22
	(0.37)	(0.39)		(0.38)	(0.44)	(0.42)		(0.43)	(0.43)	(0.42)		(0.43)	(0.42)	(0.41)		(0.41)
Private school	0.79	0.80	0.01	0.80	0.67	0.70	0.03	0.68	0.64	0.69	0.05	0.67	0.68	0.69	0.01	0.69
	(0.41)	(0.40)		(0.40)	(0.47)	(0.46)		(0.46)	(0.48)	(0.46)	**	(0.47)	(0.47)	(0.46)		(0.46)
Other	0.05	0.01	−0.04	0.03	0.08	0.07	−0.01	0.07	0.10	0.09	−0.01	0.10	0.10	0.10	0.00	0.10
	(0.21)	(0.11)	***	(0.17)	(0.27)	(0.25)		(0.26)	(0.31)	(0.28)		(0.29)	(0.29)	(0.30)		(0.30)
Obs	947	895		1,842	867	1,088		1,955	1,213	1,446		2,659	1,605	1,760		3,365

Note: Standard deviations are reported in parentheses below the mean. ***, **, and * denote that the means for girls and boys are different at 1, 5, and 10 percent significance levels, respectively, by a *t*-test of equality of means. Other school includes all types of schools other than public and private schools, including religious schools (e.g., madrasas) and NGO schools.

Table 2
Summary statistics of annual education expenditure in BDT by items for secondary school enrollees from 1995 to 2010

	1995				**2000**				**2005**				**2010**			
	Boy (B)	**Girl (G)**	**G-B**	**% Zeros**	**Boy (B)**	**Girl (G)**	**G-B**	**% Zeros**	**Boy (B)**	**Girl (G)**	**G-B**	**% Zeros**	**Boy (B)**	**Girl (G)**	**G-B**	**% Zeros**
Item	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)
Core	1,873	1,834	−39	1%	2,332	1,924	−408	1%	3,019	2,637	−382	1%	5,631	5,040	−591	1%
	(2,341)	(3,025)			(2,808)	(3,537)	***		(3,690)	(3,883)	***		(6,563)	(8,133)	**	
Tuition	322	212	−110	31%	338	157	−181	48%	460	245	−215	50%	601	408	−193	46%
	(770)	(344)	***		(476)	(476)	***		(1,377)	(1,551)	***		(1,169)	(2,044)	***	
Private Tutoring	938	1,012	74	44%	1,225	1,020	−205	49%	1,589	1,455	−134	42%	3,589	3,213	−376	27%
	(1,791)	(2,755)			(2,342)	(3,113)	*		(2,913)	(2,844)			(5,624)	(6,293)	*	
Material	613	609	−4	1%	769	747	−22	1%	970	936	−34	2%	1,442	1,419	−23	1%
	(464)	(441)			(550)	(523)			(629)	(597)			(1,052)	(1,086)		
Peripheral	775	826	51	1%	1,050	955	−95	1%	1,345	1,177	−168	0%	2,347	2,288	−59	0%
	(1,036)	(1,139)			(1,652)	(1,188)			(2,100)	(1,572)	**		(3,332)	(2,877)		
Admission	139	152	13	24%	200	181	−19	26%	244	232	−12	27%	479	406	−73	21%
	(249)	(233)			(527)	(502)			(672)	(729)			(1,327)	(1,142)	*	
Exam	120	127	7	5%	155	149	−6	5%	179	186	7	5%	313	303	−10	6%
	(155)	(145)			(186)	(146)			(218)	(224)			(352)	(303)		
Uniform	222	255	33	45%	241	259	18	46%	344	347	3	35%	621	650	29	20%
	(298)	(280)	**		(324)	(295)			(463)	(390)			(545)	(792)		
Meal	49	29	−20	99%	191	178	−13	63%	193	155	−38	68%	426	394	−32	58%
	(553)	(616)			(422)	(353)			(418)	(360)	**		(837)	(806)		
Transportation	110	136	26	80%	159	133	−26	83%	155	171	16	86%	251	392	141	84%
	(455)	(478)			(587)	(475)			(701)	(777)			(1,005)	(1,407)	***	
Others	135	127	−8	44%	104	55	−49	75%	230	86	−144	65%	257	142	−115	75%
	(285)	(350)			(824)	(429)			(1,331)	(458)	***		(1,745)	(899)	**	
Total	2,648	2,660	12		3,382	2,879	−503		4,363	3,814	−549		7,979	7,328	−651	0%
	(2,940)	(3,611)			(3,874)	(4,355)	***		(4,938)	(4,913)	***		(8,318)	(9,961)	**	
Core Share	0.68	0.65	−0.03		0.68	0.63	−0.05		0.68	0.65	−0.03		0.66	0.64	−0.02	
	(0.19)	(0.20)	***		(0.19)	(0.20)	***		(0.20)	(0.20)	***		(0.20)	(0.19)	***	
Obs	947	895		1,842	867	1,088		1,955	1,213	1,446		2,659	1,605	1,760		3,365

Note: Standard deviations are reported in parentheses below the mean. ∗ ∗ ∗,∗∗, and ∗ denote that the means for girls and boys are different at the 1, 5, and 10 percent significance levels, respectively, by a *t*-test of quality of means. The summary statistics are for the subsample of the children who were enrolled in secondary school at the time of the survey. Core share stands for the ratio of core components to the total education expenditure. The annual session and registration fees are included in admission because they are not separately reported in HES 1995.

Table 3
Three-part model estimation by years (secondary school age group).

Coef.	*d* (1)	Cond *y* (2)	Cond *s* (3)
1995			
Girl	−0.000	−0.088***	0.003
	(0.042)	(0.033)	(0.035)
Obs.		5,053	
2000			
Girl	0.330***	−0.173***	−0.075***
	(0.039)	(0.049)	(0.015)
Obs.		4,951	
2005			
Girl	0.272***	−0.141***	−0.061***
	(0.035)	(0.028)	(0.012)
Obs.		5,723	
2010			
Girl	0.256***	−0.119***	−0.050***
	(0.033)	(0.025)	(0.009)
Obs.		6,402	

Note: ∗ ∗ ∗,∗∗, and ∗ denote statistical significance at the 1, 5, and 10 percent levels, respectively. Standard errors clustered at the household level are reported in parentheses. The estimation is based on the three-part model constructed in Section 3. *d*, Cond *y*, and Cond *s* stand for enrollment decision, conditional total education expenditure and conditional share of core component, respectively. In all regressions, the following covariates are also included: logarithmic per capita expenditure, logarithmic household size, father's and mother's education in years, number of children, female head, wage worker head, head's age and religion (Muslim/Hindu), urban area, and dummy variables for the child's age and whether the father's and mother's education are missing. In addition, the school accessibility variables, school-type dummy variables (public/private), and logarithmic education expenditure are also included in the equations for x_d, x_y, and x_s, respectively. Detailed results are presented in Table 17 in Appendix F. Results for the primary school age group are presented in Table 18 in Appendix F.

tutors should be ideally included in our measurement. If girls are disproportionately taught at home by parents while boys are disproportionately taught by private tutors, then the observed gender gap in the expenditure on private tutoring would overstate the actual gender gap. While we do not have relevant information in the HIES data to measure the informal tutoring activities, we argue that this possibility is unlikely to be important in this study, particularly in rural areas. Given that the average parental education in our sample is far below the level of secondary-school completion (i.e., 10 years) as shown in Table 1, average parents are unlikely to be able to teach secondary-level school children effectively.

Table 2 also shows that girls on average spend less on tuition. It is worth noting that a significant share of children spend nothing on tuition (31 [46] percent in 1995 [2010]). In particular, this share is significant for girls than that for boys (14 [49] percent for boys and 30 [60] percent for girls in 1995 [2010]). The high prevalence of zeros can be explained by the tuition waiver provided by various programs including the FSPs, as discussed in detail in Section 6.[15]

5. Contradirectional Gender Gap

In this section, we document the persistent contradirectional gender gap using the three-part model developed in Section 3. We first present the ML estimates and then compute the marginal

[15] Private schools tend to be more expensive than public schools and other types of schools, even though the difference is small relative to the size of total education expenditure. The gender difference in spending on tuition is not driven by the school type, since the proportion of children going to private schools is similar between boys and girls.

Table 4
Marginal effects of the girl dummy at the sample mean.

Marginal effects at the sample mean	E(d) (1)	E(y) (2)	E($y\|d=1$) (3)	E(ys) (4)	E($ys\|d=1$) (5)
1995	0.000	−38.7	−184.0**	−2.6	−110.9
	(0.017)	(27.2)	(74.1)	(29.3)	(107.8)
Obs.	5053	5053	1842	5053	1842
2000	0.126***	153.3***	−230.5***	3.7	−315.8***
	(0.016)	(37.5)	(83.8)	(16.4)	(58.2)
Obs.	4951	4951	1955	4951	1955
2005	0.106***	117.0**	−465.2***	−23.6	−408.4***
	(0.014)	(49.1)	(97.0)	(19.8)	(65.1)
Obs.	5723	5723	2659	5723	2659
2010	0.099***	284.4***	−519.7***	−20.2	−542.3***
	(0.014)	(86.8)	(167.7)	(36.0)	(120.0)
Obs.	6402	6402	3365	6402	3365

Note: ∗ ∗ ∗,**, and ∗ denote statistical significance at the 1, 5, and 10 percent levels, respectively. Standard errors in parentheses are obtained by simulation with 100 replications (see Appendix B for details). E(·) stands for the expectation operator. Estimates in column (1) are the marginal effect of the girl dummy on the expected enrollment in secondary school for the children in the secondary school age group. The marginal effects presented in columns (2) to (5) are in BDT in nominal terms. Unconditional [conditional] expectations are evaluated at the mean of the full sample [subsample of secondary school enrollees].

effects of being a girl, which have direct quantitative interpretations.

5.1. Estimation of coefficients

Table 3 presents the ML estimates of the coefficient on the girl dummy—the covariate of primary interest—in the three-part model for each year for secondary school age group. All the reported estimates have standard errors clustered at the household level.[16]

Column (1) of Table 3 shows the presence of a clear and strong profemale bias in the enrollment decision from the year 2000 onwards, after controlling for the observables discussed in Section 4. In other words, all else being equal, parents are more likely to send girls to school than boys. Column (2) reveals that, conditional on enrollment, households spend significantly less on the secondary education of girls than that of boys in all four survey rounds. Further, conditional on enrollment, the core component for girls tends to account for a lower share of the total education expenditure than that for boys as shown in column (3). Our analysis thus uncovers the presence of a persistent contradirectional gender gap.

Table 3 also indicates that the gender gap in 1995 is different from the three recent rounds. While we still see a promale bias in the conditional education expenditure, the coefficient on the girl dummy in 1995 is substantially smaller in absolute value than those in other years. Furthermore, the estimated coefficients on the girl dummy in the enrollment and core share equations are insignificant. We attempt to explain this observation in the subsequent sections. Note that we only present the estimated coefficients on the girl dummy in Table 3, because it is our main covariate of interest. The complete regression results of Table 3 together with some additional discussions are provided in Appendix F.

While we allow for dependence in error terms in Table 3, equation-by-equation regressions under the assumption that ρs are all zero yield qualitatively similar results as reported in Table 19 in Appendix F. Since the estimation results for the enrollment and conditional education expenditure equations correspond to the hurdle model estimation, Table 19 also indicates that the extension to the three-part model would marginally increase the estimated size of the gender bias in the conditional education expenditure. Further, the three-part model captures the presence of gender bias in the pattern of education expenditure, which the standard hurdle model fails to capture.

5.2. Marginal effects

Our regression coefficients from the three-part model do not provide readily interpretable quantities. Hence, we report the marginal effect of being a girl at the sample mean in Table 4, using the formula presented at the end of Section 3. Column (1) shows the presence of a significant profemale bias in the probability of enrollment except in 1995. For example, at the sample mean in 2010, girls are 9.9 percentage points more likely to enroll in secondary schools than boys. The effects of being a girl on the total education expenditure and core expenditure conditional on enrollment are shown, respectively, in columns (3) and (5). If we focus on school enrollees, girls enjoy less total education expenditure and less core expenditures than boys.

For example, column (3) shows that the gender difference in the total education expenditure in 2005 was 465.2 BDT at the mean of the subsample of secondary school enrollees. Similarly, there exists a significant promale bias in the core expenditure from 2000 onwards. However, as shown in column (2), when we consider the combined effect of enrollment and conditional expenditure, girls actually have a higher unconditional education expenditure than boys except for the year 1995. Further, the gender gap in the unconditional core expenditure is negligible, as column (4) shows. These observations highlight the importance of clearly distinguishing the conditional and unconditional expectations.[17]

The results above consistently show that girls received less expenditure in the core component than boys conditional on enrollment, and this gender gap grew over time. To identify the source of this growing gap, we compute the marginal effect of being a girl at the sample mean for the secondary school enrollees using item-by-item Tobit regressions alternatively. The results of this analysis (Table 22 in Appendix F) show that girls receive significantly less investment in tuition than boys for all the survey rounds. Girls also receive less in private tutoring, though the differences are statistically insignificant at the conventional significance levels. On the other hand, the only item for which girls somewhat consistently receive a higher amount is uniform, but this difference does not make up for the disadvantages in other expenditure items. Therefore, girls have overall lower education expenditure

[16] By comparing Tables 3 and 18, it can be seen that the significance of the gender gap for the primary school age group is smaller both economically and statistically than that for the secondary school age group. This also provides a motivation for us to focus on the secondary school age group.

[17] The discussion above also highlights the fact that the results for 1995 are qualitatively different from other years. As further discussed in Section 6, this may be because the FSPs have not yet been fully rolled out by then.

and lower core expenditure conditional on enrollment, and this female disadvantage mainly comes from tuition and, to a lesser extent, from private tutoring.

5.3. Robustness of contradirectional gender gap

Our identification relies on the implicit assumption that the sex of the child is exogenous. However, this assumption would be violated when parents have an unobserved gender preference, which would be correlated with the sex of the child. For example, such a gender preference may lead to sex-selective abortion. However, sex-selective abortion is unlikely to be a relevant concern in Bangladesh, since sex ratios at birth did not change between 1993 and 2011 (Talukder et al., 2014). Gender preference may also lead to a fertility stopping rule, in which households stop having additional children when a desired number of boys has reached. As a result, girls tend to live in a larger household that has more children. This possibility is consistent with the summary statistics in Table 1. To address this potential endogeneity concern, we run linear regressions with household fixed effects, controlling for all time-invariant household characteristics. The gender difference in household composition also affects intrahousehold competition that girls and boys face. We address this by analyzing a subsample of households with only one child and a subsample of children living in households with one boy and one girl and consistently find a contradirectional gender gap. The details of these robustness checks and the discussion of other relevant results are provided in Appendix C.

6. FSPs and the quantity measures of education

The contradirectional gender gap reported in the previous section is unique to Bangladesh and deserves further investigation. We conjecture that the FSPs may have played a role here for two reasons. First, the FSPs would encourage girls' school enrollment but may not necessarily affect the total education expenditure and core share conditional on enrollment. Second, India and Pakistan, which did not have a nationwide program similar to the FSPs in Bangladesh, exhibit a clear codirectional promale bias.

We start with a brief background of the FSPs. Then we provide supporting evidence for the relevance of the FSPs to the contradirectional gender gap in this and next two sections. In this section, we focus on the impact of the FSPs on the quantity measures of education using the double-difference approach as this analysis provides relatively clean identification. We then incorporate the individual status of being an FSP recipient and the girl recipient ratio (GRR) in the three-part model in the next section, where the GRR is defined as the number of FSP recipients over the total number of girls of the same age in the division of residence and interpreted as a measure of the FSP intensity.

6.1. Background of FSPs

The FSPs, which started as a small pilot program in 1982 and were rolled out nationwide in 1994, consist of the following four projects: 1) the Female Secondary School Assistance Project, 2) the Female Secondary Stipend Project, 3) the Secondary Education Development Project, and 4) the Female Secondary Education Project. These projects are similar except that their funding agencies and the locations of operation differ. FSPs' target population is unmarried girls studying in secondary schools outside of the metropolitan areas that have signed a participation agreement. At the entry grades (grades 6 and 9), all female students in participating schools are eligible to benefit from the FSPs regardless of past attendance or performance. However, the following three conditions must be maintained to remain in the program: 1) attending at least 75 percent of school days, 2) achieving minimum marks of 45 percent in the annual school examination, and 3) staying unmarried until the SSC examination. The stipends are disbursed in two equal installments per academic year, and the amount increases as the grades progress. The FSP recipients are also entitled to enjoy free tuition and schools are paid directly by the FSPs. However, around 15 percent of the FSP recipients, including both private- and public-school children, pay a small amount for tuition fee in our data. The FSPs' financial assistance is designed to cover slightly less than half of the expenditure on secondary education.[18]

The nationwide rollout of FSPs took place rapidly between 1994 and 1995. According to Banbeis, 2006, the number of FSP recipients was only 70,000 in 1994. The number jumped to 1.4 million in 1995 and more than doubled in the following two years. It continued to increase rapidly until reaching its peak of 4.2 million in 2002, after which it dropped to 2.3 million in 2005. These numbers are sizable both in absolute terms and relative to the cohort size (17.3 million in 2005) and the total enrollment (7.4 million in 2005) for the secondary school age group.

However, with the intention of improving the quality of education and reaching out to the poor regardless of gender, the FSPs were subsequently replaced by the Secondary Education Quality and Access Enhancement Program (SEQAEP) in 2008, which targeted the poor in remote subdistricts in Bangladesh. Thus, the FSPs are relevant only to the early three rounds of our analysis, namely 1995, 2000, and 2005, whereas the SEQAEP was in place by 2010.

Because of the lack of clarity in the way the resources for the FSPs were allocated in practice and because of the lack of information on the individual FSP eligibility in our dataset, we use the FSP status—whether the individual is actually receiving the stipends—in our analysis. Along with this problem, it is also difficult to obtain a clean identification of the impacts of the FSPs for two additional reasons. First, the assignment of FSPs is nonrandom as there are some eligibility criteria as noted above. Second, we have limited data before the national rollout of the FSPs. In particular, the individual-level information on education expenditure is only available from the year 1995 when the FSPs were already available nationwide. Therefore, we start the analysis of the FSPs with quantity measures of education to enable a relatively clean identification through a double-difference approach.

6.2. Double-difference analysis

In this subsection, we focus on the impact of the FSPs on two quantity measures of education. The first measure is the completed years of education (YrEdu_{ih}) for each working-age individual i between 19 and 65 years of age in each household h for each HIES survey round. The second measure is enrollment (Enroll_{iht}) for each child i in household h in calendar year t from the retrospective panel data. The retrospective panel data are created under the assumptions that each child enters secondary school (grade 6) at the stipulated secondary school entry age of age 11 and that no child repeats a grade.[19] Then, we go back through the calendar year to determine whether the child was in school. As an example, consider a boy who is 17 years old in 2005. If he completed grade 8, the last age at which he was in school would be 13. Therefore, he

[18] The monthly stipend amount starts from 25 BDT for grade 6 and reaches 60 BDT for grade 10, The tuition fee paid under the FSPs also increases from 10 BDT per month in grade 6 to 15 BDT per month in grade 10 for public schools, and the amount is higher for private schools by 5 BDT per month. In addition, the book allowance and examination fee are given to grade 9 and 10 recipients, respectively. See also Table 2 of the Bangladesh Ministry of Education, 1996 for further details of the FSPs.

[19] According to Banbeis (1995, ?), the repetition rate was around 5 percent and 4 percent in the years 1995 and 2010, respectively. Thus, our nonrepetition assumption serves as a reasonable approximation.

Table 5
Linear regressions of quantity measures of education on FSP coverage and its interaction with the girl dummy

Coef.	HES 1995 (1)	HIES 2000 (2)	HIES 2005 (3)	HIES 2010 (4)
	Panel A: Years of education			
Girl	−1.979***	−1.742***	−1.783***	−1.809***
	(0.041)	(0.039)	(0.036)	(0.038)
FSPCover	0.177	−1.493***	−0.506	−0.513
	(1.167)	(0.552)	(0.485)	(0.470)
Girl × FSPCover	0.016	0.933	1.809***	1.836***
	(1.392)	(0.715)	(0.128)	(0.090)
Obs	18,303	18,823	24,912	29,519
Mean of dep. var.	3.460	3.607	4.193	4.410
	Panel B: Enrollment using retrospective data			
Girl	−0.134***	−0.143***	−0.158***	−0.161***
	(0.004)	(0.004)	(0.004)	(0.004)
FSPCover	−0.061	−0.141***	−0.071	−0.067
	(0.050)	(0.048)	(0.052)	(0.047)
Girl × FSPCover	0.106***	0.173***	0.192***	0.195***
	(0.016)	(0.010)	(0.008)	(0.008)
Obs	102,319	110,439	150,518	162,056
Mean of dep. var.	0.265	0.279	0.319	0.335

Note: ∗ ∗ ∗,∗∗, and ∗ denote statistical significance at the 1, 5, and 10 percent levels, respectively. Standard errors clustered at the household level are reported in parentheses. In Panel A, we additionally include the fixed-effects terms specific to the birth year and household. In Panel B, we additionally include the fixed-effects terms specific to the birth year, age at the time of observation, household, and year of observation. Panel A uses a sample of working-age adults, and Panel B uses retrospective data constructed following Heath and Mobarak (2015).

was in a secondary school between 1999 and 2001 (ages 11–13) and out of school between 2002 and 2005 (ages 14–17). We do this for all individuals born in or after 1949 in each round of the HIES survey up to 2007 and focus on the records that correspond to the secondary school ages of 11–15, such that the calendar year for the analysis starts from 1960 (= 1949 + 11).[20]

We estimate the impacts of the FSPs on these quantity measures using double-difference regressions, where one difference is taken between the two genders and the other between those who are covered and not covered by the FSPs. Specifically, we obtain from Table 3 of (Shamsuddin (2015)p. 432) the year in which each subdistrict was covered by an FSP and use it to determine the FSP coverage (FSPCover), or whether an individual is in a subdistrict covered by an FSP in the reference year. Here, the reference year is year t [the calendar year in which the child is aged 11] for the regression of Enroll [YrEdu]. The construction of FSPCover is based on the assumption that the location of individuals does not change over time, and this is a reasonable approximation because the migration rate is low, especially in early years, in Bangladesh. Since the rollout of the FSPs is plausibly exogenous and all unobservable time-invariant household effects are controlled for, the double-difference approach substantially reduces the endogeneity concerns. While the timing of the FSP rollout is potentially endogenous, we argue below that the endogeneity issue is unlikely to seriously affect our results.

We use the following double-difference specifications:

$$\text{YrEdu}_{ih} = \alpha_1 \text{Girl}_{ih} + \alpha_2 \text{FSPCover}_{ih} + \alpha_3 \text{Girl}_{ih} \times \text{FSPCover}_{ih} + \sum_b \mu_b \times \mathbf{1}(\text{Birth year}_{ih} = b) + \omega_h + \varepsilon_{ih}, \quad (12)$$

and

$$\text{Enroll}_{iht} = \alpha_1 \text{Girl}_{ih} + \alpha_2 \text{FSPCover}_{iht} + \alpha_3 \text{Girl}_{ih} \times \text{FSPCover}_{iht} + \sum_{a=11}^{15} \beta_a \times \mathbf{1}(\text{Age}_{iht} = a) + \sum_b \mu_b \times \mathbf{1}(\text{Birth year}_{ih} = b) + \lambda_t + \omega_h + \varepsilon_{iht},$$

where μ_b , β_a, λ_t, and ω_h represent, respectively, birth-year-, age-, time-, and household-specific fixed effects. ε is the idiosyncratic error term. Our main coefficient of interest is α_3 on Girl × FSPCover in both equations.

Table 5 shows the ordinary least-squares (OLS) regression results of the two equations above. Panel A reports the regressions of the FSP coverage on the completed years of education for working-age individuals for each survey round, where the mean of the dependent variable for a given round is reported in the last row. Because the overwhelming majority (99.7 percent) of the working-age adults in 1995 were not covered by the FSPs, it is not surprising that the impact of the FSPs on the years of completed education is insignificant (column (1)). In the later rounds when the FSPs started to rapidly roll out nationwide, the years of schooling increased significantly for girls who were eligible for the FSPs at the age of 11. Column (4) shows that the promale gender gap in the years of education narrowed by 1.836 years after the FSPs rolled out.

Panel B presents the regression of the enrollment status for secondary school children aged between 11 and 15. The first row indicates that girls are *less* likely to be in secondary school than boys by 13–16 percentage points across years, but the FSPs had a significantly positive impact and indeed more than offset this negative effect of being a girl after 2000 as the third row shows. For example, column (4) shows that the positive impact of the FSPs on enrollment was 19.5 percentage points, reversing a promale gap of 16.1 percentage points to a profemale gap of 3.4 (= 19.5–16.1) percentage points with a t-statistic of 31.1. This profemale gap is both statistically and economically significant.

The double-difference specification significantly reduces the endogeneity concerns, since it is immune to selection on time-invariant household characteristics. However, one might argue that the rollout of the FSPs is not random. That is, the government and donors may have chosen to start the program in places where the promale gender bias is most prevalent or these places are different in other dimensions, which may have an impact on our estimates. Nevertheless, the selection of program areas is unlikely to be a serious threat to our identification, since the coverage of the FSPs was extremely limited before 1994[21] and it expanded rapidly

[20] We followed Heath and Mobarak (2015) to determine the starting year of our study period. The results remain similar even when we shift the starting year to 1980.

[21] For example, among working-age adults aged between 19 and 65 in 2010, only 2 percent of the FSP coverage came from the pre-1994 period.

Table 6
Three-part model estimation with the FSP status.

Year	*Coef.*	*d* (1)	**Cond** *y* (2)	**Cond** *s* (3)	*d* (4)	**Cond** *y* (5)	**Cond** *s* (6)
2000	Girl	0.330***	−0.216***	−0.056***	0.193**	−0.191**	−0.004
		(0.039)	(0.056)	(0.018)	(0.090)	(0.086)	(0.027)
	FSP		0.077	−0.032**		0.107**	−0.033**
			(0.049)	(0.014)		(0.050)	(0.015)
	GRR				0.852**	−1.376***	0.266**
					(0.339)	(0.308)	(0.129)
	Girl × GRR				0.472*	−0.177	−0.161**
					(0.281)	(0.265)	(0.080)
	Obs.		4,951			4,951	
2005	Girl	0.270***	−0.155***	−0.049***	0.079	−0.112	−0.005
		(0.035)	(0.035)	(0.014)	(0.093)	(0.073)	(0.026)
	FSP		0.027	−0.024**		0.054	−0.025***
			(0.037)	(0.009)		(0.037)	(0.010)
	GRR				0.465	−1.068***	0.020
					(0.306)	(0.236)	(0.101)
	Girl × GRR				0.708**	−0.214	−0.158*
					(0.314)	(0.238)	(0.083)
	Obs.		5,723			5,723	

Note: ***, **, and * denote statistical significance at the 1, 5, and 10 percent levels, respectively. Standard errors clustered at the household level are reported in parentheses. *d*, Cond *y*, and Cond *s* stand for enrollment decision, conditional total education expenditure and conditional share of core component, respectively. Girl recipient ratio (GRR) is the ratio of girl recipients to all girls for a given age group in a given division. The covariates discussed in Table 3 are also included in all regressions.

in 1994. Put differently, our identification is primarily through the interaction between the girl dummy and cohorts born after 1983 (= 1994–11) and not through the differences in timing in the implementation of the FSPs across subdistricts. Further, we have conducted a falsification test to boost the credibility of the discussion above. In this test, we focus on the period in which FSPs were not introduced and re-estimate the impact of FSPs by hypothetically shifting the introduction of the FSPs in each subdistrict earlier by five years (thus, for a majority of subdistricts, we pretend that the FSP coverage started in 1989 instead of in 1994). As expected, the impact of FSP coverage in the falsification test was found to be small in absolute value and statistically insignificant. Further details of the falsification test is given in Appendix D.

It should also be noted that our finding of the positive impact of the FSPs on enrollment and years of schooling is in line with existing studies (Khandker et al., 2003; Schurmann, 2009; Asadullah and Chaudhury, 2009; Shamsuddin, 2015; Tanaka et al., 2021). However, it is notably at odds with (Heath and Mobarak (2015) hereafter HM), who found no positive impact of the FSPs on female enrollment. Instead, they found that what led to an improvement in female secondary education—in their study areas—was an increasing demand for female labor.

Their analysis is based on a triple-difference approach, where the primary school children are used as a comparison group for the third difference in addition to the two differences in our double-difference estimation (i.e., the difference between the two genders and the difference between before and after the coverage by the FSPs). Thus, to understand the source of the difference from HM clearly, we also conducted a triple-difference analysis. We first replicated their results and progressively changed some elements of their analysis, including the data, the subdistricts studied, and the definitions of the FSP coverage and eligibility criterion. This exercise shows that the HM's findings are driven by a combination of the particular data they used, geographic coverage of their data, and the FSP eligibility criterion used in their study. In particular, their FSP eligibility criterion of at least six years of schooling appears to have led to an underestimation of the FSPs' impact on enrollment. Those girls who have completed primary school are eligible for the FSPs if they go to a secondary school. This means that those girls who are in grade 6 (and thus have not yet completed six years of schooling) are already able to benefit from the FSPs. Our preferred estimate of the FSPs' impact on enrollment within the framework of the triple-difference estimation, which uses the nationally representative HIES data and the completion of primary school as the eligibility criterion for the FSPs, shows that the FSPs' impact on enrollment is positive and statistically significant. Appendix E provides further details of this exercise and explain why we prefer the double-difference estimation discussed earlier over the triple-difference estimation discussed here.

7. Incorporating the FSPs in the three-part model

To obtain a more comprehensive understanding of the FSPs' impact on education expenditure, we now incorporate the FSPs in the three-part model using the HIES data for the years 2000 and 2005 as they contain information on the individual status of the receipt of FSPs.[22] This is important because the education expenditure of the FSP recipients is affected by the tuition waiver and stipend provided by the FSPs. Thus, we include the dummy variable for the FSP recipients, who are all girls, in the conditional expenditure and core share equations.

The regression results are reported in columns (1)-(3) of Table 6. As the comparison with Table 3 shows, the inclusion of the FSP dummy makes the coefficients on the girl dummy in the conditional expenditure equation even more negative. The point estimates on the FSP dummy are positive in the conditional expenditure equation, while they are significantly negative in the core share equation for both years.

To understand where this impact is coming from, we report in Table 23 in Appendix F the marginal effects by item-by-item Tobit regressions that include both the girl and FSP-recipient dummy variables. This analysis shows that the FSP recipients spend less on tuition as expected, because the tuition is waived for the FSP recipients. The FSP recipients receive more expenditure on materials compared with nonrecipients, but this positive effect of the FSPs does not offset the negative effect of being a girl. Thus, the

[22] HES 1995 does not contain the information on FSP status. HIES 2010 was not used either, because the FSPs had already been terminated by then. It should also be noted that the HIES 2000 dataset appears to underrepresent the FSP recipients. Based on Banbeis, 2006, the ratio of the number of FSP recipients to the number of female enrolled secondary school students is 86 percent, while the figure directly derived from the HIES 2000 data is 58 percent. Therefore, the interpretation of the results for the year 2000 requires some caution. This issue does not exist for the year 2005.

Table 7
Three-part model estimation with a subsample of boys.

	HIES2000			HIES2005		
	d	Cond *y*	Cond *s*	*d*	Cond *y*	Cond *s*
Coef.	(1)	(2)	(3)	(4)	(5)	(6)
	Panel A: All boys					
FSP HH	0.179*	−0.236***	0.008	0.277***	−0.131*	−0.060*
	(0.099)	(0.089)	(0.028)	(0.101)	(0.070)	(0.033)
Obs		2,534			2,906	
	Panel B: Boys in one-boy-one-girl households					
FSP HH	0.341	−0.202	0.053	0.446***	−0.058	0.014
	(0.356)	(0.405)	(0.082)	(0.142)	(0.140)	(0.063)
Obs		591			609	

Note: ∗ ∗ ∗,**, and ∗ denote statistical significance at the 1, 5, and 10 percent levels, respectively. Standard errors clustered at the household level are reported in parentheses. *d*, Cond *y*, and Cond *s* stand for enrollment decision, conditional total education expenditure and conditional share of core component, respectively. The covariates discussed in Table 3 are also included in all regressions. Panel A uses a subsample of all boys, and Panel B uses a subsample of boys living in a one-boy-one-girl household.

recipients of the FSPs still do not enjoy as much core education expenditure as boys. For the peripheral items, FSP recipients get a higher expenditure in most items, especially in uniform, meals, and transportation with the notable exception of admission. Overall, this analysis indicates that the FSPs did not significantly increase the core expenditure among school enrollees.

Next, we study the spillover effect of FSPs by exploiting the variations across regions and ages in the (treatment) intensity of FSPs as measured by the GRR. In columns (4)-(6) of Table 6, we report the results of the three-part model estimation that includes as covariates the GRR and its interaction with the girl dummy in addition to all the covariates used in columns (1)-(3) of the same table. These results show that girls living in more FSP-intensive divisions (for their age) are more likely to be enrolled in school. This indicates that the FSPs may have a positive spillover effect on families living in the same area such that parents are more likely to enroll their children, particularly daughters, in school. However, there is no evidence that the FSPs facilitate parental investment in the quality of education for girls. The coefficient on the interaction terms in the conditional education expenditure is negative for both 2000 and 2005, and the same coefficient in the conditional core share equation is significantly negative in both years. However, caution must be exercised when interpreting these estimates, because they are based on an assumption that the differences across divisions in the outcomes of interest for a given age group can be attributed to the differences in GRR conditional on other covariates.

We also investigate the spillover effect of FSPs on boys' education expenditure. Due to the nonrandom assignment of FSPs and the limited data of the pre-FSP period, clean identification is difficult. Nevertheless, we provide some supporting evidence of the spillover impact of the FSPs by comparing the education expenditure of boys from households with and without an FSP recipient. We estimate the three-part model with a subsample of boys (Panel A) and a subsample of boys in households with exactly one boy and one girl who are aged between 11 and 15 (Panel B) as reported in Table 7. The table shows that boys from an FSP-receiving household (FSPHH), or a household with at least one FSP recipient, are more likely to enroll in school than boys from a household without an FSP recipient. However, conditional on enrollment, they receive less education expenditure than boys from non-FSP households. This indicates that there are positive spillover effects on boys' enrollment status, even though we cannot exclude the possibility that this is driven by the unobserved heterogeneity between FSP-receiving and non-FSP-receiving households. The negative spillover effects of the FSPs on boys' education expenditure conditional on enrollment suggest that households with FSP recipients may shift some education expenditure from boys to girls.

7.1. Muting the FSPs' tuition waiver

As mentioned above, the tuition waiver is an important component of the FSPs. The tuition waiver encourages enrollment but also tends to negatively affect the conditional expenditure and core share among the school enrollees. However, the latter negative effects may be spurious. This may be simply because the FSPs are replacing the household's tuition expenditure for girls through the tuition waiver; the FSPs might not have any impact on the conditional expenditure and core share once the tuition waiver is taken into consideration.

To see if this is a possible explanation, we attempt to mute the impact of the tuition waiver through two alternative empirical exercises: exclusion and imputation. In the exclusion exercise, we exclude the tuition fee from the calculations of both the total education expenditure and core expenditure. In the imputation exercise, we impute the tuition fee for the FSP recipients using a linear prediction model. Then, the imputed tuition fee is computed by predicting the fee with the estimated parameter values but omitting the term involving the FSP-recipient dummy. This predicted amount, which is truncated from below at zero, can be interpreted as the tuition fee parents would have to spend had their daughter not received a tuition waiver.

The results of these two exercises are presented in Table 8 together with the baseline estimates taken from Table 3 for ease of comparison. As the table shows, the absolute value of the coefficient on the girl dummy becomes smaller than the baseline results in each of the three equations after turning off the impact of the tuition waiver either by exclusion or imputation. This indicates that our finding is indeed driven in part by the spurious effect coming from the tuition waiver. However, as Table 8 shows, the sign and statistical significance of the coefficient on the girl dummy mostly remain the same. Therefore, the earlier finding of a contradirectional gender gap still remains valid even after muting the effects of the tuition waiver.

Since Table 8 does not distinguish girls by the FSP-recipient status, we also consider a model that incorporates the FSP status in the three-part model and mute the effects of the tuition waiver. In the top panel of Table 9, we present the baseline estimation of the three-part model with the FSP status reported in Table 6. Then, as with Table 8, we mute the tuition wavier effects by either exclusion or imputation.

As Table 9 shows, FSP girls tend to enjoy a higher total education expenditure than non-FSP girls, and the difference is significant, both economically and statistically, when the tuition waiver effects are muted. By comparing the signs and sizes of the coefficients on FSP and Girl, it can also be seen that the positive impacts of the FSPs can substantially mitigate the promale bias in the total

Table 8
Three-part model estimation with the impact of the tuition waiver muted.

Year	Model	*d*	Cond *y*	Cond *s*
	Baseline	0.330***	−0.173***	−0.075***
		(0.039)	(0.049)	(0.015)
2000	Exclusion	0.317***	−0.079*	−0.055***
		(0.039)	(0.046)	(0.013)
	Imputation	0.314***	−0.064	−0.047***
		(0.039)	(0.048)	(0.011)
	Baseline	0.272***	−0.141***	−0.061***
		(0.035)	(0.028)	(0.012)
2005	Exclusion	0.262***	−0.065**	−0.049***
		(0.035)	(0.028)	(0.011)
	Imputation	0.258***	−0.082***	−0.041***
		(0.035)	(0.029)	(0.010)

Note: * * *,**, and * denote statistical significance at 1, 5, and 10 percent levels, respectively. The point estimates for the girl dummy are reported in each row and their standard errors clustered at the household level are reported in parentheses. *d*, Cond *y*, and Cond *s* stand for enrollment decision, conditional total education expenditure and conditional share of core component, respectively. Additional covariates discussed in Table 3 are also included. The baseline results are taken from Table 3. In the exclusion exercise, tuition fee is excluded from both total education expenditure and core expenditures to compute *s*. In the imputation exercise, we instead impute the tuition fee for FSP recipients using the predicted value from a linear model estimated with the pooled sample that includes the fixed-effects terms for the following categorical variables: enrollment status, FSP-recipient status, district of residence, survey year, gender, and school type (private/public).

Table 9
Three-part model estimation with FSP status after muting the tuition waiver.

	HIES2000			**HIES2005**		
Coef.	*d*	cond *y*	cond *s*	*d*	cond *y*	cond *s*
Baseline						
Girl	0.330***	−0.216***	−0.056***	0.270***	−0.155***	−0.049***
	(0.039)	(0.056)	(0.018)	(0.035)	(0.035)	(0.014)
FSP		0.077	−0.032**		0.027	−0.024**
		(0.049)	(0.014)		(0.037)	(0.009)
Exclusion						
Girl	0.318***	−0.163***	−0.044***	0.261***	−0.104***	−0.040***
	(0.039)	(0.054)	(0.017)	(0.035)	(0.035)	(0.013)
FSP		0.149***	−0.018		0.079**	−0.018*
		(0.050)	(0.016)		(0.036)	(0.011)
Imputation						
Girl	0.317***	−0.198***	−0.049***	0.261***	−0.158***	−0.042***
	(0.040)	(0.056)	(0.016)	(0.035)	(0.035)	(0.013)
FSP		0.249***	0.003		0.161***	0.004
		(0.047)	(0.017)		(0.036)	(0.012)

Note: * * *,**, and * denote statistical significance at the 1, 5, and 10 percent levels, respectively. Standard errors clustered at the household level are reported in parentheses. *d*, Cond *y*, and Cond *s* stand for enrollment decision, conditional total education expenditure and conditional share of core component, respectively. Additional covariates discussed in Table 3 are also included. Baseline results are taken from Table 6. See the table note for Table 8 for details on the exclusion and imputation exercises.

education expenditure (conditional on enrollment). Nevertheless, the FSP did not remove the gender gap in the core share conditional on enrollment. Taken together, the FSPs do not appear to have removed the gender gap in the education expenditure on the core component conditional on enrollment.

8. Impact on Timely Secondary School Graduation

The results of the previous subsections suggest that the FSPs promoted girls' enrollment in secondary schools but fell short of reducing the gender gap in the investment in the quality of education. Indeed, the FSPs have been criticized for the lack of attention to the quality of education (Mahmud, 2003; Raynor and Wesson, 2006). Our analysis highlights the reason why the quality of education for girls lags behind that for boys among the school enrollees from the perspective of complementary investment in education from households.

Nevertheless, it is not evident from the preceding analysis how this has affected the performance of girls in school relative to boys. Unfortunately, our data do not contain standard education performance measures such as test scores. Therefore, we use completion of secondary school (roughly) on time as an indicator of education performance. Specifically, a child is regarded to have completed secondary school on time if he/she has already passed at least grade 10 (SSC or equivalent) when he/she is in the age range 16–20. This is a reasonable indicator because the child has to pass the SSC exam to complete secondary education, which requires a certain level of mastery of the secondary-level curriculum.[23] For this exercise, we additionally use the HES 1991 dataset as it contains the information necessary to construct the indicator for completion on time.

In columns (1)-(5) of Panel A of Table 10, we report the estimated effects of being a girl on timely completion of secondary school for each survey year through OLS regressions. The effects have become less promale and the beginning of the narrowing of the gap roughly corresponds to the onset of the FSPs, which seems to indicate that the FSPs helped close the gender gap in timely completion of secondary education.

[23] Because we do not observe the age at which the child passed the SSC examination, we derive the on-time secondary school completion from the age of the child and highest grade completed. As shown in Fig. 1, the passing rate may be as low as 40 percent depending on the year, indicating that passing the SSC examination is not a trivial matter.

Table 10
Linear regressions of on-time secondary school completion by year

Coef.	**1991** (1)	**1995** (2)	**2000** (3)	**2005** (4)	**2010** (5)	**2005** (6)	**2010** (7)
				Panel A: All individuals aged 16–20			
Girl	−0.043***	−0.054***	−0.044***	−0.014	−0.007	0.009	0.059**
	(0.012)	(0.012)	(0.012)	(0.010)	(0.011)	(0.020)	(0.027)
Lagged GRR						0.237***	0.712***
						(0.091)	(0.093)
Girl×Lagged GRR						−0.084	−0.247***
						(0.070)	(0.095)
Obs	3,043	3,721	3,988	5,056	5,316	5,056	5,316
				Panel B: All primary graduates aged 16–20			
Girl	−0.018	−0.084***	−0.064***	−0.022*	−0.026*	0.039	0.083**
	(0.027)	(0.019)	(0.017)	(0.013)	(0.014)	(0.027)	(0.033)
Lagged GRR						0.350***	0.858***
						(0.122)	(0.117)
Girl×Lagged GRR						−0.227**	−0.416***
						(0.093)	(0.117)
Obs	1,223	2,093	2,621	3,712	4,098	3,712	4,098

Note: ∗ ∗ ∗,**, and ∗ denote statistical significance at the 1, 5, and 10 percent levels, respectively. Standard errors clustered at the household level are reported in parentheses. The dependent variable is a dummy variable for the completion of secondary school on time, and takes one if an individual aged between 16 and 20 at the time of the survey had already completed grade 10 or higher. Lagged GRR is the GRR at the division-age level five years before the survey. In 2005 [2010], we use GRR for the year 2000 [2005]. In all regressions, the following covariates are also included: logarithmic expenditure per capita, logarithmic household size, the dummy variables for the household heads' education level (primary, secondary, and higher), female head, wage worker head, head's age and religion (Muslim/Hindu), urban area, and dummy variables for the child's age and whether father's and mother's education are missing. Panel A uses a sample of all individuals aged between 16 and 20, and Panel B uses a subsample of primary graduates among them.

However, if we restrict the sample to those who have already completed primary education, the picture looks different as columns (1)-(5) in Panel B of Table 10 show. The gender gap in the timely completion of secondary education conditional on the completion of primary education is larger than that in the unconditional sample—except for the year 1991 when the FSPs were yet to be rolled out nationwide. This indicates that the narrowing of the gender gap observed in Panel A may be due to the improvement in girls' secondary enrollment. In other words, because more girls were enrolled, they had a higher unconditional probability of completion. However, the results of panel B indicate that the secondary school performance of girls among the potential school enrollees, or those who have completed primary school, was worse than that of boys, even though the gap appears to be getting smaller over time as with Panel A. Assuming that the gender gap in the quality of education translates into the gender gap in school performance, the results above are consistent with our finding that the quality of education for girls conditional on enrollment consistently lagged behind that for boys.

Next, we attempt to understand the impact of the FSPs on the timely graduation from secondary school. This is challenging, because we do not have the history of the FSP-recipient status in the past. Instead, we include in the regressions the lagged FSP intensity—as measured by GRR five years prior to the survey—and its interaction with the girl dummy. That is, we use the GRR for the year 2000 [2005] and its interaction term in the analysis of timely graduation in the year 2005 [2010]. The lagged variable would arguably reflect the cumulative impact of the FSPs in the last five years. Note, however, that the results for the year 2010 suffer from the contamination of the sample because some of the individuals in the sample may have benefited from the SEQAEP.

The results of this analysis are presented in columns (6)-(7) of Table 10. For all children aged between 16 and 20, girls living in more FSP-intensive areas are less likely to graduate on time than boys. This can be seen from the negative point estimates on the interaction term (i.e., Girl × LaggedGRR). When we look only at the subsample of those who have completed primary education, the promale gender gap is significant in more FSP-intensive areas. Thus, in line with our earlier findings, there is no evidence that the FSPs improved the quality of education for secondary school girls relative to boys. If anything, the girls in high FSP-intensive areas are less likely to graduate from secondary school on time than the girls in low FSP-intensive areas, indicating that the impact of the FSPs on the performance in secondary school was possibly negative. While the negative coefficient on the interaction term may be due to the selection of location for the FSPs, it is also possible that the FSPs directly lowered the quality of education, as argued in the next section.

In sum, the analyses presented in Sections 6,1,2,3,4,5,6,7,8 collectively elucidate two points. First, the FSPs increased the female secondary school enrollment and years of education. Second, despite the increase in these quantity measures of education, the FSPs did not attract sufficient complementary investment from households in the quality of education for girls. As a result, the quality and performance of education for girls appear to have lagged behind those for boys among school enrollees.

Of course, the lack of investment in the quality of education for girls is not the only possible reason for their underperformance. For example, it is also possible that girls may have received less investment in health or be pressured to spend more time on household chores than boys. To the extent that they are correlated with the investment in education quality, we can interpret the latter as a reflection of the opportunity given by the household to perform well in education.

9. Discussion

In this paper, we focus on the demand side of education and explore the gender gap in the intrahousehold allocation of educational resources in Bangladesh. To this end, we decompose education decisions into enrollment, conditional total education expenditure, and conditional core share by extending the hurdle model to the three-part model. As detailed in Section 5, we find that there is a contradirectional gender bias—profemale bias in enrollment and promale bias in the other two decisions—in the intrahousehold allocation of educational resources and this finding remains true even when we take potential endogeneity concerns into account.

At first glance, the contradirectional gender gap is puzzling because it cannot be explained simply by gender discrimination and because it is not documented anywhere else. We argue that the contradirectional gender gap is at least in part attributable to the FSPs. As demonstrated in Sections 6 and 7, the FSPs have increased the school enrollment for girls relative to boys. However, the FSPs did not remove the gender gap in conditional expenditure or conditional core share. Hence, even though the FSPs have helped bring girls to school, the lack of complementary investment from households in girls' education may have resulted in a wider gender gap in the quality of education. Consistent with this possibility, girls underperformed boys among primary school graduates in on-time graduation from secondary school, as shown in Section 8. Girls also performed poorly in comparison with boys in terms of both the passing rate and the share of top students in the SSC examination (Fig. 1).

Taken together, the current paper clearly illustrates that gender parity in enrollment is only a milestone on the journey towards gender parity in education. Even though gender parity in enrollment is a big achievement, the current paper underscores the relevance of gender parity in education quality arising from demand-side constraints. It is clearly an important challenge to be tackled in Bangladesh and similar constraints are likely to be important in other South Asian countries and elsewhere that have traditional patriarchal norms.

Because of the data limitations, at least five potentially important factors were not taken into account in this paper. First, it is possible that the FSPs *directly* lower the quality of education for girls by selectively attracting girls to school and putting them in crowded classrooms, as suggested in the introduction section. The teacher-student ratio in secondary schools was only 1:24 in 1990 but rose by 50 percent to 1:36 in 2010, indicating that classrooms have become overcrowded. Moreover, given the crowded classrooms, many school teachers capitalized on this opportunity by systematically exerting less effort in school teaching and promoting private tutoring to earn extra income (Mahmud, 2003). The increase in household's dependence on private tutoring would also exacerbate the female disadvantage in the presence of the pro-male intrahousehold allocation of resources.[24]

The increase in the class size may also alter the class dynamics and affect the gender gap in education. While we are unable to directly observe the class dynamics, the change in the class dynamics may well depend on the gender of the teacher. To explore this possibility, we have also estimated a three-part model that includes district-level female teacher ratio and its interaction with a girl dummy (Panel A, Table 24). The sign and size of the coefficient on the girl dummy remain similar to those in Table 3. Similarly, the inclusion of the district-level female teacher ratio and its interaction with a girl dummy do not qualitatively alter the results on graduation on time reported in Table 10 (Panel B, Table 24). Hence, it seems unlikely that the class dynamics is an important causal channel.

Second, there is a supply-side constraint on female private tutors. While we are not aware of data on the availability of tutors, it seems likely that female private tutors were scarce, particularly in earlier years. Therefore, some parents with traditional social norms may choose not to hire a private tutor for their daughters, not because they are unwilling or unable to pay but because there is no female tutor available. However, the supply-side constraint is unlikely to be of primary importance, because the contradirectionality of the gender gap has not changed much since the year 2000, even though women have been getting better educated.[25]

Third, even if the supply-side constraint on female private tutors is not binding, there may be gender differences in the effective price of private tutoring because parents incur additional supporting costs for girls. Such costs would include the cost of private transportation for an accompanying guardian,[26] their opportunity costs, and higher search costs if parents only allow girls to be taught by female tutors. Given that first generation learners typically get no help with their studies outside the classrooms, after-school tutoring is crucial for students struggling academically, particularly in mathematics and English (Nakata et al., 2018). This especially makes it difficult for girls from disadvantaged backgrounds to pass the SSC examination. Hence, besides the availability issue discussed above, the effective price of private tutoring is also an important consideration.

Fourth, as noted in endNote 8, we did not take into account early marriage and pregnancy in our study explicitly. While most of the children in the secondary-school age group analyzed in our study are neither married nor pregnant, they may also be affected by the anticipation for early marriage and pregnancy. For example, households may save resources for a bride dowry instead of investing them in girls' education. This indicates that our results may be driven by the combination of the presence of FSPs, which reduces the opportunity cost of letting girls *enroll* in school, and the anticipation for early marriage and pregnancy, which would discourage households from investing in the quality of education for girls.[27]

Fifth, we did not address the possibility that our results may be driven by the presence of gender difference in labor market returns to the quality of education. Such gender difference may arise not only because employers do not value the quality of education for males and females equally but because females have a lower probability of employment and lower average working hours conditional on employment than males. In the working paper version (Xu et al., 2019), we show that our results are indeed consistent with the potential gender difference in labor market returns.

Despite the limitations above, this study offers four important policy implications. First, CCT programs have the potential to narrow the gender gap in enrollment. We reaffirm previous findings that the FSPs were successful in substantially increasing the secondary school enrollment rate for girls. Indeed, even though the secondary enrollment rate for girls historically lagged far behind that for boys, girls overtook boys soon after the nationwide rollout of the FSPs. This demonstrates that incentives work, even in a traditionally patriarchal country like Bangladesh.

Second, the quantity of education as measured by enrollment or years of education does not tell the whole story about the gender gap in education, as the incentive to increase the quantity of education does not necessarily lead to an improvement in the quality of education. Our results suggest that the quality of education for girls lagged behind that for boys among school enrollees because of the lack of investment in the former. As a result, girls' observable educational outcomes have also been worse than those of boys. Therefore, our results clearly show that narrowing the gender

[24] There is some suggestive evidence on the link between the FSP intensity and private tutoring. Based on the regressions of the (binary) use and (continuous) spending amount of private tutoring on the FSP intensity as measured by GRR, we find i) both girls and boys are more likely to have private tutoring in more FSP-intensive areas, ii) the share of the expenditure on private tutoring in the total expenditure for girls tends to be lower than that for boys conditional on the use of private tutoring, and iii) this gender gap was larger in more FSP-intensive areas in 2000 and 2005 (see endNote 22 for the reason for the choice of these years). Although the sign is consistent between these two years, we refrain from drawing strong conclusions because the estimates are not always statistically significant and because we do not observe the teacher-student ratio in the schools children attend.

[25] According to (Banbeis, 2010 Table 2.1.0, p. 30), the proportion of female teachers in secondary schools was 13.88 percent in 1995. This figure reached 23.09 percent in 2010.

[26] Transportation can be an important barrier for girls to access education. In India, Muralidharan and Prakash (2017) found that conditional kind transfer of a bicycle to girls substantially narrowed the gender gap in enrollment.

[27] See also the analysis of dowry market in India (Anukriti et al., 2018; Chiplunkar and Weaver, 2021; Rao, 1993).

gap in the quantity of education does not narrow the gender gap in the quality of education.[28] This, in turn, indicates that gender parity in enrollment may not translate into gender parity in learning, a point underscored by Asadullah and Chaudhury (2015) in a study of Bangladesh and by Psaki et al. (2018) in a study of 43 countries. Therefore, policy-makers should be aware of such potential adverse effect when implementing CCT programs.

Third, it is impossible to truly achieve gender equality in education without addressing the gender gap in education quality, as is apparent from the underperformance of girls in secondary schools. Conversely, girls may do as well as boys when both have equal access to opportunity as the evidence from nonformal education program suggests (Gee, 2015). Of course, quality may be more difficult to address than quantity, because the factors affecting the former may be beyond the control of those who make education policies. Nevertheless, interventions that are targeted at improving the access to quality education among disadvantaged groups (e.g., the voucher program in India (Muralidharan and Sundararaman, 2015)) may narrow the gender gap in the quality of education.

Finally, the empirical findings in this study also call for a nuanced interpretation to understand the changing gender gap in Bangladesh and elsewhere in South Asia. Female disadvantage in Bangladesh has significantly reduced or disappeared by some indicators. Girls already surpassed boys in the enrollment rates in both primary and secondary schools. Similarly, the rate of decline in the under-five child mortality for girls was faster than that for boys between 1995 and 2015 in Bangladesh.[29] The progress in these indicators can be attributed to the presence of various social programs—such as the FSPs—implemented by the government and non-governmental organizations (Asadullah et al., 2014).

On the other hand, our paper suggests that the persistent gender gap remains in the intrahousehold allocation of resources. Besides education expenditure analyzed in this paper, there is indeed an emerging body of evidence on gender inequality within the household. For example, Hossain et al. (2021) find that there is gender inequality in the nutritional investment. They show that girls are particularly disadvantaged when their mothers are not empowered. Similarly, Asadullah et al. (2021) document the persistence of son preference in the actual fertility behavior in Bangladesh, even though the stated preference for boys among female respondents has disappeared. They also note that the stated preference for boys is disappearing in India and Nepal. Together with the fact that the number of unwanted births is on the rise, their results suggest that the lack of female empowerment leads to the discrepancy between stated and actual fertility behaviors.

On the whole, this study cautions against equating the narrowing of gender gap in one indicator with the narrowing of gender gap in general, since an improvement in one indicator may be accompanied by worsening of others. Even though the FSPs have narrowed the gender gap at the extensive margin (to enrol the child or not), they also lead to a deterioration of gender gap at the intensive margin (how much to spend on the enrolled children's education, and quality education in particular). Hence, it is essential for policy-makers to carefully examine what each indicator really means and appreciate the complexity of household decisions. Neglecting such complexity can lead to unintended and possibly undesirable consequences.

[28] Additional indicative evidence comes from Tanaka et al. (2021), who find that a higher number of years of education is associated with a *lower* probability of female labor force participation (FLFP) in a fuzzy regression discontinuity design, taking the introduction of the FSPs as a plausible exogenous shock. Even though their study provides no explanation for this finding, it is indeed consistent with the possibility that the females who had longer education because of the FSPs were less likely to work than those who had the same amount of education without FSPs, since the quality of the education for the former was worse than that for the latter.

[29] Under-five mortality was 110.4 [117.8] per 1,000 live births for girls [boys] in 1990. This figure has dropped by 68.1 [66.2] percent to 35.2 [39.8] per 1,000 live births in 2015, according to the World Development Indicators.

CRediT authorship contribution statement

Sijia Xu: Conceptualization, Methodology, Software, Validation, Formal analysis, Data curation, Writing - original draft, Writing - review & editing, Visualization, Project administration, Funding acquisition. **Abu S. Shonchoy:** Conceptualization, Validation, Investigation, Data curation, Writing - review & editing, Supervision. **Tomoki Fujii:** Conceptualization, Methodology, Validation, Formal analysis, Investigation, Data curation, Supervision, Project administration, Writing - original draft, Writing - review & editing.

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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Appendix A. Supplementary data

Supplementary data associated with this article can be found, in the online version, athttps://doi.org/10.1016/j.worlddev.2021.105730.

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