Sibling Rivalry and Gender Gap: Intrahousehold Substitution of Male and Female Educational Investments from Male Migration Prospects

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Abstract

Improved migration prospects for men could have negative spillover effects on women. We use an exogenous change in an education-based policy for recruiting Nepali men to work in the British Army to examine the effect of new job prospects for men on the human capital of women within the same household. Men who were directly exposed to this change raised their education. These gains came at the expense of their female siblings, who lost 0.12 years of schooling and increased their participation in economic activities. This spillover accounts for a 8% decline in female education and widens the gender gap by 31%. For every additional year of education completed by men, female siblings "lose" 0.394 years of education. This gender spillover is more severe for poor and agricultural households that are more resource constrained.

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Poor, rural households in developing economies invest more in the health and education of their sons, relative to their daughters (Sen, 1990; Das Gupta et al., 2003; Anderson and Ray, 2010; Jayachandran, 2015). This gender gap in human capital depends, in part, on the local labor markets that are largely agricultural and tend to favor men (Alesina et al., 2013; Carranza, 2014). An increasingly global economy has hastened the arrival of more skilled jobs in economies that are still poor and rural; and it has encouraged the movement of labor out of developing countries through international migration. If these new jobs are more accessible to women, they could alter the incentives that shape household decisions on resource allocation across male and female children.

Global jobs that come through outsourcing industries that are accessible to women have been shown to improve human capital investments in education (Oster and Millett, 2013); and to positively affect marriage and fertility decisions (Jensen, 2013). Better migration prospects for men, on the other hand, have been shown to increase male human capital investments (Shrestha, forthcoming). If international migrant jobs are dominated by male migrants, they could increase households' incentives to invest in male children relative to female children and reinforce pre-existing gender gaps.

Identifying how households allocate resources is however challenging, as there are significant unobserved heterogeneities across households that affect their member's labor market prospects and human capital. In this paper, we use a plausibly exogenous change introduced by a selective education-based policy for recruiting Nepali men to work in the British Army, to examine the effect of improved job prospects for men on the human capital of women within the same household. This exogenous change in the selection criteria for joining the British Army increased relatively skilled emigration prospects for Nepali men, and led to an improvement in their human capital investments (Shrestha, forthcoming). The quasi-experimental setting defined by this change in selection criteria allows us to overcome the endogeneity problem and identify the causal effect of male migration opportunities on girls' human capital investment.

The setting of this experiment in Nepal is characterized by gender gaps in multiple domains, including education (United Nations, 2010; Jayachandran, 2015). On average, men have 4.06 years of education, while women have 2.30 years. The education gap for working-age adults is also similar.[1] This provides us with an ideal case to study the effects

[1] Based on the 2001 Nepal Census data. Among working-age population (18 to 45 years old), men have 5.54 years education, while women have only 2.71 years.

of migration on gender gaps in human capital. Nepal is also a poor and largely agricultural economy, which has witnessed large increases in work-related migration, mostly for men in recent years. 47.4% of women participate in the labor market, and 20% of them cultivate their own land. In contrast, 66.9% of men work, and they are largely employed in the non-agricultural wage sector (26.7%), or they migrate abroad for work (20.2%). Only 2.8% of women migrated abroad for work (2008 Nepal Labor Force Survey). Between 2001 and 2011, the rate of out-migration of the working-age adult population more than doubled from 3.4% to 7.4% (Shrestha, 2015). Migration is therefore an increasingly popular and viable employment opportunity for men in Nepal.

We use a two-step strategy to examine the effect of the introduction of education as selection criteria for the British Army on gender-specific human capital. First, we demonstrate that men who were directly exposed to this rule change based on their ethnicity and age (age-eligible males) raised their education. We then focus on the indirect effects of this rule change on female siblings of these affected males. We use a difference-in-difference approach to identify the causal impact of having affected male siblings living in the household. In addition, we use the sibling's eligibility criteria for recruitment to instrument for male sibling's education, and to estimate the rate of intrahousehold substitution between the education of male and female siblings.

We find that having an age-eligible male sibling reduced the education of girls living in the same household by 0.12 years. The decline was mainly due to girls not entering formal education, rather than due to an increase in their early dropout rates. And it was accompanied by an increase in their labor towards household economic activities. This negative gender spillover on education is not small. It accounts for an 8% decline over the average female education in Nepal. This decline in female education was accompanied by a 0.380-year increase in education for their age-eligible male siblings, which widened the education gap by 31%.

The IV estimate of the intrahousehold substitution in child human capital suggests that for every additional year of education completed by males, their female siblings complete 0.394 less years of education. The negative gender spillover on female education is larger for poorer households who face more binding financial constraints, and for agricultural households who are more likely to be labor constrained. This suggests that the observed decline in female education likely reflects a market driven reallocation of monetary and non-monetary resources from male to female siblings within the household.

The empirical literature on the effect of migration on intrahousehold allocation of financial resources and labor time has placed significant emphasis on households with successful migrants. Such migrants typically send remittances back home, which could help alleviate household resource constraints. Remittances, which could help relax credit constraints, have been shown to contribute to increased child educational attainment (Yang, 2008, 2011; Antman, 2012). The absence of these migrants from their homes, which reduces parental time investments in children, has also been shown to have a negative effect on education outcomes (Cortes, 2015). The effects of migration on education of female children is mixed. Parental migration is associated with a lag in girls' education in China (Meyerhoefer and Chen, 2010) and Mexico (McKenzie and Rapoport, 2011); and with an increase in girls' education in El Salvador (Acosta, 2011).[2] There is also some evidence that the absence of male household heads due to migration also shifts bargaining power within the household to women, who invest more in girl children, but only during the periods of such migration (Antman, 2015).

These ex-post effects are only one component of the effect of migration on human capital in developing countries. In particular, ex-ante human capital investments in households who aspire to send migrants, in expectation of access to global jobs, can also have important human capital effects. When returns in the destination country are lower than at home, the incentive effect of the prospect of future migration for children growing up in migrant households may actually lower the incentive to invest in education and counteract the positive effect of remittances (McKenzie and Rapoport, 2011). In contrast, in contexts where the return to education is higher in the destination, these effects are likely to be positive and foster a local "brain gain" (Fan and Stark, 2007; Beine et al., 2008; Gibson and McKenzie, 2011; Batista et al., 2012; Docquier and Rapoport, 2012). The effects of such migration are likely to be large as the prospect of migration has large expected returns, despite the low odds of success (Clemens et al., 2009; Clemens, 2013).

We use a quasi-experiment to identify the effect of such anticipated migration on intrahousehold resource allocation, and find that the prospect of migration for men can lower female education. In a context where migration is increasingly spoken about as one of the most effective development policies (Gibson and McKenzie, 2014; McKenzie and Yang,

[2]For more, see (Antman, 2013).

2014), our paper hopes to contribute to a better understanding of its gender impacts in the poor economies that send mostly male migrants.

Our results also speak to the literature on the role of differential labor market opportunities for men and women in creating gender gaps in poor, developing economies (Rosenzweig and Schultz, 1982; Pitt et al., 2012; Rosenzweig and Zhang, 2013). Gender-differences have been shown to be caused by the nature of jobs that are available in the local labor market (Qian, 2008; Jensen, 2013; Oster and Millett, 2013; Carranza, 2014), home production technologies (Coen-Pirania et al., 2010; Dinkelman, 2011), maternal mortality rates (Jayachandran and Lleras-Muney, 2009), and cultural norms (Alesina et al., 2013). Globalization brings a new dimension to the economic factors that underlie the gender gap. While it has been demonstrated that global jobs that foster a local service sector which bring jobs for women can help close this gap, our results suggest that male focused migrant job opportunities could actually widen the gap.

Finally, our results on intrahousehold decisions that underlie the allocation of resources towards male children relate to the literature on the role of the household in fostering child human capital. This role may be more important in developing countries, where the absence of well-established credit markets and social protection systems may drive parents to base their intrahousehold resource allocation on efficiency rather than equity concerns (Yi et al., 2011). In particular, credit constrained households may invest where the returns to market investment are greater (Strauss and Thomas, 1995). In our case, we find that households respond to a positive shock in the male labor market, by investing more resources in their male children despite the latter already having better human capital relative to their sisters.

The rest of the paper is structured as follows: Section 1 describes the British Army recruitment and estimates the positive impact on male education investments. Section 2 explains the empirical strategies; Section 3 describes the data; Section 4 presents the results; and Section 5 concludes.

1 Background

The British Brigade of Gurkha is the unit in the British Army that is composed of Nepali soldiers. It was established in 1816 under the Treaty of Sugauli, which marked the end of the Anglo-Gurkha war between the British East India Company and the Government of

Nepal. The treaty allowed the British Army officers to enter Nepal freely and enlist Nepali men into their army. This practice continues till the present day. Currently, the British Army has two permanent recruitment centers inside the country. Each year, they select new Gurkha soldiers based on a series of physical examinations, medical checkups, interviews, and mathematics and English tests. Successful recruits join the British Gurkha Regiment, which is based in England. Gurkha soldiers remain citizens of Nepal throughout their careers abroad in the British Army, and are entitled to benefits and promotions in rank similar to British natives.

The present value of the lifetime income from serving in the British Gurkha Army is estimated around USD 1.3 million, more than 50 times greater than the lifetime earnings of an average salaried employee in Nepal (Shrestha, forthcoming). Given such large financial windfall, the British Gurkha Army is a lucrative foreign employment opportunity for Nepali men. More than 25,000 individuals apply each year for 300 available slots. British Gurkha soldiers account for 22.73% of migrant workers to the UK (2008 Nepal Labor Force Survey), and remittances from Gurkha soldiers and pensions for ex-Gurkha soldiers were the country's largest source of foreign currency earnings until the recent development of other sources of migration for Nepali men.

1.1 *Ethnicity Based Recruitment into the British Gurkha Army*

The early recruits in the British Gurkha Army included men from ethnic groups such as the Rajput, Thakuri, Chetri and Brahman, who had originally migrated to Nepal from the present-day India and were closely associated with Indian ethnic groups. In 1857, Indian soldiers serving in the British Indian Army led an unsuccessful rebellion against British rule in South Asia. This *Sepoy Mutiny* made the British wary of Indian nationals serving in their army. After 1858, the British Gurkha Army also stopped recruiting Nepali men who belonged to the ethnicities that originated in India. The new Nepali recruits were mainly drawn from the five Monglo-Tibetan tribes who, unlike other ethnic groups in Nepal, had no cultural or historical ties with India because they had migrated to Nepal from across the northern border with China (Farwell, 1984; Rathaur, 2001). The letter by the British Commanding Recruitment Officer from the early 1900s highlights this ethnicity-based recruiting, which states: "I first consider his caste. If he is of the right caste, though his physique is weak, I take him" (Banskota, 1994).

This ethnicity bias in the annual recruitment of British Gurkha soldiers continues to exist even though the British government no longer uses ethnicity as a criterion for selection into the army. While other ethnicities could in principle apply to the British Gurkha Army, these five tribes–Gurung, Rai, Limbu, Magar, and Tamang–continue to make up this entire regiment. The historical roots of this ethnicity-based selection has established a tradition wherein they are the only ethnicities that in effect join this regiment. This ethnicity-specific tradition is so entrenched, that these five tribes are jointly known as Gurkha ethnic group (Banskota, 1994). Many Gurkha-dominated villages in Nepal are named after the title of their highest-ranking British Gurkha officer, such as the Captain's village; and the retired Gurkha soldiers and their wives are known in their villages by their titles of the British Army (Hitchcock, 1966; Caplan, 1995). Evidence of this selection can also be seen in the data. According to the 2008 Nepal Labor Force Survey (NLFS), all current British Gurkha soldiers belong to one of the Gurkha tribes.

1.2 *Change in Education Criteria and Response from Gurkha Men*

Education is an important aspect of the British Gurkha Army recruitment process today. Prior to 1993, however, no formal education was required to join and the selection criteria was solely limited to physical examinations. Starting in 1993, recruits were required to have completed at least eight years of education, and written tests in mathematics and English became part of the selection process. In 1997, the minimum education requirement was increased to 10 years. This set of changes was instigated by a larger restructuring of the British Army in the early 1990s, following a series of post-cold war era defense reviews termed Option for Change (Alexandreou et al., 2000). This led to an 18% reduction in manpower in the British Army, which was accompanied by an emphasis on improving education and training of soldiers.

Shrestha (forthcoming) finds positive impacts of introducing education as a selection criterion on human capital investment decisions of Gurkha ethnic men living in Nepal. We follow the same estimation strategy in Shrestha (forthcoming) to estimate the impact of this rule change on Gurkha men of multiple single-age cohorts.[3] We then use these results to motivate the main analysis of this paper- the gender impacts of increased incentives to invest in male human capital that stem from male-centered opportunities to migrate.

[3]Each year of birth defines a single-age cohort.

An individual's gender, ethnicity, and age in 1993 determine exposure to the rule change. Since recruits must be male and between 17 1/2 and 21 years old, Gurkha men who were 22 or older in 1993 were not affected by the change; whereas, younger Gurkha men were affected. The difference-in-difference strategy compares male education between Gurkha and non-Gurkha ethnic groups for each single-age cohort that was affected by the change relative to the same inter-ethnic difference for the older single-age cohorts who were ineligible to apply in 1993. This empirical strategy is expressed using the following regression framework:

$$Y_{iklm} \;=\; c + \;\alpha_{1kl} \;+\; \beta_{1m} \;+\; \Sigma_x \; (P_{ix} \; X \; G_{im}) \; X \; \gamma_x \;+ \Sigma_j \; (P_{ij} \; X \; R_m) \; X \; \delta_j \quad + \epsilon \qquad (1)$$

where Y_{iklm} is the education outcome for individual i of age k and ethnicity m, residing in ward l; α_{1kl} is an age-ward dummy for each age k and ward l; β_{1m} is the ethnicity dummy for each m; G_{im} is a dummy indicating whether individual belongs to the Gurkha ethnic group; P_{ix} is a dummy indicating whether individual is age x in 1993; and R_m is an ethnicity-specific characteristics.

Each γ_x can be interpreted as the effect of the selection criteria change on the education outcome of Gurkha men of age x. The identification assumption is that in the absence of this change in the selection criteria, the cohort trends in the education outcomes of men would not have differed across Gurkha and non-Gurkha ethnic groups.

There are two main threats to the identification assumption. First, the estimates of γ_xs could be confounded by regional cohort trends if regions with different concentrations of Gurkha and non-Gurkha ethnic groups evolve differently over time. Therefore, the above specification includes age-ward dummies that control for any age-specific regional shocks such as ward-level[4] changes in socio-economic conditions and school infrastructure that could differentially affect education of men living in different wards.

Second, the timing of ethnicity-specific educational policies could be correlated with the introduction of education as the selection criterion in the British Gurkha Army. The specification controls for a potential correlation with government policies that might have targeted underperforming ethnicities at the time of the selection criteria change. For this purpose, we include the interactions of age dummies and ethnicity-specific average distance-

[4]A ward is the smallest administrative unit, which also acts as a political institution to facilitate the planning, programming and implementation of development programs and projects. Gurkha and non-Gurkha men living in the same ward are likely to experience the same socio-economic changes that are unrelated to changes in the selection criteria for the British Gurkha Army.

time to the nearest school measured around the time of the change.

After controlling for these two age-varying confounding factors, if any differential cohort trends still remain, we should be able to identify this through γ_xs for age cohorts that are older than 21 years in 1993.

We estimate equation (1) using the data from the 2001 Nepal Census, which collected information on age, ethnicity, and education for all members of each household in the nationally representative sample. The ethnicity-level access to the nearest school variable is constructed using the 1995/96 Nepal Living Standards Survey. We restrict the 2001 Nepal Census data to men who were six or older in 2001 (-2 years in 1993), six being the youngest cohort for whom we have education data. We limit the oldest cohort to 38 years old in 1993 (46 years in 2001), which allows us to examine the 15-year ethnicity-specific cohort trends prior to the change in selection criteria. This provides us with the sample of 908,211 men. The dependent variable is the years of education completed as of 2001, and the standard errors are adjusted for within-ethnicity correlations. Figure 1 plots the estimates of γ_xs from equation (1) and the 95-percent confidence interval for $-2 \leq x \leq 36$. The comparison group for inter-ethnic differences is the age-ineligible cohort that comprises men who were 37 and 38 years old in 1993.

The estimates of γ_xs are close to zero, and are statistically insignificant for 15 out of 16 values of $21 < x \leq 36$.[5] This implies that the long-term cohort trends prior to the rule change were not different between Gurkha and non-Gurkha men, providing support for the validity of the identification assumption. In contrast, for $x \leq 21$, γ_xs are mostly positive and, more importantly, increase as age decreases. For $13 \leq x \leq 21$, the estimates are positive for most γ_xs but small in magnitude; and most of the estimates of γ_xs are statistically insignificant at the 5% level.[6] However, for $x \leq 12$, γ_xs are large and statistically significant at the 5% level. This differential cohort trend by ethnicity among affected cohorts (for $-2 \leq x \leq 21$)

[5] In addition, we compare the education of the (22 to 28) year old age cohort to the (29 to 38) year old age cohort, across Gurkha and non-Gurkha ethnic groups. Given that men in both these cohort groups are too old to apply for the British Gurkha Army in 1993, this difference-in-difference estimate provides an alternate test of whether cohort trends are different between Gurkha and non-Gurkha ethnic groups prior to the rule change. We find that this estimate is close to zero, and it is not statistically significant at conventional levels.

[6] For Gurkha men aged 13 to 21 in 1993, the effect of the rule change was positive but small in magnitude compared to the younger cohorts. Gurkha men aged 13 to 21 are mostly unaffected by the change in 1997, and their ability to respond successfully to the introduction of the educational requirement is also constrained by the years of education they have already completed by its 1993 introduction. For example, Gurkha men aged 20 would only be able to respond if they already had at least 7 years of education in 1993. Because the data on education completed by 1993 is not available, these older cohorts (13 to 21 years old in 1993) include some men who were affected by the change in 1993 and others who were not.

relative to the inter-ethnic trend among older cohorts (for $21 < x \leq 36$) can be interpreted as the causal impacts of the rule change on Gurkha men.[7]

The positive impacts on younger cohorts ($x \leq 12$) are consistent with the age group of men most likely to respond to the rule change. They were more likely to be enrolled in primary school at the time when the education criteria was introduced and to have enough years to change their educational trajectory in line with the new selection rule in 1993; and they are also affected by the change in 1997. Therefore, in this paper, we consider males aged 12 or younger in 1993 as age-eligible members, to examine intrahousehold spillovers in human capital on other members in their households.

The impact of the rule change on this younger age cohort comes from an increase in school enrollment and an increase in the proportion of boys who completed at least 10 years of education- which are the two margins that should have been affected by the rule change (Shrestha, forthcoming). More importantly, this positive educational response from Gurkha men is line with the net benefits expected from complying with the new education requirement. The expected lifetime earnings from the British Gurkha Army for eligible applicants is estimated to be USD 16,000.[8] The costs of receiving 10 additional years of schooling, on the other hand, is the shadow wage of the child plus any direct monetary costs such as tuition and transportation fees. Based on the private school fees in Nepal reported by Sangeeta (2009) and the under-16 median wage from the 2008 NLFS, we estimate the total costs to be around USD 3,800.[9] The expected benefits exceed these costs as long as the probability of success is not less than one in every 351 applicants. The selection odds into the British Gurkha Army of one in 83 far exceeds the threshold at which the expected benefits from investing in more education outweigh the costs of doing so. In addition, the demand elasticity of educational response from Gurkha men is estimated to be 0.3 (Shrestha, forthcoming). Responses of similar magnitude have also been observed in other contexts: (Kochar, 2004) estimates a similar response for urban migration induced educational response in rural India.

[7]For detailed analysis of the impact of the change in the selection criteria for the British Gurkha Army, and for the robustness checks of the empirical strategy, see Shrestha (forthcoming).

[8]The lifetime earning of a Gurkha soldier is USD 1,334,091.81; and around 25,000 individuals apply for 300 available slots each year. The expected lifetime earnings=probability of getting selected*lifetime earnings.

[9]Out of this total cost, about $2,300 is the direct monetary cost of investing in 10 years of schooling, and approximately $1,500 is the forgone earnings. Based on the 2008 NLFS, the under-16 median monthly earning is $12.94. The median monthly earnings of all working male and female adults are $95.62 and $66.37, respectively.

2 Estimation Strategy

Economic models of household decision-making suggest that an increase in education among Gurkha men is likely to affect investments on other members of their household. Our empirical analysis seeks to estimate the intrahousehold tradeoffs that could underlie this increased investment in male children. In particular, we focus on Gurkha girls, who are not eligible for the British Gurkha Army based on gender, but could be indirectly affected by the presence of a male sibling who was affected by the change in the selection criteria for the British Gurkha Army. Male siblings aged 12 or younger in 1993 are henceforth refereed to as age-eligible male siblings.

We first identify the effect on Gurkha girls of having an age-eligible male sibling in the household via a difference-in-difference estimation. We then extend this empirical strategy to instrument for male sibling's education and estimate the causal impact of male human capital investment on female sibling's educational outcomes.

In the difference-in-difference estimation, we compare education between girls who have an age-eligible male sibling and who do not have an age-eligible male sibling in their household, across Gurkha and non-Gurkha ethnic groups. The simple difference in the education between Gurkha and non-Gurkha girls with an age-eligible male sibling could be arguably correlated with the unobserved ethnic characteristics. Subtracting from this difference, the inter-ethnic difference for those who do not have an age-eligible male sibling would net out both ethnic differences and unobserved household characteristics that could be correlated with having an age-eligible male sibling and preferences for girls' human capital. The identification assumption is that in the absence of the change in the selection criteria for the British Gurkha Army, the difference in female human capital between those with and without an age-eligible male sibling would have been identical across Gurkha and non-Gurkha ethnic groups. The above identification strategy can be expressed using the following regression frame work:

$$Y_{ilm} = c + a_{1l} + b_{1m} + \rho E_i + \lambda (E_i X G_m) + \Gamma K_i + \Theta (K_i X G_m) + \varepsilon \quad (2)$$

where Y_{ilm} is the human capital outcome for girl i of ethnicity m and residing in ward l; a_{1l} is a ward dummy for each ward l; b_{1m} is the ethnicity dummy for each m; G_m is a dummy indicating whether girl belongs to the Gurkha ethnic group; E_i is a dummy indicating whether girl i has at least one age-eligible male sibling living in the household; and K_i is a vector of girl i's characteristics such as her age, region of birth, and characteristics related to her parent's fertility outcomes and her siblings.

The coefficient λ estimates the spillover effects on Gurkha girls who have an age-eligible male sibling that experienced an increase in returns to education due to migration prospects. E_i, which is the measure of having at least one age-eligible male sibling, could be argued to be a function of household's fertility choices. Therefore, the main threat to our identification assumption is that unobserved characteristics that influence fertility outcomes and female human capital investment decisions could be different between Gurkha and non-Gurkha ethnic groups, which could bias the coefficient λ in equation (2). Given that the sibling's eligibility is jointly determined by its ethnicity, gender, and age, our estimation strategy can allow for such unobserved fertility-related characteristics to be different between Gurkha and non-Gurkha ethnic groups. In particular, we can control for three different types of fertility related outcomes - that are likely to influence preferences related to childbearing - separately for Gurkha and non-Gurkha ethnic groups.

First, E_i could be correlated with observed and unobserved ethnicity-specific characteristics that influence whether girl i has at least one sibling.[10] Second, the coefficient λ could be biased due to differential parental preferences for having a male child by ethnicity. Third, any ethnic differences in preferences for birth spacing could be correlated with $E_i X G_m$ if such preferences also influence female investment, and thereby, bias the coefficient λ. To address these concerns, we include in equation (2): (a) a dummy indicating whether girl i has at least one sibling (of any age and gender), and its interaction with a Gurkha dummy variable; (b) a dummy variable indicating whether girl i has at least one male sibling of any age, and an interaction between a Gurkha dummy and this male sibling dummy; and (c) we add a dummy indicating whether girl i has at least one age-eligible sibling of any gender, and its interaction with a Gurkha dummy variable.

Adding these ethnicity-specific fertility outcomes strengthens the internal validity of the empirical strategy.

We extend the above empirical strategy to estimate an instrumental variable (IV) model where the second stage estimates the impact of male siblings' education on that of their

[10] In this paper, we define a sibling as a brother, sister, or cousin whose parents are part of the main household. The siblings themselves could be residing in the household or living separately.

female counterparts. The IV approach involves estimating the following equation:

$$Y_{ilm} = c' + a'_{1l} + b'_{1m} + \rho'\, E_i + \lambda'\, \hat{B}_i + \Gamma'\, K_i + \Theta'\, (K_i X G_m) + \Phi'\, S_i + \Sigma'(S_i X G_m) + \epsilon' \quad (3)$$

where $\hat{B}_i$ is the instrumented male sibling's education, predicted by $E_i X G_m$ in the first stage:

$$B_i = c'' + a''_{1l} + b''_{1m} + \rho''\, E_i + \lambda''\, (E_i X G_m) + \Gamma''\, K_i + \Theta''\, (K_i X G_m) + \Phi''\, S_i + \Sigma''(S_i X G_m) + \epsilon'' \quad (4)$$

B_i is the education measure of girl i's nearest-age male sibling, and S_i is a vector of her nearest-age male sibling's characteristics such as his age.

There are two potential concerns with using $E_i X G_m$ to instrument for male education B_i. First, the instrument could be correlated with ethnicity-specific cohort trends related to male and female education. In Figure 1, prior to the rule change in 1993, we do not observe differential cohort trends between Gurkha and non-Gurkha men. Nevertheless, in the IV model above, we allow for ethnicity-specific linear cohort trends for male education, and we include girl age dummies interacted with a Gurkha dummy to control for any ethnicity-specific cohort shocks that could affect female education.

Second, the instrument could be correlated with ethnicity-specific characteristics that influence household's fertility choices. In line with the difference-in-difference strategy, the IV specification also controls for three types of fertility outcomes separately for Gurkha and non-Gurkha households. The exclusion restriction, which requires that having an age-eligible male sibling in the household affects education of Gurkha girls only by increasing educational attainment of their age-eligible male sibling, is satisfied as long as gender-specific birth spacing preferences are not different between Gurkha and non-Gurkha households. While we can not explicitly address this, we however can control for a variable that measures the linear age-difference with her nearest-age male sibling, and its interaction with a Gurkha dummy.

3 Data

We use the 2001 Nepal Census data and we focus on girls aged 6-12 in 2001. Since this age cohort is the primary school-going age, having an age-eligible male sibling is likely to matter to their human capital.[11] This provides us with a sample of 226,075 unmarried girls of primary school-going age from a nationally representative household sample, with Gurkha girls making up almost 20% of the sample.[12]

Table 1, Columns 1, 2 and 3 report the averages for important socio-economic indicators and household characteristics for the entire sample as well as separately for Gurkha and Non-Gurkha ethnic groups, respectively. The school enrollment rate for girls in the sample is 72%. With an average age of nine, 4% of these girls work on a household farms or other household economic activities, and another 4% of them perform household chores as their main daily activity. 67% of them were born in a rural region, and 76% live in households that own an agricultural land.

Age-eligible male siblings are defined as brothers, and male cousins from an age-eligible cohort who reside in the same household. Three-fifth of girls had an age-eligible male sibling residing in their household in 2001.[13] The household roster might not however represent the household composition at or around the time of the rule change in 1993, if this change itself caused Gurkha households to split, with age-eligible Gurkha boys moved to separate household by 2001.[14]

If the likelihood that an age-eligible boy moves out of Gurkha household after 1993 is correlated with household characteristics that also influence female investments, this could undermine the identification assumption. We examine the possibility of such endogenous household formation among Gurkha ethnic group in two ways.

First, we test whether Gurkha households are different in composition compared to non-Gurkha households in 2001. Table 1 reports various characteristics of household structure for Gurkha and non-Gurkha ethnic groups; column 4 presents the p-value of the difference in means between the two groups. 96% of Gurkha girls and 95% of non-Gurkha girls come from

[11] In addition, the girls of this age cohort are not married, and therefore, they are more likely to be living with their parents, in contrast to married girls who are members of their spouse's household. The sibling relationship variables are constructed based on the household roster, and fertility information of household members.

[12] The sample of households is drawn from the complete household count conducted in the first phase of the census in 2001. For each ward, 1 of 8 housing units was selected, and for 52 wards in 6 districts, complete enumeration was done. The sample comprises 20% of the population.

[13] The dummy indicator for having an age-eligible male sibling in the household is constructed based on the household roster.

[14] In addition, we test whether the fertility rate also changed among Gurkha households following the rule change in 1993. For this purpose, we compare the cohort size of the Gurkha ethnic group who were born five years prior and five years after 1993, relative to the same difference for the non-Gurkha ethnic group. We also compare the gender composition of cohorts born before and after the rule change, across Gurkha and non-Gurkha ethnic groups. On both measures, we do not find any significant differential change by ethnicity.

a nuclear household. The two means are not different at conventional levels of statistical significance. Only 5% of girls have a male sibling (including cousins with parents who are members of the household) living in a different household, and more importantly, this is not statistically significantly different between Gurkha and non-Gurkha ethnic groups (p-value = 0.580).[15] Lastly, Gurkha and non-Gurkha girls have almost identical likelihood of having an age-eligible male sibling living in their household (62.78% and 63.10% respectively), and this difference is also not statistically significant.

Second, we examine whether the difference-in-difference estimation strategy might be biased due to endogenous household formation by estimating λ in equation (2) with household characteristics as the dependent variable. Table 2 presents the estimates of λ for three types of household head characteristics, two measures of household wealth[16], and two indicators of female empowerment measured by whether any female household member owns land and property in her name. For all seven outcomes, the estimated coefficient λ is close to zero and it also not statistically significantly different from zero. The results support the validity of the identification assumption, and provide no evidence for endogenous household formation that could bias the difference-in-difference. It also shows that the difference-in-difference instrument $E_i X G_m$ is not correlated with the observed household characteristics that could directly affect female education, and therefore, supports the exclusion restriction of the IV model.

4 Results

Table 3 compares the years of education completed as of the 2001 Census of Gurkha and non-Gurkha girls who have an age-eligible male sibling in their household to those who do not have an age-eligible male sibling. The latter group comprises of girls with either no siblings, only female siblings, or age-ineligible male siblings. Among girls without an age-eligible male sibling, the average education of Gurkha and non-Gurkha girls are almost

[15] The 2001 Nepal Census collected information on gender of the siblings who were living separately from their parents, but did not collect information on their age or the timing of their split. Hence, we cannot identify whether the male sibling, who is living separately from his parents in 2001, is of an age-eligible cohort. For all girls who have a male sibling living separately, we assume that the sibling is of an age-eligible cohort, and reassign the dummy indicator for having an age-eligible male sibling in the household (E_i) the value of one. This does not change the findings of the paper.

[16] One of the measures of household wealth is the wealth index. It is constructed by taking a weighted mean across the standard distributions of four different measures of housing quality and two measures of household asset: drinking water source, lighting source, cooking fuel source, type of toilet, and household ownership of a television set and radio. The weights are calculated based on the first principal component.

identical, and the difference between the two ethnic groups is also not statistically significant at conventional levels. Among those with an age-eligible male sibling, however, Gurkha girls completed 0.10 less years of education than non-Gurkha girls. This difference is statistically significant at the 1% level. The difference-in-difference estimation shows that Gurkha girls with an age-eligible male sibling in the household completed an average of 0.12 less years of education. This estimate is statistically different from zero at the 1% level.

To account for a possible bias due to ethnicity-specific characteristics that are correlated with fertility and female education, we estimate λ from equation (2) that allows for unobserved variables correlated with different types of fertility-related outcomes to be different between Gurkha and non-Gurkha ethnic groups. The results from four different specifications that control for such ethnicity-specific fertility preferences and characteristics are presented in Table 4. Across the four specifications we add more rigorous controls sequentially to test the robustness of our difference-in-difference estimates. The fourth specification is the most rigorous. Additional robustness checks are provided in Appendix A and in Appendix Table A1.

The specification in Column 1 controls for ethnicity-specific parental preferences related to having more than one child; Column 2, in addition, controls for ethnicity-specific parental preferences for having a male child. If the likelihood of having an age-eligible male sibling measured by E_i is a function of parents' fertility preferences, then differences in such preferences between the Gurkha and non-Gurkha ethnic groups could confound the coefficient of $E_i X G_m$, i.e. λ, in equation (2). In Column 3, we control for any potential ethnic differences in the labor market earnings of older male siblings that could directly affect their younger female sibling's education through household income. The estimated impacts on the years of education in Columns 1, 2, and 3 in Table 4 are -0.079, -0.141, and -0.126 respectively, and the estimates are statistically significant at the 1% or 5% level.

Lastly, the estimates of λ could still be biased if there are any differential parental preferences for birth spacing between Gurkha and non-Gurkha households. Therefore, in Column 4 we control for ethnicity-specific birth spacing in two ways. First, we include a dummy indicating whether the girl has any age-eligible sibling of any gender in the household, and its interaction with a Gurkha dummy. Second, we also control for gender-specific birth spacing by including as controls the variable that measures age-difference between the girl and her nearest-age male sibling, and its interaction with a Gurkha dummy.

Across all our specifications in Table 4, the estimated impacts of an age-eligible male sibling on education for Gurkha girls are very similar in magnitude, and they are also similar to the simple mean difference-in-difference in Table 3. The robustness of the results to various ethnicity-specific controls underlines the internal validity of the identification strategy, and therefore, provides a plausibly causal impact on Gurkha girls of having an age-eligible male sibling. Based on our most rigorous specification (Column 4), having an age-eligible male sibling reduced the education of Gurkha girls living in the same household by 0.12 years (statistically significant at the 1% level). This net negative intrahousehold spillover effect is large and accounts for a 7.6% decline in education compared to the mean (1.585 years).

Table 5, Columns 1 and 2 examine the impact on two different margins of female education using the most rigorous specification (as in Column 4 of Table 4). Column 1 estimates the impact on Gurkha girls with an age-eligible male sibling on ever enrolling in school, while Column 2 examines the impact on their dropout rates. The results show that having an age-eligible male sibling reduced the probability of Gurkha girls to ever enroll in a formal school by 3.5 percentage points. This represents a 13.7% increase in the fraction of girls without any education, and the effect is statistically significant at the 5% level. On the other hand, the effect of having an age-eligible male sibling on dropout rates of Gurkha girls is close to zero, and this is also not statistically significantly different from zero. These results suggest that the negative spillover effect on female education is mainly due to a decrease in formal education rather than girls dropping out of school early.

Columns 3 and 4 examine the impacts on child labor outcomes. While these are important human development indicators in and of themselves, in the context of our results they could provide suggestive evidence of resource reallocation (across siblings) being the appropriate intervening mechanisms for the observed negative intrahousehold spillovers on education. In particular, we can examine the reallocation of non-monetary resources that mainly comprises of household members' labor time. We therefore focus on female child labor time spent on the household's economic activities.

Our results suggest that the change in selection criteria increased the fraction of Gurkha girls with an age-eligible male sibling who were working on a household farm and other household economic enterprise as their main activity by 1.4 percentage points. This is a 33.3% increase in the fraction of girls who are involved in economic activities. This effect is also statistically significant at the 1% level. In contrast, we do not observe any increase in the fraction of girls who performed household chores as their main activity. The lack of impact on household chores is perhaps not surprising, given such activities are predominately performed by girls, and therefore, the change in returns to education for boys is unlikely to elicit any reallocation in child labor time. These results suggest that Gurkha girls with an age-eligible male sibling reduced schooling, and reallocated their time towards farming and other economic activities; and suggests that labor requirements for agriculture and other household economic enterprise might be strictly binding for male and female members of the household. We further examine this reallocation of non-monetary household resources; and the question of how households allocate monetary resources later in this section.

Table 6 presents the results from the IV model described in equations (3) and (4). For this purpose, we restrict our sample to girls aged 6 to 12 years old, who have at least one male sibling. The endogenous variable of interest B_i measures the years of education of the nearest-age male sibling. Column 1 presents the first-stage results by estimating the coefficient λ'' in equation (4), with B_i as the dependent variable. In addition to the controls from our most rigourous specification, we include the nearest-age male sibling's age dummies, and also include ethnicity-specific linear cohort trends to allow for differential trajectory of male education for Gurkha and non-Gurkha ethnic groups.

Based on the first-stage IV results in Column 1, E_iXG_m predicts 0.380 more years of education for age-eligible Gurkha male siblings. More importantly, the estimate is statistically significant at the 1% level, and the F-statistic on E_iXG_m– the excluded instrument– on the first-stage regression is 7.832. This increase in education is assumed to be solely driven by the changes in educational requirement for the British Gurkha Army. It signifies a 12.7% increase relative to the mean education of male siblings, and it is in line with the positive impact found among age-eligible Gurkha men in Section 1, and that estimated by Shrestha (forthcoming).

Columns 2 presents the IV estimates of the impact of male sibling's education, which is instrumented by E_iXG_m, on female education. The IV result suggests that for each additional year of education completed by a male sibling, his female counterpart reduces her education by 0.394 years. The estimate is statistically significant at the 10% level. Additionally, the Anderson-Rubin test statistics (presented at the bottom of Column 2) suggest that the IV estimate is robust to the weak instrument bias.

In this context where intrahousehold spillovers are large and almost two-thirds of the age-eligible men tend to have at least one female sibling, the changes in educational requirement for British Gurkha Army that raised male education in Nepal might have had substantially negative impact on female education, and widen the gender gap. For instance, if all age-eligible Gurkha men of 6 to 12 years old cohort are assumed to have raised education by 0.380 years, then the rule change would improve the average male education in Nepal by 0.070 years.[17] Assuming that there is no impact on females beyond the intrahousehold spillover effects on Gurkha girls who have an age-eligible male sibling, the rule change would decrease the average female education of the 6 to 12 years old cohort by 0.014 years.[18] These results suggest a widening of the gender gap on education by 0.455 more years among the Gurkha ethnic group, and by 0.084 years overall–which is 31.0% increase over the mean gender gap for 6 to 12 years old cohort (0.271 years).[19]

These negative intrahousehold spillovers on education could be due to the household's decision to reallocate its resources from female to male children, given future migration prospects raised returns on male human capital investments. On the other hand, the changes introduced by the British Gurkha Army could have differentially affected preferences related to gender discrimination on child investments for Gurkha households with age-eligible men.

However, we do not observe impacts on the propensity of female household members to own their own property or land among Gurkha households with an age-eligible male in Table 2, Columns 6 and 7. If such female empowerment indicators are correlated with gender preferences, then it is unlikely that the negative intrahousehold spillovers can be explained by a change in preferences for non-market related gender discrimination.

In Table 7 we examine whether household resource constraints, in some part, drive the negative intrahousehold gender spillovers. In particular, we focus on two main types of resources: monetary that include expenditure on child education, and non-monetary that comprise of child labor time for household economic activities. In Table 5, we observed that

[17] In the 2001 Census data, 18.39% of boys aged 6 to 12 years old belong to the Gurkha ethnic group. Therefore, the average change in male education due to the rule change is given by 0.1839*0.380. For this analysis, we ignore any intrahousehold substitution between male siblings although similar spillovers estimated in this paper across gender are also likely to affect male siblings.

[18] Gurkha girls make up 18.94% of all girls between 6 and 12 years old; and among them, 62.78% have an age-eligible male sibling living in their household. Therefore, the average change in female education is 0.1894*0.6278*-0.121.

[19] In absence of any intrahousehold gender spillovers, the educational response from Gurkha boys of 6 to 12 years old cohort is expected to raise the average education by 0.04 years for this cohort. Taking into account the negative gender spillovers, the increase in average education for the cohort is 0.03 years.

Gurkha girls with an age-eligible male sibling decreased their education, while simultaneously increasing their time spent on household farms and economic enterprise. If child labor for household economic activities is one of the costs associated with investing in children's education, then the intrahousehold spillovers should be more severe for girls in agricultural households for whom such labor requirements are likely to be more binding. In Columns 2 and 4 of Table 7, we estimate the impact of an age-eligible male sibling on education of Gurkha girls differentially by whether a household is involved in its own agricultural production or not. The negative gender spillover on female education is higher for agricultural households relative to non-agricultural households. The difference between the two types of households are also statistically significant at the 5% level (and at the 10% level in Column 4).

In Columns 3 and 4, we estimate the intrahousehold spillover separately for households who are equal to or above the median wealth index and those that are below.[20] Given that monetary resources required for education investments are likely to be less binding for wealthier households, we should expect a lower propensity to reallocate resources away from female education; and a relatively more moderate intrahousehold substitution in wealthier households. The results in Columns 3 and 4 suggest that the estimated gender spillover on female education is mitigated by household wealth. This difference is statistically significant at the 1% level.

These differential results provide highly suggestive evidence that the changes in gender-specific educational returns led to a reallocation of monetary and non-monetary resources away from female to male children. This intrahousehold reallocation, which is partly due to resource constraints, helps account for the observed negative gender spillovers.

5 Conclusion

We find that an education based change in the selection criteria for the British Gurkha Army that raised migration prospects for relatively skilled Gurkha men led to an increase in male education in the source country. The increase in male education however comes at the expense of reduced human capital investments in their female siblings. The greater allocation of resources towards male children, who already had higher human capital endowments, could

[20]The correlation between agricultural household dummy and wealth dummy is -0.26.

have important intergenerational impacts for gender inequality.

Our quasi-experimental setting allows us to estimate the rate of substitution in human capital between male and female children within the household. Moreover, the differential effects on intrahousehold substitution by poorer and agricultural households suggest that the negative rate of substitution is due to a market-driven reallocation of resources. This interpretation is likely to be true as long as preferences for gender discrimination did not evolve differently following the rule change for these two types of households. Preferences for gender discrimination however have been shown to be be resistant to economic changes alone. While the persistence of culture and norms that underlie preferences for gender discrimination have been long recognized in the South Asian context (Das Gupta et al., 2003), such norms have also been shown to sticky more generally from one generation to the next and in the longer term (Abrevaya, 2009; Alesina et al., 2013). Therefore, this result on differential effects arguably demonstrates that resource poorer households respond more strongly to the market incentives to lower investments in female human capital. This finding that poverty, through liquidity constraints, can exacerbate the effect of biases against women is in line with similar findings in the literature (Jayachandran, 2015).

Migration has been shown to affect households' economic decisions-particularly those related to human capital investments on children- through positive income shocks due to remittances (Yang, 2008); and by changing the future employment opportunities of children that raise their expected returns to human capital investments (Chand and Clemens, 2008; Batista et al., 2012). Both the prospect of such migration and the departure of successful males could have spillover effects on women.

There is however very little evidence on these gender spillovers. While there is an emerging literature on the secondary impacts of migration on women in migrant households (Antman, 2013), there is much less evidence on the effect of the prospect migration on wider human capital investments in women in the source country. In this paper we find that any "brain gain" effects, which are associated with expected migration opportunities is likely to be restricted to male children when foreign jobs are accessible to only men; and that this could leave girls in already gender-unequal societies like Nepal further behind. Accounting for these negative spillovers is therefore important to better understand the effectiveness of international migration as a development policy.

Compliance with Ethical Standards:

Conflict of Interest: The authors declare that they have no conflict of interest.

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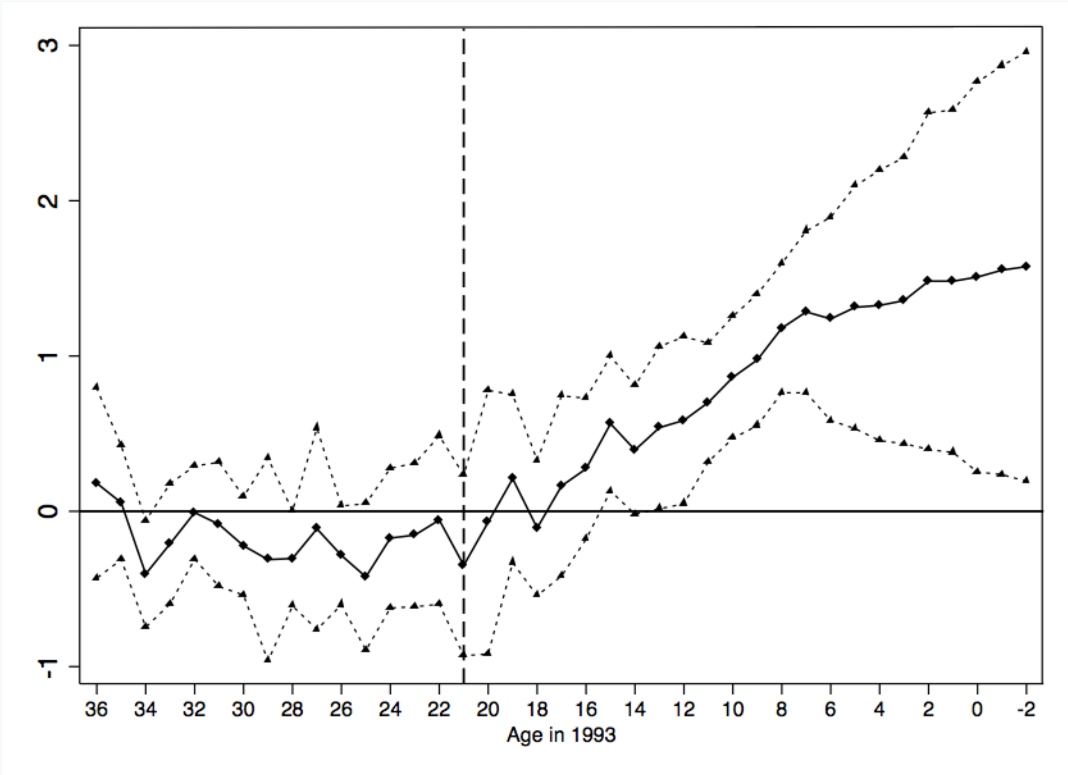
Figure 1: Effect on educational outcome of Gurkha men



Notes: The figure plots γ_xs in equation (1) with 95% confidence interval for $-2 \leq x \leq 36$.

Table 1: Descriptive statistics

	Whole Sample (1)	Gurkha (2)	Non-Gurkha (3)	P-value *(2)=(3)* (4)
Total sample	226,075	42,810	183,265	-
% of sample	-	18.94%	81.06%	-
Age *(in years)*	8.94	8.96	8.93	0.310
Rural birth	66.99%	79.35%	64.10%	0.021
Years of education	1.58	1.54	1.60	0.402
Currently enrolled	72.72%	74.80%	72.23%	0.541
Agriculture/Economic work	4.16%	5.36%	3.87%	0.203
Household chores	3.71%	1.85%	4.15%	0.926
Household size	6.61	6.48	6.64	0.615
Nuclear household	95.28%	96.01%	95.11%	0.434
Number of male sibling	1.04	1.05	1.03	0.209
Number of female sibling	0.95	1.00	0.94	0.981
Number of age-eligible male sibling	0.95	0.97	0.95	0.317
Age-eligible male sibling	63.04%	62.78%	63.10%	0.430
Male sibling living separately	5.17%	6.93%	4.76%	0.580
Female sibling living separately	9.81%	9.77%	9.82%	0.004
Male sibling's employment status	13.70%	14.58%	13.50%	0.650
Male sibling's years of education	2.99	2.85	3.03	0.512
Age difference w/ male sibling	3.74	3.72	3.74	0.635
Household head male	86.89%	83.75%	87.62%	0.024
Household head age *(in years)*	42.85	43.33	42.74	0.213
Household head years of education	2.81	1.80	3.05	0.042
Household wealth index	0.00	-0.05	0.01	0.773
Household owns agricultural land	76.36%	83.81%	74.62%	0.296
Household owns livestock	73.12%	82.08%	71.03%	0.845
Female member owns land	10.48%	9.26%	10.76%	0.257
Female member owns property	5.44%	4.82%	5.58%	0.327

Notes: Based on the 2001 Nepal Census.

Table 2: Test of endogenous correlation with household characteristics

	Household head characteristics			Household assets		Female ownership	
	Gender (1)	Age (2)	Education (3)	Wealth[a] (4)	Ag land (5)	Property (6)	Land (7)
E_i x G_m	-0.014	0.477	0.124	0.013	-0.004	-0.008	0.010
	(0.0159)	(0.4450)	(0.0886)	(0.0149)	(0.0075)	(0.0071)	(0.0123)
R-squared	0.112	0.113	0.242	0.445	0.366	0.058	0.079
Observations	226,075	226,075	226,075	226,075	226,075	226,075	226,075
Mean dep. var.	0.869	42.85	2.815	0.405	0.764	0.054	0.105

Notes: The table presents the estimates of λ in equation (2) using the most rigorous specification of Column 4, Table 4. This specification includes ethnicity dummies, ward of residence dummies, and E_i. It also includes age dummies, a rural birth dummy, any sibling dummy, any male sibling dummy, male sibling employment status dummy, age-eligible sibling dummy, age difference with male sibling variable, and their interactions with a Gurkha dummy. The standard errors are reported in parentheses and are adjusted for within-ethnicity correlation; *p<0.1, **p<0.05, ***p<0.01. [a] *Wealth* is a dummy variable indicating whether the household wealth index is above or equal to the median wealth index. The wealth index is constructed by taking a weighted mean across the standard distributions of four measures of housing quality and two measures of household asset: drinking water source, lighting source, cooking fuel source, the type of toilet, and the ownership of television and radio. The weights are calculated based on the first principal component.

Table 3: Mean female education by ethnicity and age-eligible male sibling

	Years of education		
	Gurkha	Non-Gurkha	Difference
No age-eligible male sibling	1.38	1.36	0.01
	(0.013)	(0.006)	(0.014)
Age-eligible male sibling	1.63	1.73	-0.10
	(0.010)	(0.005)	(0.012)
Difference	0.25	0.37	-0.12
	(0.017)	(0.009)	(0.020)

Notes: The table reports the average years of education completed as of 2001 for girls of Gurkha and non-Gurkha ethnic groups and those with and without an age-eligible male sibling in their household. The standard errors are reported in parentheses.

Table 4: Educational outcomes of Gurkha girls with an age-eligible male sibling

Dependent variable: Years of education	(1)	(2)	(3)	(4)
E_i x G_m	-0.079***	-0.141***	-0.126**	-0.121***
	(0.0234)	(0.0521)	(0.0584)	(0.0453)
Controls (and interactions with G_m):				
Sibling dummy	x	x	x	x
Male sibling dummy	-	x	x	x
Male sibling employment status	-	-	x	x
Age-eligible sibling dummy	-	-	-	x
Age difference w/ male sibling	-	-	-	x
R-squared	0.456	0.457	0.460	0.460
Observations	226,075	226,075	226,075	226,075
Mean dependent variable	1.585	1.585	1.585	1.585

Notes: The table presents the estimates of λ in equation (2). All specifications include E_i, ethnicity dummies, ward of residence dummies, age dummies and their interactions with Gurkha dummy, and rural birth dummy and its interaction with a Gurkha dummy. The standard errors are reported in parentheses and are adjusted for within-ethnicity correlation; *p<0.1, **p<0.05, ***p<0.01.

Table 5: Educational and labor outcomes of Gurkha girls with an age-eligible male sibling

Dependent variable:	Never enrolled (1)	Dropped out (2)	Ag/Economic work (3)	Household chores (4)
E_i x G_m	0.035**	-0.007	0.014***	0.001
	(0.0135)	(0.0046)	(0.0064)	(0.0073)
R-squared	0.274	0.030	0.171	0.148
Observations	226,075	226,075	226,075	226,075
Mean dependent variable	0.255	0.018	0.042	0.037

Notes: The table presents the estimates of λ in equation (2) using the most rigorous specification of Column 4, Table 4. The specification includes ethnicity dummies, ward of residence dummies, and E_i. It also includes age dummies, a rural birth dummy, any sibling dummy, any male sibling dummy, male sibling employment status dummy, age-eligible sibling dummy, and age difference with sibling variable, and their interactions with a Gurkha dummy. The standard errors are reported in parentheses and are adjusted for within-ethnicity correlation; *p<0.1, **p<0.05, ***p<0.01.

Table 6: Intrahousehold substitution between male and female educational investments

Dependent variable:	First stage B_i = Male sibling's years of education (1)	IV Y_{ilm} = Years of education (2)
E_i x G_m	0.380***	
	(0.1394)	
Male sibling's years of education (B_i)		-0.394*
		(0.2268)
First stage statistics:		
R-Squared		0.597
F-statistics		7.83
Probability > F		0.007
Weak instrument robust inference:		
P-value of Anderson-Rubin Test ($H_o : \lambda_i' = 0$)		0.042
Observations	147,004	147,004
Mean dependent variable	2.995	1.715

Notes: The IV model is predicted using the most rigorous specification of Column 4, Table 4. In addition, the above specifications also include nearest-age male sibling's age dummies, and age interacted with a Gurkha dummy. The standard errors are reported in parentheses and are adjusted for within-ethnicity correlation; *p<0.1, **p<0.05, ***p<0.01.

Table 7: Differential effects on Gurkha girls with an age-eligible male sibling

Dependent variable: Years of education	(1)	(2)	(3)	(4)
E_i x G_m	-0.121***	-0.061	-0.165**	-0.128**
	(0.0453)	(0.0614)	(0.0493)	(0.0583)
E_i x G_m x Ag^a		-0.085**		-0.039*
		(0.0285)		(0.0231)
E_i x G_m x $Wealth^b$			0.116***	0.102***
			(0.0234)	(0.0165)
P-value of F-test:				
E_i x G_m + E_i x G_m x Ag		0.004		0.001
E_i x G_m + E_i x G_m x $Wealth$			0.371	0.684
R-squared	0.460	0.466	0.466	0.466
Observations	226,075	226,075	226,075	226,075
Mean dependent variable	1.585	1.585	1.585	1.585

Notes: Column 1 reports the estimate from the most rigorous specification of Column 4, Table 4. In addition, the specifications in Columns 2-4 also include agricultural household dummy (Ag), above median wealth dummy ($Wealth$), and their interactions with a Gurkha dummy. The standard errors are reported in parentheses and are adjusted for within-ethnicity correlation; *p<0.1, **p<0.05, ***p<0.01. [a] Ag is a dummy variable indicating whether the household is involved in its own agricultural production, based on whether it owns agricultural plots and livestock. [b] $Wealth$ is a dummy indicating whether the household wealth index is above or equal to the median wealth index. The wealth index is constructed by taking a weighted mean across the standard distributions of four measures of housing quality and two measures of household assets: drinking water source, lighting source, cooking fuel source, the type of toilet, and the ownership of television and radio. The weights are calculated based on the first principal component.

A Appendix: Further Robustness Checks

Appendix Table A1 provides additional robustness checks for estimating the causal impact of having an age-eligible male sibling on Gurkha girl's years of education using the difference-in-difference estimation strategy described in Section 2.

In Column 1, we provide a falsification test where we estimate the impact on Gurkha girls of having a male sibling of older age-cohorts. We estimate equation (2) using our most rigorous specification from Column 4, Table 4. In addition to E_i and $E_i X G_m$, we also include a dummy variable for having a male sibling of 13 to 20 years old in 1993 and a dummy variable for a male sibling of 21 to 25 years old in 1993, and their interactions with a Gurkha dummy. The results from Column 1 suggest that having an age-eligible male sibling reduced Gurkha girl's education by 0.117 years. The estimate is statistically significant at the 5% level. In contrast, the estimated impacts on Gurkha girls of having a male sibling of 13 to 20 years old cohort, and of 21 to 25 years old cohort are close to zero (0.045 and -0.009 respectively) and both estimates are not statistically significant at conventional levels.

Column 2 estimates the coefficient λ in equation (2) by restricting the sample of girls to those who do not have more than one sibling. This allows us to estimate the impacts by comparing girls with the same number of siblings, and henceforth, the diff-in-diff estimate is not likely to be confounded by differential quantify-quality trade-offs due to different number of children (two versus more than two) between Gurkha and non-Gurkha households. In Column 3, we restrict the sample to girls who do not have any male sibling living separately; and in Column 4 we restrict the sample to households that do not have migrants in 2001. The estimates in Columns 2, 3, and 4 are -0.122, -0.199, and -0.132 respectively, and all three estimates are statistically significant at the 1% level.

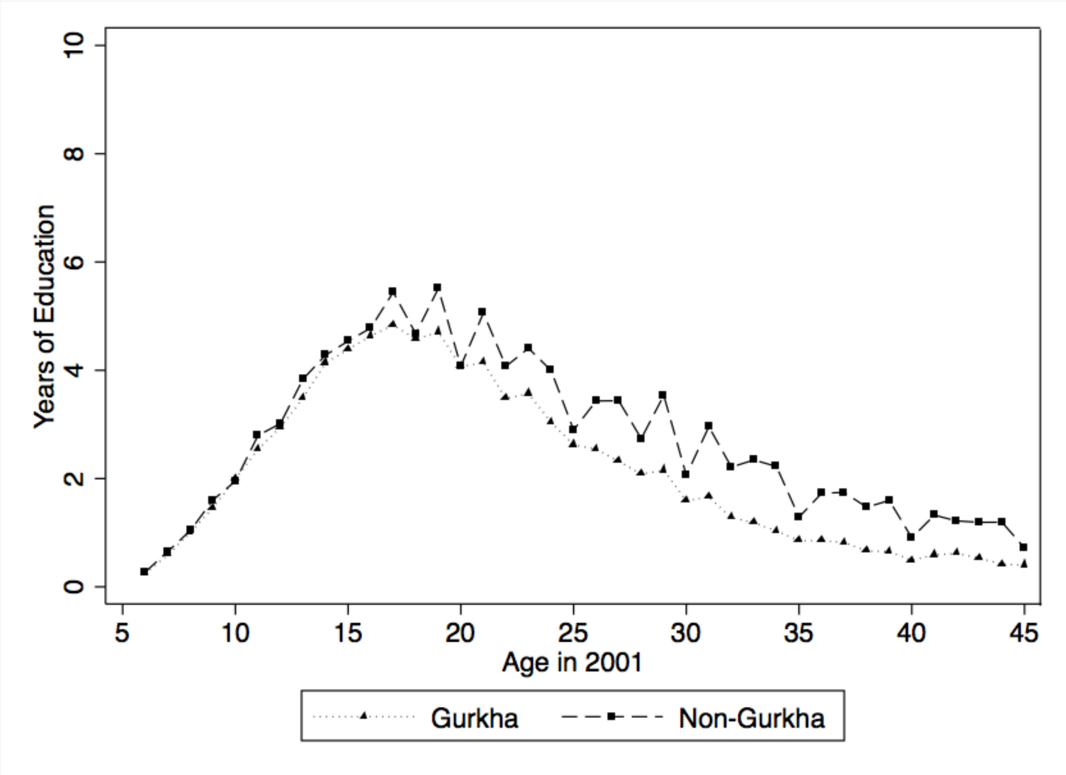
Lastly, we use an alternative definition to identify sibling relationships. In particular, we exclude cousins from the definition of siblings. In the 2001 Census data, we can identify brother- and sister-relationships for girls who are daughters of the head of the household. This provides us with the restricted sample of 195,593 girls. The result in Column 5 show that Gurkha girls who have an age-eligible male brother living in the household reduce education by 0.113 years, and the estimate is statistically significant at the 5% level. The results in the paper are therefore robust to the definition of sibling relationship.

Appendix Table A1: Educational outcomes of Gurkha girls with an age-eligible male sibling

		Restricted sample:			Own siblings[a]
Dependent variable: Years of education		0 or 1 male siblings	No male sibling living separately	No migrants	
	(1)	(2)	(3)	(4)	(5)
E_i x G_m	-0.117**	-0.122***	-0.199***	-0.132***	-0.113**
	(0.0512)	(0.0451)	(0.0529)	(0.0417)	(0.0527)
I(Male sibling aged 13-20) x G_m	0.045				
	(0.0469)				
I(Male sibling aged 21-25) x G_m	-0.009				
	(0.0649)				
R-squared	0.461	0.481	0.462	0.458	0.458
Observations	226,075	164,581	214,385	219,183	195,593
Mean dependent variable	1.585	1.548	1.581	1.572	1.592

Notes: The table presents the estimates of λ in equation (2) using the most rigorous specification of Column 4, Table 4. The specification includes ethnicity dummies, ward of residence dummies, and E_i. It also includes age dummies, a rural birth dummy, any sibling dummy, any male sibling dummy, male sibling employment status dummy, age-eligible sibling dummy, and age difference with sibling variable, and their interactions with a Gurkha dummy. The specification in Column 1 also includes male sibling aged 13-20 dummy, and male sibling aged 21-25 dummy. The standard errors are reported in parentheses and are adjusted for within-ethnicity correlation; *p<0.1, **p<0.05, ***p<0.01. [a]Sibling relationship variables including E_i, which is a dummy indicator for whether girl i has at least one age-eligible male sibling living in the household, are constructed based on girl i's own siblings, and cousins are excluded.

Appendix Figure A1: Mean female education by ethnicity and age



Notes: Based on 2001 Nepal Census.