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ORIGINAL RESEARCH

To What Extent Does the Fertility Rate Explain the Education Gap?

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Abstract
The theory of Quantity–Quality (Q–Q) trade-off suggests that given the resource constraints in a household, an increase in family size would result in lower investments in the human capital development of children. Following this theory, we investigate the role of fertility in explaining the educational gap between Muslims and Hindus in India. A historically large difference in the total fertility rates (TFR) between them, which is as high as 24% in 2015–2016, may have contributed to the existing gap in education. Using decomposition techniques, we find that family size accounts for about 10% of the gap in years of schooling between high-caste Hindus and Muslims. Examining the likelihood of completion of different levels of education, we find that the contribution of family size increases with the level of education, rising to 16% for secondary education. Upon further investigation, we find that the unmet need for family planning is higher for Muslim women than for Hindu women. Thus, appropriate supply side measures addressing these unmet needs may help to reduce the fertility gap, with the potential to reduce the education gap in due course. Additionally, with a comparatively higher desired fertility of Muslims on average, public investments in good-quality schooling, safer and cheaper transportation to schools, and general awareness initiatives about pecuniary and non-pecuniary benefits of schooling may reduce the Q–Q trade-off. This may weaken the association between fertility and education, which could go a long way in reducing the educational disadvantage of Muslim children.

Keywords Fertility · Education · Muslim · Quantity-quality trade-off · Decomposition · Oster bound · India

JEL Classification I24 · I25 · J13 · O15

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Introduction

India is a large diverse country with a population of about 1.3 billion that varies widely in terms of religion, caste, and socio-economic conditions. According to the 2011 population census, Muslims, constituting around 14% of the population, are the second largest religious group in India after Hindus, who comprise about 80% of the population. Muslims are the largest religious minority in India. Yet, with low education levels, high poverty, and low participation in government services and politics, they are one of the most marginalized groups in India (Government of India, 2006).

Despite their significant disadvantages in educational attainment and income, Muslims have lower infant and child mortality rates than other groups. The sex ratios (especially infant and child) are also better among Muslims as compared to their Hindu counterparts (Government of India, 2006). A preference for sons over daughters has resulted in higher levels of female infant mortality, sex-selective abortions, and rising male–female sex ratios amongst Hindus in India (Bhalotra & Cochrane, 2010; Borooah et al., 2009). While Muslim families in India are also embedded in strongly patriarchal systems with a preference for sons over daughters, religious beliefs make them less inclined towards abortions, infanticides or sex selection (Almond et al., 2009; Bhalotra & Cochrane, 2010). The combined effect of intrinsic son-preferring attitudes along with religious beliefs discouraging abortion and sex selection may lead to a higher number of births and increased family size among Muslims (Bhalotra et al., 2018; Borooah & Iyer, 2009). Moreover, the *minority status hypothesis* suggests that larger minority groups, such as Muslims in India, may choose higher fertility than the majority group as an insurance mechanism against the uncertainty and insecurity associated with the minority group status (Chabé-Ferret & Melindi Ghidi, 2013; Goldscheider & Uhlenberg, 1969). According to India's National Family Health Survey (NFHS) data, the Total Fertility Rate (TFR) of Muslims in 2015–2016 was 2.6, which was 24% higher than that of Hindus who had a TFR of 2.1.

While cultural values, religious affiliation, and group identity are important determinants of fertility (de la Croix & Delavallade, 2018; Fernandez & Fogli, 2009; Goldscheider & Uhlenberg, 1969), fertility, in turn, may influence investment in children's education. The Quantity–Quality (Q–Q) trade-off model of Becker and Lewis (1973) suggests that, given resource constraints at the household level, a larger family size would result in lower investment in the future of children. Therefore, driven by relatively higher TFR, larger family sizes among Muslims may result in lower investment in children's education compared to other groups.[1]

Accordingly, we explore the role of fertility differences between Hindu and Muslim women in explaining the gap in the educational attainment of their children. The

[1] There is a large body of literature that has empirically tested the Q–Q trade-off theses across several countries and found mixed results (discussed in more detail in the next section). However, Rosenzweig and Wolpin (1980), Kugler and Kumar (2017), and Azam and Saing (2018) find evidence of a Q–Q trade-off in India with respect to children's schooling.

fertility differences may lead to an education gap between Hindus and Muslims in two ways. One, with Muslim women having higher fertility than Hindu women on average, the Q–Q trade-off would reduce investment in the education of Muslim children on average. Two, the extent of trade-off for each additional child could also be higher for a Muslim even with a given family size. Together, these two processes may result in a Muslim family investing less in their children's education as compared to a Hindu family, the latter having fewer children and a lower amount of the Q–Q trade-off per additional child.

Given the limitations of data, we primarily focus on school education and use the educational attainment of children as a measure of educational investments. Moreover, as the Hindu society is composed of several castes with high inter-caste inequality, we compare Muslims separately with high-caste and low-caste Hindus. Our baseline estimates indicate a negative association between family size and educational attainment among all the groups.[2] However, the magnitude of this negative association is higher for Muslims as compared to Hindus. Therefore, while a larger family size on average among Muslims is associated with their lower educational attainment, the greater magnitude of the negative association between family size and educational attainment among Muslims suggests that each additional child accentuates their educational gap further.

Following Oaxaca (1973) and Blinder (1973), when we decompose the difference in education between high-caste Hindus and Muslims into explained and unexplained parts, we find that around 57% of the difference in total years of schooling between the two groups can be explained by socio-economic and demographic characteristics, with family size having a significant contribution of about 10%. On further investigation of the difference between the two groups at different levels of education, we find that the explanatory power of family size increases with the level of education, rising to 16% for secondary education. We find qualitatively similar results when we compare Muslims with low-caste Hindus. Our results support the theory of a Q–Q trade-off in educational investments and help in partially explaining the gaps in human capital development between the minority Muslim and majority Hindu castes in India. Our estimates are robust to time-variant (birth year-specific dummies), and time-invariant location-specific unobservable factors that could also affect educational participation. Additional specifications with location-specific time-trend do not seem to affect our findings either.

Our paper contributes to the literature examining the Q–Q trade-off in educational investment. The existing literature has focused on examining the relationship between fertility and education. We complement this literature by examining how Hindu–Muslim differentials in fertility explain the differentials in educational attainment across those groups. To the best of our knowledge, this is the first effort of its kind and uses a nationally representative sample. A growing body of empirical literature shows that religious affiliation plays an important role in fertility choices (e.g., Adsera, 2006; Berman et al., 2018; de la Croix & Delavallade, 2018; Heaton,

[2] We also compute the Oster (2016) bounds of these estimates to assess their sensitivity to omitted variables and find that the negative coefficient on family size is robust.

2011). We add to this literature by showing that religious identity also matters for the relationship between fertility and educational outcomes.

Our study has important policy implications. The NFHS data that we use in this study shows that unmet demand for family planning is significantly higher for Muslim women compared to Hindu women. Therefore, policymakers may focus on appropriate supply side measures to address these unmet family planning needs which may help reduce the fertility differential with potential to reduce the education gap in due course. Despite these supply side measures, there might still be differences in fertility rates across Hindus and Muslims as the desired number of children is higher among Muslims than Hindus. Moreover, even if the gap in fertility between the groups declines over time, the strength of the association between the additional child and educational investment may continue to be different across groups. Thus, policymakers also need to take steps to weaken the association between fertility and education. Our results show that the role of fertility in explaining the education gap between Hindus and Muslims increases with the level of education. This suggests that as the cost of education increases, the Q–Q trade-off becomes stronger. Therefore, public investments in good-quality schooling, or on safer cost-effective transportation to schools may reduce the cost of this trade-off. These are expected to weaken the association between fertility and education, which could go a long way in addressing the relative deprivation of Muslim children's education in India.

The rest of the paper is organized as follows. In Section "Conceptual framework, data and descriptive statistics", we elaborate on the analytical framework and the data we used along with descriptive statistics. In Section "Empirical strategy", we discuss in detail our empirical methodology. Section "Results" presents the findings of our analysis. Section "Potential concerns" discusses a few potential concerns, and Section "Concluding discussion and policy recommendations" concludes with a discussion on the implications of our findings and policy recommendations.

Conceptual Framework, Data and Descriptive Statistics

Conceptual Framework

In a country with imperfect credit markets, families find it difficult to smooth out consumption and resource allocation over time. Therefore, following Becker and Lewis's (1973) Quantity–Quality (Q–Q) trade-off thesis, a family with many children may face more resource constraints and invest less in each additional child than a family with fewer children. However, a well-functioning public education system, as available in developed or industrialized countries, may reduce the cost of this trade-off. By contrast, a lack of good public-school infrastructure in developing and low-income countries may accentuate this trade-off.

In line with the Q–Q trade-off theory, the empirical literature has found a strong negative correlation between family size and children's schooling (e.g., Hanushek, 1992; Iacovou, 2008). However, these correlations may not necessarily imply a causal link between child quantity and quality because both fertility and investment in children may be related to omitted variables, such as parental preferences or attitudes. Recognizing the potential endogeneity of fertility, a large body of empirical literature has tried to examine the causal impact of fertility on educational investments using instrumental variable strategy by relying on several instruments such as twin birth (e.g., Angrist et al., 2010; Black et al., 2005; Rosenzweig & Wolpin, 1980; Rosenzweig & Zhang, 2009), siblings' sex composition (e.g., Angrist et al., 2010; Conley & Glauber, 2006), sex of the first-born child (e.g., Kugler & Kumar, 2017; Lee, 2008), infertility (e.g., Bougma et al., 2015), miscarriages (e.g., Maralani, 2008) and timing of institutional changes in the One Child Policy in China (e.g., Qian, 2009; Zhong, 2017).

The empirical investigations in causal identification of the Q–Q trade-off provide mixed results. Several studies examining the validity of the Q–Q trade-off in the context of developed countries find no causal impact of family size on education (e.g., Angrist et al., 2010, in Israel; Black et al., 2005, in Norway; De Haan, 2010, in the United States and the Netherlands), which could be because of the well-functioning public education systems in such countries. However, some studies in developed countries support the Q–Q trade-off thesis and find negative effects of fertility on education (e.g., Goux & Maurin, 2005 in France; Lee, 2008 in South Korea). Even for developing countries, where the Q–Q trade-off is more likely to hold, the evidence on the causal effect of fertility on educational outcomes is inconclusive. While several studies find a negative causal impact of fertility on education, thereby providing support for a Q–Q trade-off (e.g., Bougma et al., 2015 in Burkina Faso, Li et al., 2008; Rosenzweig & Zhang, 2009 in China, Ponczek & Souza, 2012 in Brazil, Li et al., 2017 in 17 Asian and Latin American countries), some others find no evidence of a trade-off (e.g., Alidou & Verpoorten, 2019 in 34 countries in Sub Saharan Africa). Interestingly, some studies even find a positive effect of fertility on educational outcomes (e.g., Alidou & Verpoorten, 2019 for the sample of families with three or more children in Sub-Saharan Africa; McCarthy & Pearlman, 2022 in a sub-district in rural Bangladesh; Qian, 2009 for the sample of first-born children in China; Zhong, 2017 for the sample of rural areas in China). Such positive effects have been explained by potential economies of scale in raising children (Qian, 2009) or spillovers within the family (McCarthy & Pearlman, 2022). Thus, the causal evidence on the Q–Q trade-off varies greatly across country settings and samples.

In a country like India, the imperfections in credit markets and the lack of good-quality public schools are expected to support the Q–Q trade-off theory. Rosenzweig and Wolpin (1980), Kugler and Kumar (2017), and Azam and Saing (2018) examine the Q–Q trade-off in education for India. Using twin birth as an instrument for family size, Rosenzweig and Wolpin (1980) find a negative causal effect of family size on children's schooling. Kugler and Kumar (2017) use the sex of the first-born child as an instrument and find a similar result. Using Oster (2016) bound strategy, Azam and Saing (2018) also find support for a Q–Q trade-off for the outcomes of current enrollment and years of schooling. Building on these findings that provide evidence of a Q–Q trade-off in educational attainment in the Indian context, in this paper, we explore the extent to which fertility can explain the educational gaps between Hindu and Muslim children in India.

Since the primary outcome of our interest is investments in education up to the high school level, it is important to understand the Indian school education system, which is spread over twelve years and divided across four levels. The primary school consists of grades I to V (for 6–11-year-old cohort), middle school consists of grades VI to VIII (for 12–14-year-old cohort), the secondary school consists of grades IX and X (for 15–16-year-old cohort), and higher secondary school consists of grades XI and XII (for the 17–18-year-old cohort). Since the cost of primary education at public schools has been borne by either the state or the federal government for more than the last two decades, the Q–Q chain is expected to be weaker at the primary level of education. Similarly, the Q–Q trade-off is expected to be weaker at the middle level of education because the universalization of elementary education in 2010 has extended free public school up to grade VIII. However, despite the policies facilitating free public-school education up to middle school, many children still study in private schools or supplement their education with private expenditures on tuition and study materials, primarily due to concerns about the quality of public schools (ASER, 2017). Therefore, poor quality of education at public schools or poor access are expected to exacerbate the Q–Q trade-off as it enhances the cost of education.

Suppose the Q–Q trade-off in educational investments exists because an extra child constrains the family budget. In that case, as the cost of education increases with each level of education, the negative effects of the additional child on educational investments will be higher. This difference in Q–Q trade-off across different levels of education, if found, may intensify the role of fertility in explaining the education gap. Hence, with respect to this study, wherein we explain the educational gap by inter-group differences in fertility, we expect the role of fertility to be larger as the children move up the educational ladder.

Data

We use the National Family Health Survey (NFHS) data of India, a nationally representative household survey with villages being the Primary Sampling Units (PSU). This cross-section data is collected using the same format as the Demographic and Health Survey (DHS). With the first round of such data collected in the year 1992–1993, currently, there are four waves of this cross-sectional data available in the public domain. We use the most recent wave (NFHS 4) of the data collected in the year 2015–2016 (International Institute for Population Sciences, abbreviated as IIPS, and ICF, 2017). As NFHS is the largest sample survey, which collects details of the fertility history of women along with the educational information of their children, we find this data to be the most useful in the context of our study.

We use the sample of 5–17-year-old children from Hindu or Muslim households living across different states of India. We merge the files having details on household members with the one collecting details on the birth history of children born to 15–49-year-old surveyed women. The women's survey conducted on 15–49-year-old women detailing the birth history of each of her children also includes the details of health conditions of the women, their children, husbands, their health-seeking behavior, education, occupation, information capturing living standards, caste and religious affiliations, and several such household and individual level information of the women's households.

There are two types of information collected about the education of household members in the NFHS: (1) total years of completed education, which is asked to all household members, and (2) the level of currently studying grade, which is asked only to the currently studying 5–25-year-old members of the household. Throughout our study, we use the information on completed years of education rather than the currently studying grade because the former includes the dropped-out children as well. The maximum age of the women who are surveyed for the birth history module is 49 years. Therefore, we limit the children's sample to 17 years to ensure that we have information on the birth history, and hence fertility, of the mothers of all the children in our sample. Throughout the paper, we define family size for child *i* as the total number of children of child *i*'s mother.

The Government of India uses a few caste categories to identify the disadvantaged social groups. Those categories are used to generate a level playing field for the disadvantaged through different social schemes or programs. The most disadvantaged among them being the Scheduled Castes (SCs) and the Scheduled Tribes (STs) (mostly belonging to the Hindu religion), are used as a separate combined category throughout our study. Although the Other Backward Castes (OBCs) have been identified as another disadvantaged class, with respect to having a disadvantage in education, they are not far behind the other Hindu population or Hindu upper castes. So, following Bhalotra et al. (2010), throughout our study, we combine this Hindu OBC group with Hindu upper castes. It is worth mentioning here that a significant proportion of Muslim households are also listed as OBCs and can benefit from policies of positive discrimination available to this group.[3]

Therefore, for the purpose of our analysis, we restrict the sample to three socio-religious categories (SRCs) only: Hindu upper castes (HUC), Hindu lower castes (HLC), and Muslim households. The HUC comprises Hindu households with 'others,' or OBC, as selected caste affiliations. HLC consists of Hindu households having SC or ST as selected caste affiliations. Hence, we have a final sample of 4,59,650 children belonging to Hindu (including both HUC and HLC) and Muslim households only. Households with any other religious affiliation are not within the scope of this study primarily for two reasons: One, we are interested in exploring the gap between two major religious groups in India, as the share of other religious groups is insignificantly small in the total population. Two, the other minority religious groups do not exhibit such disadvantages as the Muslims do.

We would also like to add that following Bhalotra et al. (2010), we have combined the ST and SC of India as one single disadvantaged Hindu group (HLC) because this kind of categorisation does not affect our main research question, which is about exploring the importance of fertility in explaining the gap between the Indian Hindus and Muslims. The share of the ST population being very low in India, we could not engage in a meaningful discussion by disaggregating the HLC population further among different disadvantaged caste groups, such as the SC and ST. Rather, we stick to disaggregating only up to HUC and HLC, where sample size does not

[3] The policies of reservation for OBCs in higher education and employment domains are applicable to Muslims who have been recognized as OBCs.

Table 1 Descriptive statistics

	Full sample		Muslim		HLC		HUC	
	Mean	N	Mean	N	Mean	N	Mean	N
Total years of completed schooling	4.45	459,650	3.89	81,495	4.26	144,373	4.74	233,782
Primary school (5th std) completion dummy	0.87	235,107	0.77	40,144	0.85	72,059	0.90	122,904
Middle school (8th std) completion dummy	0.77	126,026	0.63	20,935	0.73	37,967	0.83	67,124
Secondary school (10th std) completion dummy	0.55	58,527	0.40	9,614	0.45	17,460	0.64	31,453
Family size	3.30	459,650	4.04	81,495	3.41	144,373	3.01	233,782
Age of child	10.79	459,650	10.66	81,495	10.68	144,373	10.89	233,782
Female dummy	0.48	459,650	0.49	81,495	0.48	144,373	0.47	233,782
Father's years of schooling	6.75	459,650	5.17	81,495	5.61	144,373	7.89	233,782
Mother's years of schooling	4.65	459,650	3.78	81,495	3.33	144,373	5.67	233,782
Rural dummy	0.69	459,650	0.57	81,495	0.79	144,373	0.68	233,782
Wealth quintile = poorest	0.24	459,650	0.21	81,495	0.37	144,373	0.18	233,782
Wealth quintile = poorer	0.22	459,650	0.22	81,495	0.25	144,373	0.20	233,782
Wealth quintile = middle	0.20	459,650	0.20	81,495	0.18	144,373	0.21	233,782
Wealth quintile = richer	0.18	459,650	0.21	81,495	0.12	144,373	0.21	233,782
Wealth quintile = richest	0.16	459,650	0.15	81,495	0.07	144,373	0.21	233,782

Weighted by NFHS survey weights

HUC Hindu Upper Caste, *HLC* Hindu Lower Caste

restrict our findings. Nevertheless, we also replicate our primary specifications in a disaggregated setting (where SC and ST are studied as separate groups). Our findings remain unchanged even with further disaggregation (Appendix Table A10).

Descriptive Statistics

Table 1 indicates that our sample of children has completed 4.45 years of schooling on average, in which HUC and HLC completed about 4.74 and 4.26 years, respectively, whereas Muslim children completed about 3.89 years of schooling. As we further decompose the total years of school completion, a consistent gap emerges between Muslim children and HUC or HLC at almost all levels of education. Between 85 and 90% of the HUC and HLC children complete primary school as compared to 77% of Muslim children. As expected, the hierarchy gets even clearer when we look at the completion of middle school, where the gap in completion between HUC and HLC is quantitatively similar to the gap between HLC and Muslim, with HLC being positioned in the middle.

The two most important observations here are: one, the moment the free public school system is over at the end of middle school, the dropout increases significantly among all groups, but more so for HLC (where the participation in secondary education drops by 28 percentage points) and the Muslims (where the participation in secondary education drops by 23 percentage points), as compared to the HUC (where the participation in secondary education drops by 19 percentage points). Two, the hierarchy in school participation of these three groups gets reversed when we rank them by average family size. The average family size for Muslim, HLC or HUC children in our sample is 4.04, 3.41, and 3.01, respectively.[4]

The low levels of education in HLC or Muslim samples seem to have continued from the previous generation, as indicated by the average years of schooling of parents within these groups. However, the gap between the mother's and father's education is not significantly different in the sample of these young children indicating a similar pattern of assortative matching in all groups.

Appendix Table A1 presents the completion rates of each level of education for the three SRCs and the gap between them at each level. The difference with Muslims in educational completion rates is higher when they are compared with HUC (12.5, 19.3, and 24.3 percentage points lower completion rates for the primary, middle and secondary levels respectively), as against being compared to HLC (7.6, 9.3, and 5.2 percentage points lower completion rates for the primary, middle and secondary levels respectively). While comparing Muslims to the HUC, the difference in educational completion keeps increasing monotonically with the level of education.

Table 2 presents the completion rates at different levels of education by family size and SRCs. The difference in educational completion rates between Muslims and HUC increases with larger family size for almost all levels of education. However, an interesting pattern emerges as we look into the Muslim-HLC differentials, with a small HLC advantage. The difference increases moderately with family size until middle school (when public school is free). For a family size of five and more, the difference gets significantly higher (with 10.2 percentage points higher participation of HLC in middle school).

For secondary education, when public school is not free anymore, Muslims seem to have an advantage over HLC for a family size below five. It may indicate that among Muslims, whoever survives in the education system till that point, is economically better off. For them, the Q–Q trade-off may not be a factor for families with average size. Still, beyond that, a family size of five generates further disadvantages even among Muslims, as compared to the HLC. This may appear to be inconsistent with the averages reported in Table 1 for the whole sample (i.e., across all family sizes), where the secondary school completion rate is lower for Muslims as compared to HLC. However, it is important to note that the share of Muslim children with family size more than or equal to five is much higher (35.78%) than that for HLC children (22.06%). Accordingly, the average secondary school completion

[4] In this respect it is important to note that the average family size computed above is higher than the national level TFR mentioned in the introduction earlier because our working sample consists of a sample of *children*. For women with more children, there are multiple child observations in our sample, but for those with no children, there are no child observations in our sample. As such, a higher average value of family size variable in our sample of children is expected.

Table 2 Educational completion rates by community and family size

Family size	Primary	Middle	Secondary
≤ 2			
Muslim	90.0	82.0	61.0
HLC	92.3	85.0	60.8
HUC	94.4	90.4	79.2
3			
Muslim	85.6	77.2	54.6
HLC	88.0	77.7	50.1
HUC	90.9	84.9	64.6
4			
Muslim	80.2	67.9	42.0
HLC	83.9	69.1	39.6
HUC	87.1	76.9	52.3
≥ 5			
Muslim	66.2	46.9	24.8
HLC	74.6	57.1	28.5
HUC	80.2	66.2	41.8

Weighted by NFHS survey weights

HUC Hindu Upper Caste, *HLC* Hindu Lower Caste

HLC-Muslim not significant for—Middle & FS = 3; Middle & FS = 4; Secondary & FS ≤ 2. Other differentials are significant at 5% level

rate across the whole sample is lower for Muslim children as compared to HLC because of the much higher share of children with family size more than or equal to five for Muslims as compared to HLC.

At higher levels of education, HLC may face more constraints as compared to Muslims because only about 57% of the latter stay in rural areas as compared to 79% of the former. However, Table 2 clearly highlights the importance of family size in educational investment, and we explore that further in the next section.

Empirical Strategy

We decompose the variation in the educational participation between explained and unexplained parts for two reasons: first, to understand how much of the differential educational participation is explained by our specified model; second, to explore further among the explained variations, how much is due to the differential effects of family size between Muslims and each of the other Hindu groups. We use the Blinder–Oaxaca Decomposition method (Blinder, 1973; Oaxaca, 1973) to decompose the mean differences in total years of completed schooling between Hindus and Muslims. This procedure divides the schooling differential between two groups into a part that can be explained by differences in observable demographic and socio-economic characteristics across the two groups, and a residual part that cannot be explained by such differences in determinants of schooling. For this purpose, we first estimate the following linear model for each of the three groups:

$$Y_i^J = X_i^J \beta^J + u_i^J \tag{1}$$

Y_i^J is the total years of completed schooling of child i of group J (J=Muslims, HUC, or HLC). The vector X_i^J contains family size, gender of the child, mother's and father's years of schooling, rural/urban location of the household, dummies indicating the wealth quintile of the households, birth cohort dummies and district dummies. The birth cohort dummies control for the time-variant unobservable factors,[5] while the district dummies control for time-invariant state-specific unobservable (e.g. developmental) factors that might influence educational attainment of children. β^J is the vector of parameters to be estimated for each group J, and u_i^J is the error term. We can decompose the predicted differentials in total years of schooling between Hindus (either HUC or HLC) and Muslims using the coefficient estimates from (1) as follows:

$$\overline{Y}^H - \overline{Y}^M = \left(\overline{X}^H - \overline{X}^M\right)\hat{\beta}^H + \overline{X}^M(\hat{\beta}^H - \hat{\beta}^M) \tag{2}$$

with H indexing Hindus (either HUC or HLC in separate specifications) and M indexing Muslims. $\overline{Y}^J$ ($J=H$ and M) is the average years of schooling for J, $\overline{X}^J$ includes the mean values of the explanatory variables used in the linear regression, and $\hat{\beta}^J$ contains the estimated coefficients for each group in J. The first term on the right-hand side of Eq. (2) represents the schooling differential that can be attributed to the different characteristics of the two groups with their responses being benchmarked by the parameters of the Hindu equation, $\hat{\beta}^H$. It is an estimate of the extent to which the gap between Hindus and Muslims will close if the latter were assigned the characteristics of the former. We can also estimate this term with the parameters set equal to $\hat{\beta}^M$ for both groups. We present estimates using both benchmarks. The second term in Eq. (2) represents the residual or unexplained variation in schooling between the two groups. This may be interpreted as reflecting either structural discrimination, differential access to 'good quality' schooling for different SRCs,[6] or group-specific attitudes, cultural norms, discount rates, returns to education, or any other omitted factors.

The characteristic effect can be further decomposed into contributions of individual predictors or sets of predictors. For the decomposition in Eq. (2), the explained part can be expressed as:

$$\left(\overline{X}^H - \overline{X}^M\right)\hat{\beta}^H = \left(\overline{X}_1^H - \overline{X}_1^M\right)\hat{\beta}_1^H + \left(\overline{X}_2^H - \overline{X}_2^M\right)\hat{\beta}_2^H + \dots \tag{3}$$

[5] We create the birth cohort dummies from the child's age variable in NFHS.

[6] The general access to schooling is accounted for in our estimates while we use district fixed effects (or PSU fixed effects for robustness, presented in Table A4).

where $\overline{X}_1, \overline{X}_2, \ldots$ are the means of the single regressors and $\hat{\beta}_1$, $\hat{\beta}_2, \ldots$. are the associated coefficients. The first term reflects the contribution of the group differences in $\overline{X}_1$, the second of group differences in $\overline{X}_2$, and so on.

In addition to the total years of completed schooling, we also decompose the differences in primary school completion (grade V), middle school completion (grade VIII), and secondary school completion (grade X) across Hindus and Muslims using the standard Blinder-Oaxaca decomposition method as explained above. However, as primary, middle and secondary school completion are binary variables (completed the specific level of schooling = 1, else = 0), we also check the decomposition results for a non-linear version of the Blinder–Oaxaca technique described in Fairlie (2006). This decomposition uses a logit model and then decomposes the predicted differentials in school completion rates between Hindus and Muslims. Our conclusion remains robust to change of method. The details on this non-linear decomposition method as well as the results are provided in Appendix Section B. Throughout our main specification, we use OLS technique for all our estimations.

One potential concern in this analysis is that the family size is not exogenous. While we acknowledge the fact that we are unable to establish any causal association between the family size and education without addressing the endogeneity of family size,[7] following Oster (2016), we also present upper and lower bounds of the coefficients. This is explained in the last part of the next section, where we present the results of the bound analysis, validating the negative association between family size and participation in education.

Moreover, even if we are unable to establish a causal impact, our work estimates the importance of family size in educational investment. We argue that an awareness is required about the role of family size if we happen to find any evidence of a Q–Q trade-off in educational investments, and that may help in reducing the gap in educational investments. Additionally, our specification is expected to control for some of the major sources of endogeneity. The demand for education being strongly associated with parent's education, throughout all our specifications, we control for father's and mother's education. The major determinants of education on the supply side being access, the robustness of our different location-specific fixed effects models (including village fixed effects, or district fixed effects, or state-fixed effects, or

[7] It is also important to note that the widely used methods in the Q–Q trade-off literature for addressing this endogeneity—using the sex of the first born child (Kugler & Kumar, 2017; Lee, 2008) or twin births (Angrist et al., 2010; Black et al., 2005; Rosenzweig & Zang, 2009) as instruments for fertility—seem to be problematic in recent times due to the unauthorized usage of sex-selection methods and the introduction of newly assisted fertilization techniques in India. For a more detailed discussion on the issues with this strand of literature using instruments, one may refer to Bhalotra and Clarke (2016) and Anukriti et al. (2018). Using NFHS 4 data, we do find a significant association between the socio-economic conditions of mothers and the likelihood of twin birth or sex of firstborn, questioning the validity of the instruments in recent years. To save space, we do not report those results, but those are available with authors on request. However, for the interests of the readers in general, in appendix Table A15, we report our estimates of the effects of fertility on educational outcomes using twin birth as an instrument and find a significant negative effect of family size on years of schooling for Muslim children, but no significant effect for HUC or HLC children.

state-age specific Z-scores), addresses that concern to some extent. We discuss some of these potential associations in the next section.

Results

Importance of Family Size Within Each Group

Appendix Tables A2 and A3 indicate that conditioning on individual and household level observables, birth year fixed effects and district-specific time-invariant unobservables, family size has a significant negative association with the educational participation of all the SRCs. Our OLS estimates from baseline specification (1) presented in the first three columns of Table A2 report that having one additional child in the family is associated with 0.08 years, 0.10 years, and 0.11 years of less schooling among HUC, HLC, and Muslim children, respectively. Also, the OLS estimates for completion of different levels of schooling suggest that an additional child in a HUC family is associated with about 1.3, 2.4, and 3 percentage points reduction in the likelihood of completing primary (column 4 of Table A2), middle (column 1 of Table A3) and secondary education (column 4 of Table A3) respectively. For Muslims, an additional child reduces the likelihood of completing primary, middle, and secondary schools by 2.2, 3.3, and 2.7 percentage points, respectively. Apart from the family size, the father's and mother's years of education seem to have significantly positive association with the educational participation of children at all levels among all the SRCs.

To check for robustness, in a separate specification (Table A11), we also control for the father's and mother's age, but our estimates do not change much. Since the birth order of a child is also expected to affect educational outcomes, one would be inclined to control for that, but just because birth order is expected to be strongly associated with family size, as higher birth order children are expected to reside in large families, we do not control for that. Throughout all our analyses, we correct for heteroscedasticity by clustering standard errors at the state level. However, our findings are robust to clustering standard errors at district levels too (the results are available with authors).

Blinder-Oaxaca Decomposition of Total Years of Schooling

In Table 3, we present the detailed decomposition results of the difference in the total years of completed schooling following Blinder–Oaxaca. The left-hand side panel presents the results comparing Muslims with HUC, and the right-hand side panel presents the comparisons of Muslims with HLC. In either of the panels, we are primarily interested in estimates where corresponding Hindu parameters are used as benchmarks because we are exploring the disadvantages faced by the Muslims with respect to the potentially more advantaged groups. However, within each comparison group, we also report estimates using Muslim parameters as a benchmark.

Table 3 Blinder–Oaxaca decomposition of Hindu–Muslim differential in total years of completed schooling

Total years of completed schooling (sample: 5–17 years old)

Benchmark[#]	Hindu Upper Caste/Muslim ($N=315{,}277$)						Hindu Lower Caste/Muslim ($N=225{,}868$)					
	HUC ($N=233{,}782$) (1)			Muslim ($N=81{,}495$) (2)			HLC ($N=144{,}373$) (3)			Muslim ($N=81{,}495$) (4)		
	years	% of $(\overline{Y}^H - \overline{Y}^M)$	z-stat	years	% of $(\overline{Y}^H - \overline{Y}^M)$	z-stat	years	% of $(\overline{Y}^H - \overline{Y}^M)$	z-stat	years	% of $(\overline{Y}^H - \overline{Y}^M)$	z-stat
$\overline{Y}^H - \overline{Y}^M$	0.853	100	7.07	0.853	100	7.07	0.370	100	2.66	0.370	100	2.66
Explained	0.482	56.5	6.24	0.627	73.5	6.85	0.067	18.1	0.64	0.181	48.9	1.71
Unexplained	0.371	43.5	3.20	0.226	26.5	2.77	0.303	81.9	2.85	0.189	51.1	3.19
Detailed contributions												
Family size	0.081	9.6	5.75	0.110	12.9	7.07	0.061	16.5	4.41	0.067	18.0	4.73
Female	− 0.001	− 0.1	− 3.09	− 0.002	− 0.3	− 2.74	− 0.0004	-0.1	− 1.3	− 0.001	− 0.2	− 1.44
Father's education	0.090	10.5	4.15	0.139	16.3	3.77	0.019	5.0	1.09	0.022	6.0	1.07
Mother's education	0.015	1.8	3.09	0.023	2.7	2.09	0.000	0.0	− 0.01	− 0.005	− 1.5	− 0.99
Rural	0.014	1.6	1.98	0.023	2.7	1.93	0.052	14.2	2.95	0.047	12.8	2.91
Wealth quintile	0.018	2.1	0.96	0.033	3.9	1.00	− 0.099	− 26.6	− 3.75	− 0.131	− 35.3	− 3.62
Birth year	0.204	23.9	5.09	0.174	20.4	5.02	0.018	5.0	0.5	0.018	4.8	0.52
District	0.061	7.2	1.30	0.127	14.8	2.03	0.016	4.2	0.28	0.164	44.2	2.57

z-statistics based on standard errors clustered at state-level. All decompositions weighted by NFHS survey weights

HUC Hindu Upper Caste, *HLC* Hindu Lower Caste

[#]Benchmark represents the group whose parameters (i.e. $\widehat{\beta}$) are used for the decomposition. In panel on the left side, which represents the decomposition of differentials between HUC and Muslim children, decomposition (1) uses the parameters of HUC equation (i.e. $\widehat{\beta}^{HUC}$), while decomposition (2) uses the parameters of Muslim equation (i.e., $\widehat{\beta}^{M}$) for the decomposition. In panel on the right side, which represents the decomposition of differentials between HLC and Muslim children, decomposition (3) uses the parameters of HLC equation (i.e. $\widehat{\beta}^{HLC}$), while decomposition (4) uses the parameters of Muslim equation (i.e., $\widehat{\beta}^{M}$) for the decomposition

Muslims versus HUC

We notice a HUC advantage of 0.85 years on average over Muslims in total years of completed schooling. Out of this, about 0.48 years are due to the difference in average characteristics, explaining about 57% of the total difference. About 10% of that is explained by the differential family size, and 10.5% is explained by the father's education. These are the two primary covariates that explain most of the gap in educational participation between groups. The contributions of other explanatory variables are either much lesser in size or statistically insignificant.[8]

While 57% of the HUC advantage over Muslims in years of schooling can be explained by different characteristics of these two groups, 43% of the total difference remains unexplained. This unexplained disadvantage faced by Muslim children is quite large and could reflect group-specific attitudes towards education, discount rates, returns to education, or structural discrimination.

Muslims versus HLC

The differences in educational attainment between Muslims and HLC are much less as expected, with the Muslims having 0.37 years less education and only about 0.07 years (which is about 18%) of the total difference is explained by our model. This is primarily because of the disadvantages faced by the HLC, which includes Hindu SCs and STs, who have been identified as socially disadvantaged groups by the Government of India. However, even then the contribution of family size is higher, which is about 17% of the total difference. Interestingly, none of the other household level covariates seem to have significant explanatory power, and staying in rural areas seems to generate a significant differential impact with 14% explanatory power of the differential participation.

As we noted earlier, fertility could be endogenous to a family. If the nature or the potential source of endogeneity has differential impact on educational investment between Muslim and Hindu families and we are unable to account for that difference, then estimates of education gap explained by fertility would be biased. Other than location of residence, one primary source of endogeneity is expected to arise from the educational backgrounds of parents. Highly educated parents are expected to invest more on children; whereas, they are expected to engage more on family planning and fertility control methods. Hence, if we do not account for the

[8] The contribution of birth year in explaining the difference between HUC and Muslims in Table 3 is 24 percent, which suggests that the age composition of children in high Hindu castes is different from that of Muslims. While the average age of children from these groups as reported in Table 1 (10.66 for Muslims vs 10.89 for HUC) may seem similar, the difference between them however is statistically significant. To explore this further, as we tabulate the percentage of sample by age for each group (available with authors on request), we notice a difference in age distribution of sample across groups. Younger children are present in higher share among HLC and Muslims as compared to HUC, and that is reflected in the contribution of birth year for HUC versus Muslim decomposition. Further note that when we take age-appropriate education (primary, middle secondary), the contribution of birth year falls as it should.

difference in parent's education, then the association between fertility and educational investment of the children could be upward biased.

However, all our estimates of associations between fertility and education investments of children being conditional on parents' education, we do not expect parents' education to be a major source of the endogeneity. As expected, the full model results of OLS estimates (as presented in columns 1–3 of Table A2) indicate that on average, one additional year of schooling of father (mother) increases the likelihood of child's schooling by 0.03 (0.008), 0.04 (0.0001) and 0.05 (0.012) years for HUC, HLC and Muslims, respectively. The decomposition presented in Table 3 indicates that father's (mother's) education can explain about 10.5% (1.8%) of the explained gap in children's education between the HUC and the Muslims. However, the explanatory power of father's or mother's education is not very high while explaining the gap between the Muslims and the HLC.

Blinder–Oaxaca Decomposition of Completion of Primary, Middle and Secondary Education

In panels A, B, and C of Table 4, we present the detailed contributions of the explanatory variables for the completion of primary, middle and secondary education levels, respectively.

Muslims versus HUC

In completion of primary education, as presented in panel A of Table 4, the difference in average characteristics between the Muslims and the HUC predicts a Muslim disadvantage of 3.8%-points, out of a total disadvantage of 12.5%-points. Thus, only around 30% of the difference is explained by differential characteristics between Muslims and HUC. Here too, the difference in average family size is able to predict the bulk of this differential (1.4%-points, or about 11.5% of the total differential), whereas, father's education being the second most important factor, seems to explain about 1.3%-points (or 10.6%) of the differential participation. None of the other factors has explanatory power as high as these two.

The total disadvantage of Muslim children increases to 19.3%-points when we consider participation in middle school, as presented in panel B of Table 4. The difference in average characteristics explains about 9.2%-points (47.4%) of the disadvantage to Muslims. The family size predicts about 2.9%-points (14.9%) of the Muslim disadvantage in middle school. As found in the case of primary education, the second highest difference is generated by the differential characteristics in father's education, which predicts about 2.5%-points (13.1%) of the differential participation. It is interesting to note that the average characteristics of father's and mother's education can explain the Muslim disadvantage more as one moves to higher levels of education. This indicates the presence of an inter-generational gap in education with the disadvantaged groups, as parent's education is found to be highly significant in predicting children's education (Basant & Sen, 2014), and it is possible that the inter-group difference in parents' education perpetuates to the next generation.

Table 4 Blinder–Oaxaca decomposition of Hindu–Muslim differential in completion of education by level

Panel A: primary school completion (sample: 11–17 years old)												
Benchmark	Hindu Upper Caste/Muslim (N=163,048)						Hindu Lower Caste/Muslim (N=112,203)					
	HUC (N=122,904) (1)			Muslim (N=40,144) (2)			HLC (N=72,059) (3)			Muslim (N=40,144) (4)		
	%-points	% of $(\overline{Y}^H - \overline{Y}^M)$	z-stat	%-points	% of $(\overline{Y}^H - \overline{Y}^M)$	z-stat	%-points	% of $(\overline{Y}^H - \overline{Y}^M)$	z-stat	%-points	% of $(\overline{Y}^H - \overline{Y}^M)$	z-stat
$\overline{Y}^H - \overline{Y}^M$	12.54	100	5.09	12.54	100	5.09	7.61	100	2.81	7.61	100	2.81
Explained	3.75	29.9	3.51	9.21	73.4	5.66	1.44	18.9	1.02	2.86	37.5	1.59
Unexplained	8.79	70.1	4.02	3.34	26.6	1.81	6.17	81.1	2.93	4.75	62.5	3.4
Detailed contributions												
Family size	1.44	11.5	4.41	2.46	19.6	5.58	1.27	16.7	3.65	1.52	20.0	4.19
Female	− 0.03	− 0.2	− 3.02	− 0.08	− 0.7	− 2.96	− 0.01	− 0.1	− 0.98	− 0.04	− 0.5	− 1.89
Father's education	1.33	10.6	3.63	2.57	20.5	3.29	0.22	2.8	0.72	0.28	3.7	0.71
Mother's education	0.34	2.7	3.13	0.92	7.3	3.01	− 0.17	− 2.2	− 1.41	− 0.31	− 4.1	− 1.39
Rural	0.35	2.8	2.31	0.51	4.0	2.07	1.29	16.9	3.26	0.96	12.6	2.94
Wealth quintile	0.13	1.1	0.43	0.40	3.2	0.57	− 1.57	− 20.7	− 3.47	− 2.87	− 37.7	− 3.55
Birth year	0.36	2.9	2.92	0.49	3.9	3.38	0.09	1.2	0.85	0.13	1.7	0.95
District	− 0.18	− 1.4	− 0.21	1.94	15.5	1.56	0.32	4.1	0.33	3.2	42.0	2.57
Panel B: Middle School Completion (Sample: 14–17 years old)												
Benchmark	Hindu Upper Caste/Muslim (N=88,059)						Hindu Lower Caste/Muslim (N=58,902)					
	HUC (N=67,124) (1)			Muslim (N=20,935) (2)			HLC (N=37,967) (3)			Muslim (N=20,935) (4)		
	%-points	% of $(\overline{Y}^H - \overline{Y}^M)$	z-stat	%-points	% of $(\overline{Y}^H - \overline{Y}^M)$	z-stat	%-points	% of $(\overline{Y}^H - \overline{Y}^M)$	z-stat	%-points	% of $(\overline{Y}^H - \overline{Y}^M)$	z-stat
$\overline{Y}^H - \overline{Y}^M$	19.30	100	6.16	19.30	100	6.16	9.23	100	2.75	9.23	100	2.75
Explained	9.16	47.4	5.95	13.35	69.2	5.29	2.18	23.6	0.91	2.57	27.9	0.93
Unexplained	10.14	52.6	3.65	5.95	30.8	3.14	7.05	76.4	3.23	6.66	72.1	5.65

Table 4 (continued)

Panel B: Middle School Completion (Sample: 14–17 years old)												
Benchmark	Hindu Upper Caste/Muslim ($N=88,059$)						Hindu Lower Caste/Muslim ($N=58,902$)					
	HUC ($N=67,124$) (1)			Muslim ($N=20,935$) (2)			HLC ($N=37,967$) (3)			Muslim ($N=20,935$) (4)		
	%-points	% of $(\overline{Y}^H - \overline{Y}^M)$	z-stat	%-points	% of $(\overline{Y}^H - \overline{Y}^M)$	z-stat	%-points	% of $(\overline{Y}^H - \overline{Y}^M)$	z-stat	%-points	% of $(\overline{Y}^H - \overline{Y}^M)$	z-stat
Detailed contributions												
Family size	2.87	14.9	7.52	3.95	20.4	8.27	2.42	26.2	4.45	2.48	26.9	4.95
Female	− 0.05	− 0.2	− 2.44	− 0.15	− 0.8	− 2.29	− 0.07	− 0.7	− 1.93	− 0.13	− 1.4	− 1.93
Father's education	2.54	13.1	4.19	3.70	19.2	4.34	0.28	3.0	0.58	0.33	3.6	0.58
Mother's education	0.65	3.4	4.03	1.76	9.1	4.2	− 0.35	− 3.8	− 1.53	− 0.67	− 7.2	− 1.56
Rural	0.60	3.1	2.32	0.79	4.1	2.09	1.91	20.7	3.47	1.45	15.8	2.9
Wealth quintile	0.31	1.6	0.45	0.60	3.1	0.52	− 3.57	− 38.7	− 4.01	− 4.68	− 50.8	− 4.14
Birth year	0.44	2.3	3.36	0.44	2.3	3.64	0.36	3.9	2.4	0.34	3.7	2.51
District	1.80	9.3	1.59	2.26	11.7	1.47	1.21	13.1	0.96	3.45	37.4	2.34
Panel C: Secondary School Completion (Sample: 16–17 years old)												
Benchmark	Hindu Upper Caste/Muslim ($N=41,067$)						Hindu Lower Caste/Muslim ($N=27,074$)					
	HUC ($N=31,453$) (1)			Muslim ($N=9,614$) (2)			HLC ($N=17,460$) (3)			Muslim ($N=9,614$) (4)		
	%-points	% of $(\overline{Y}^H - \overline{Y}^M)$	z-stat	%-points	% of $(\overline{Y}^H - \overline{Y}^M)$	z-stat	%-points	% of $(\overline{Y}^H - \overline{Y}^M)$	z-stat	%-points	% of $(\overline{Y}^H - \overline{Y}^M)$	z-stat
$\overline{Y}^H - \overline{Y}^M$	24.25	100	6.83	24.25	100	6.83	5.12	100	1.30	5.12	100	1.3
Explained	13.80	56.9	3.69	11.40	47.0	3.08	2.43	47.4	0.55	− 1.89	− 36.8	− 0.43
Unexplained	10.45	43.1	3.60	12.85	53.0	7.34	2.69	52.6	0.90	7.00	136.8	3.74
Detailed contributions												
Family size	3.77	15.6	6.43	3.41	14.1	6.04	2.14	41.8	4.13	2.23	43.5	4.47

Table 4 (continued)

Panel C: Secondary School Completion (Sample: 16–17 years old)												
Benchmark	Hindu Upper Caste/Muslim ($N=41,067$)						Hindu Lower Caste/Muslim ($N=27,074$)					
	HUC ($N=31,453$) (1)			Muslim ($N=9,614$) (2)			HLC ($N=17,460$) (3)			Muslim ($N=9,614$) (4)		
	%-points	% of $(\overline{Y}^H - \overline{Y}^M)$	z-stat	%-points	% of $(\overline{Y}^H - \overline{Y}^M)$	z-stat	%-points	% of $(\overline{Y}^H - \overline{Y}^M)$	z-stat	%-points	% of $(\overline{Y}^H - \overline{Y}^M)$	z-stat
Female	− 0.09	− 0.4	− 1.88	− 0.16	− 0.7	− 1.89	− 0.11	− 2.1	− 1.64	− 0.16	− 3.1	− 1.75
Father's education	3.18	13.1	3.96	3.18	13.1	4.83	0.45	8.8	0.72	0.37	7.2	0.72
Mother's education	1.89	7.8	4.03	2.30	9.5	4.40	− 0.72	− 14.2	− 1.56	− 0.91	− 17.8	− 1.61
Rural	0.71	2.9	2.43	0.56	2.3	1.92	1.64	32.1	3.64	0.97	19.0	2.37
Wealth quintile	0.60	2.5	0.52	0.75	3.1	0.58	− 4.5	− 88.0	− 4.03	− 5.11	− 99.7	− 3.61
Birth year	0.27	1.1	2.67	0.27	1.1	2.57	− 0.01	− 0.1	− 0.05	− 0.01	− 0.1	− 0.05
District	3.46	14.3	1.22	1.10	4.5	0.47	3.54	69.2	1.07	0.72	14.2	0.28

Refer to the note to Table 3

For completion of secondary education, the panel C indicates that HUC advantage generates a total of 24.3%-points differential with Muslim children. The average characteristics predict about 13.8%-points (56.9%) of the differential participation in secondary schools between Muslims and the HUC, out of which, family size predicts about 3.8%-points (15.6%) differential. Father's education is again the next most important predictor, predicting 3.2%-points (13.1%) of the Muslim disadvantage in the secondary schools.

As we proceed from primary to middle or to secondary education, the importance of family size in predicting the Muslim disadvantage over HUC keeps increasing from 1.4%-points (11.5%) in the primary school to 3.8%-points (15.6%) in the secondary school.

Muslims versus HLC

As explained earlier, Muslim children face less disadvantage when compared to the HLC because a majority of the HLC reside in the rural areas of the country and may face some socio-economic disadvantage as compared to the Muslims. There exists about 7.6, 9.2 and 5.1%-points disadvantage of Muslim children in completion of primary, middle and secondary school respectively with respect to the HLCs (see panels A, B and C of Table 4). The Muslim disadvantage reduces when we compare participation in secondary education, which further indicates the importance of the rural–urban divide among the Muslims and the HLC. The divide is larger in rural areas with limited supplies of good quality secondary schools as compared to urban areas, where low quality private schools meet a large share of the demand. However, even if the total differential participation between Muslims and HLC is less, the predictability of differential participation by the average family size between the two groups increases with the level of education. The contribution of family size out of the total differential is about 16.7%, 26.2% and 41.8% for the primary, middle and secondary education, respectively. Although the wealth quintiles generate a significant amount of HLC disadvantage, but family size is still able to predict the Muslim disadvantage even in comparison with the HLC just like it did while comparing with the HUC.

In alternative specification, when we control for state-birth year time trend to take care of the state-specific common time trends, such as building of school infrastructures, road-transportation that could potentially affect educational participation differently, our findings remain unchanged (as presented in Appendix Table A6). We do not include the state-trends model in the main specification because we do not have any variation in the sample of secondary education, where we only have 16- and 17-year-old cohorts in our sample.

As a robustness check, we also perform the B-O decomposition using age and state (location) specific -standardized z-score of total years of schooling as the dependent variable (following Alidou & Verpoorten, 2019; Bhalotra & Clarke, 2016), as this is expected to reduce the possibility of our findings being driven by time-location fixed-effects. The estimates which are presented in appendix Table A14 show that our findings remain unchanged.

Oster Bounds for Estimates of Total Years of Schooling

Since omitted variable bias is expected to be the potential source of endogeneity of family size, we provide the bounds of the coefficients of family size from the OLS estimates of total years of schooling to test the robustness of the Q–Q trade-off, which is the premise of explaining the educational gap in our paper. Extending the assumption of Altonji et al. (2005) that one can use the degree of selection on observables to derive an estimate of degree of selection on unobservables, we estimate Oster (2016) bounds of our OLS estimates. The Oster methodology helps in analyzing whether the estimates are robust to omitted variable bias as explained below. Say,

$$Y = \beta X + \alpha Z + W \tag{4}$$

where Y is the outcome of interest, X is our treatment variable of interest, Z contains all observed variables, and W contains all unobserved variables. While estimating β, one would be concerned about the bias arising from W. Say, δ is the proportion of relation between X and unobservables to the relation between X and observables (Altonji et al., 2005), that is:

$$\frac{Cov(X, W)}{Var(W)} = \delta \frac{Cov(X, \alpha Z)}{Var(\alpha Z)} \tag{5}$$

According to Oster (2016), a consistent estimator of the effect of family size on education would be

$$\beta^* = \beta_{controls} - \delta\left[\beta_{nocontrols} - \beta_{controls}\right] \frac{R^2_{max} - R^2_{controls}}{R^2_{controls} - R^2_{nocontrols}} \tag{6}$$

Here, $\beta_{nocontrols}$ and $R^2_{nocontrols}$ are coefficient of family size and R-squared respectively from estimation of Eq. (1) without any controls. $\beta_{controls}$ and $R^2_{controls}$ are coefficient and R-squared respectively from estimation of the same equation with full set of controls.R^2_{max} is the R-squared of a hypothetical regression of outcome on treatment along with full set of controls including observables and unobservables, so that if the outcome is fully explained, then $R^2_{max} = 1$. β^* is then a consistent estimator for the effect of family size on education outcomes, as a function of δ and $R^2_{max} \in (R^2_{controls}, 1)$. If there is zero selection on unobservables, then $\beta_{controls}$ gives one side of the bound, and if there is equal selection on observables and unobservables ($\delta = 1$), then β^* provides the other side of the bound for a given R^2_{max}. The estimates can be claimed to be robust to omitted variable bias if the bound excludes zero.

Using a sample of randomized papers from top journals, Oster (2016) finds that about 90% of the randomized results would remain valid if $R^2_{max} = 1.3R^2_{controls}$. Therefore, we report the bound assuming $R^2_{max} = \min(1.3R^2_{controls}, 1)$. Table 5 presents the results of the bound analysis. Each row in the Table presents the estimates for each group separately. We see that the bounds exclude zero for each of the three groups (column 5). Thus, we find evidence of Q–Q trade-off among all groups even

Table 5 Robustness of the coefficient of family size to omitted variable bias (oster bound analysis)

Dependent variable: total years of schooling	No controls	Controls	$R^2_{max} = \min(1.3R^2_{controls}, 1)$		
			δ for $\beta = 0$	β for $\delta = 1$	Oster's bound, $\delta = 1$
	(1)	(2)	(3)	(4)	(5)
HUC sample					
Family size	0.047 (0.052)	– 0.079*** (0.011)	– 3.19	– 0.113	[– 0.113, – 0.079]
R^2	0.0003	0.860			
HLC sample					
Family size	0.018 (0.039)	– 0.097*** (0.012)	– 3.06	– 0.143	[– 0.143, – 0.097]
R^2	0.0001	0.7950			
Muslim sample					
Family size	– 0.043 (0.042)	– 0.106*** (0.010)	– 8.02	– 0.138	[– 0.138, – 0.106]
R^2	0.0006	0.7384			

Estimates from Oster bound analysis for the OLS coefficient on Family Size that are presented in columns 1–3 in Table A2, with the same specification. Each of the three rows present separate estimate from corresponding sample

*$p<0.01$, **$p<0.05$, ***$p<0.01$

when selection on unobservables is assumed to be same as selection on observables. Moreover, we provide the value of δ for which β^* would become zero (column 3). The obtained values indicate that the selection on unobservables will have to be more than three times relative to the selection on observables to explain away the Q–Q trade-off for HUC and HLC, and more than eight times to explain away the Q–Q trade-off for Muslims. This seems incredibly large as Oster (2016) finds that in 86% of the cases, the selection on unobservables is less than or equal to the selection on observables.[9]

Potential Concerns

Azam and Saing (2018) recommend using inputs as measures of Q–Q trade-off because output is a combination of parents' spending on input and other unobserved factors. However, our objective is to explain the gap in educational outcomes using the logic of Q–Q trade-off. Hence, for our context, output is the measure that we are interested in.

The birth order effects on investment in children may be confounded in effects of family size because higher birth order children belong to large families. Sometimes,

[9] A negative δ means that if the observables are positively (negatively) correlated with the treatment, the unobservables have to be negatively (positively) correlated with the treatment to get a $\beta^* = 0$.

negative effects of family size tend to disappear when birth orders are controlled for (Black et al., 2005). In the context of developing countries, it has been found that first-born children attend less schooling as compared to the children born later (De Haan et al., 2014; Ejrnaes & Pörtner, 2004; Emerson & Souza, 2008), which may be due the fact that the elder children need to look after the younger siblings and share household chores. However, the relationship between birth order and investment in education is just the opposite in case of developed countries (Black et al., 2005; Booth & Kee, 2008; Conley & Glauber, 2006). Therefore, to ensure that our estimates for the effect of family size on education are not capturing such birth order effects, in separate OLS estimations not included in this text, we also control for birth order of the child, and find that our estimates are unaffected.[10] However, we do not present this model as our primary specification because higher birth order is always conditional on higher family size.

An important point to note is, due to the son preferring attitudes, the girl children may end up in large families. This is more likely for Muslim families as they have lower rates of sex-selective abortions. Hence, the relationship between fertility and education in explaining the gap in education between Hindu and Muslim children could be challenged if Muslim parents would invest less on the education of girls than Hindu parents. However, in India, investments in education in Muslim families do not seem to be biased against girls, which is evident from the fact that the educational attainments among Muslim girls are more as compared to Muslim boys. Therefore, ignoring the girl-biased sex composition in large families would imply that our estimate of the differential Q–Q trade-off for Muslims relative to Hindus is likely to be downward biased. In other words, the actual Q–Q trade-off for Muslims relative to Hindus would be even higher than what our estimates suggest.

Our estimates are not able to take into account the differential access to good quality education across religions, such as, if the quality of schools is below average in the Muslim dominated villages.[11] However, since our estimates are robust to village (PSU) fixed effects (see Appendix Tables A4 and A5), one can surmise that physical access to schools or quality differential within the village is not expected to contribute to a significant differential participation. However, we are unable to account for any religion-based discrimination within school or within village that could result in non-participation or early withdrawal of Muslim children even when the costs of schooling are negligible. We try addressing this issue with the limited data, which has information on reasons of withdrawal from school, asked to children who have dropped out of school. The purpose of this additional exercise as presented below is to figure out if there is any systematic difference among the dropout children between Muslims and Hindus that could be ascribed to differential institutional quality.

[10] Results available from authors on request.

[11] The Sachar Committee report highlighted that availability of schools in Muslim dominated villages was less compared to other villages (Government of India, 2006). Overall, access may have changed since then, but the robustness of our estimate to the village fixed effects should take care of such concerns to a large extent.

Table 6 OLS estimation: dummy dependent variable assuming 1 if institutional quality or access seems reasons for drop out

	(1)	(2)	(3)
HLC	− 0.034*** (0.011)	− 0.033*** (0.012)	− 0.032*** (0.010)
HUC	− 0.014 (0.016)	− 0.015 (0.016)	− 0.012 (0.014)
R^2	0.132	0.123	0.126
N	22,902	23,851	23,851

Standard errors clustered at state level in parentheses. All regressions weighted by NFHS survey weights. All regressions include district and birth year FEs

Column 1 excludes observations where reason for drop out is "other"/"don't know"/"missing"

Columns 2 and 3 check for robustness by including observations where the reason for drop out is "don't know/other": in column 2 these categories are treated as non-institutional reasons (i.e. dependent variable takes value zero), whereas in column 3 these categories are treated as institutional reasons (i.e. dependent variable takes value 1)

*$p<0.10$, **$p<0.05$, ***$p<0.01$

All the possible categories cited as reasons for dropout have been tabulated in Appendix Table A7. Using this information, we test if the reasons for dropout due to concerns of quality or access to schools are different between Muslims and Hindu groups. That is, we estimate the following OLS specification to explore if there exists any gap between SRCs originating from poor institutional quality that has been cited as reasons of dropout by both the groups:

$$IR_{chdt} = \alpha_0 + \alpha_1\left(HLC_h\right) + \alpha_2\left(HUC_h\right) + \alpha_3\left(FS_h\right) + \theta_t + \pi_d + \mu X_{ch} + \varepsilon_{chdt} \quad (7)$$

Here, the dependent variable IR_{chdt} is a dummy variable assuming value 1 if the child dropped out due to concerns related to access to- or quality of- schools. Hence, IR_{chdt} assumes a value one if the reason for not attending school is any of the following: school too far away, transport not available, costs too much, no proper school facilities for girls, no female teacher, did not get admission. Observations with all the remaining categories of responses (as in Appendix Table A7) assume a value zero while constructing this dependent variable. *HUC* and *HLC* are dummy variables indicating HUC and HLC households respectively, with Muslim households being the reference group. As in earlier specifications, we control for family size, gender of the child, father's and mother's education in years, wealth quintile of the household, and rural/urban residence of the household. We are interested to get estimates of α_1 and α_2, conditional on a set of relevant variables, district fixed effects and birth year fixed effects.

As reported in column 1 of Table 6 (with full results in Appendix Table A8), HUC children do not seem to have a significantly different reason of dropout than the Muslim children when the reasons are categorized to a binary variable capturing institutional quality as explained above. However, concerns for institutional quality leading to school dropout seem to be 3%-points less for the HLC children as compared to the Muslim children. This is also possible because a large percentage of HLC resides in rural areas, where children are engaged more in family farms for agricultural activities. Hence, for them, the primary reason for drop out is expected to be something beyond the definition of 'institutional quality' as defined here.

There are a few observations for which the reasons are not clear, such as, "other" (867 observations), "don't know" (83 observations), and "missing" (30,037 observations) categories. Our primary estimates as reported in the first column of Table 6, do not include the above three categories of observations. However, our estimates remain robust even when we expand the set of observations. The last two columns of Table 6 include observations where the reason for drop out is "don't know" or "other" by pooling them either with non-institutional reasons for drop out (in the second column), or with institutional reasons for drop out (in the third column).

It is also important to note that the education gap between the two groups could be driven by difference in preference for education. For instance, Muslims may be less keen to invest in a long education because of lower employment prospects, say, in the formal sector. In order to probe this further, we explore heterogeneity with respect to residence area (urban/rural). Since the prospects of getting employment after completion of education is lower in rural areas, it should be more demotivating for the disadvantaged section, hence the gap in education even at the same fertility level can be higher in rural areas. Without accounting for that, we expect the explanatory power of fertility to be higher in rural areas. However, the decompositions done separately for rural and urban samples as presented in Appendix Tables A12 and A13 do not reflect higher explanatory power of fertility in rural area.

One may find the motivation of our research question using the theory of Q–Q trade-off intriguing because Muslim children are better off than Hindus in certain health indicators, such as neonatal, infant and child mortality. These are expected to lead to better educational outcomes as well. However, we should note that investment in health is different decision from investment in education. Maintaining good health of the children is directly linked to their survival and can be considered a basic minimum. Due to neighborhood effects (Adukia et al., 2021) or different cultural norms, Muslims are found to have better sanitation practices, which have direct associations with infant and child mortality (Coffey & Spears, 2017). But non-pecuniary returns or long-term returns from education may not be rightly perceived by all as that may not be directly linked to survival. Also, Bhalotra et al. (2010) point out that more than two-third of the survival advantage of Muslims over high-caste Hindus is found in the neo-natal period, suggesting that the differentials could be explained more by customs, attitudes, behaviors, and early feeding practices, and less by access to health and nutrition after birth. Muslims were found to have no advantage with respect to stunting (height) and only a small advantage with respect to wasting (weight), indicating that community differences in nutritional status are much smaller than the community differences in survival.

Our study is based on the sample of children from 2015–2016 NFHS survey, whose mothers can have a maximum age of 49 years. This sets an upper limit on schooling attainments of the observed children, which may not have been completed yet. This would be a concern if our dependent variable would analyze only the differential attainment in total years of schooling. However, when we analyze the completion of age-appropriate schooling levels (i.e. primary completion for age group 11–17 years old, middle school completion for 14–17 years old and secondary school completion for 16–17 years old), our results are robust. For levels of schooling, we avoid estimation above secondary level because of the sample restriction to 17 years.

Concluding Discussion and Policy Recommendations

In this paper, we use Q–Q trade-off to examine the role of fertility differences between Hindus and Muslims in explaining the differentials in their educational attainment. Using Blinder-Oaxaca decomposition, we find that fertility differences can explain around 10% (17%) of the difference in years of schooling between high-caste (low-caste) Hindus and Muslims. These results suggest that policies to reduce fertility might have some relevance in reducing the educational disadvantage of Muslims in India.

Several studies have highlighted the convergence in fertility rates among Hindus and Muslims in India (Government of India, 2006). In 2005–2006, the total fertility rate (TFR) was 3.4 for Muslims and 2.6 for Hindus, which declined to 2.6 and 2.1, respectively in 2015–2016 (Kulkarni, 2020). This reflects a decline in the Hindu–Muslim fertility gap from 0.8 to 0.5. Our results suggest that as fertility rates converge further, the gap in the educational participation between Hindu and Muslim children is expected to decline driven by an increase in the school participation of Muslim children. However, even with the same TFR in the future, if that is achieved, the difference in the strength of the association between family size and education will still remain a concern as long as the association is negative. Therefore, policies that can facilitate a decline in fertility rates in general and the Hindu–Muslim fertility gap, in particular, might be useful. The utility of these policies is amplified by the finding that apart from family size, differences in parental education (especially father's education) is significantly associated with gaps in educational participation of the two communities. Given the association between fertility differences and education gap, parental education would also see a positive shift over time with the narrowing of the fertility gap in the two communities. This will further help in narrowing the education gap in the next generation.

High fertility could be a consequence of inadequate access to contraception (Jones, 2015; Pop-Eleches, 2010). Although the use of contraception depends on both the demand and supply of contraceptives, improving contraceptive access could lead to fertility reductions when the supply of contraception does not meet the demand. As such, family planning programs have increasingly focused on the provision of services that address the unmet needs for family planning. Unmet needs take two broad forms: unmet need for spacing (those who want/wanted to postpone the next birth) and for limiting (those who want/wanted to stop childbearing). While recognizing that not all unmet needs can be addressed, Kulkarni (2020) estimates that lowering the unmet need to an achievable low level would have brought down the TFR in India from 2.18 to 1.83, a reduction of 0.35, which is quite significant. This result holds some relevance in the context of our paper as the unmet needs of Muslim women are higher than that of Hindus. Our analysis of the NFHS 4 data (presented in Appendix Table A9), shows that the percentage of family planning demand satisfied for married women in the age-cohort of 15–49 is 73.2% for Muslims, 81.2% for HUC and 80.7% for HLC, reflecting a gap of about 8 percentage points between Muslims and Hindus. Besides, the unmet needs of Muslim women are higher than those of HUC and HLC women for both spacing (6.96% vs. 5.26% and 5.46%) and limiting (9.58% vs. 7.52% and 7.20%). Even for women whose needs are met, they are met by modern methods for a larger proportion of Hindu women (73% for HUC and 72.4% for HLC) than for Muslim women (61.3%).[12] Therefore, focusing on appropriate supply side measures to address the unmet needs for family planning may help reduce the fertility differential with potential to reduce the education gap in due course.

While addressing the unmet need for family planning may help in reducing fertility differentials to some extent, it is important to note that parents' demand for children plays a considerably larger role in determining fertility than access to contraceptives or family planning services (Pritchett, 1994). Our analysis of the NHFS 4 data shows that the average number of desired children as reported by Muslim, HUC and HLC women is 2.66, 2.15 and 2.31, respectively (Appendix Table A9). As the desired fertility is higher for Muslims than Hindus, the fertility differentials, and hence educational differentials, across these groups may persist. Under such circumstances, policies that weaken the association between fertility and education may assume greater significance in reducing the educational disadvantage of Muslim children.

Our results show that the contribution of family size in explaining the education gap between Hindus and Muslims increases with the level of education. This suggests that as the cost of education increases from primary to middle to secondary school, the Q–Q trade-off becomes stronger. Hence, public investments in good-quality schooling may reduce the strength of this trade-off. While we do not recommend any generalized policy prescription suited for all countries, but in the Indian context, the related policy options could be to reduce the opportunity cost of schooling through the reduction of cost of transportation to school (Muralidharan & Prakash, 2017), and through improving the labor market outcomes of women. These may lead to increased schooling, and thereby could weaken the association between fertility and education. Awareness campaigns through radio and TV shows about the pecuniary and non-pecuniary benefits of education, and labor market opportunities may be helpful in that direction.

The extant literature from all around the world about the effects of education on fertility is ambiguous, where the developed countries in general do not always see a reduced fertility due to additional schooling. But in Germany, there is evidence of a drop in fertility caused by additional schooling (see Cygan-Reham & Maeder, 2013 for a detailed discussion). However, our policy recommendations are more

[12] Modern methods include female and male sterilization, contraceptive pills, intrauterine devices (IUD/PPIUD), implants, injectables, male and female condoms, standard days method (SDM), diaphragm, foam/jelly, lactational amenorrhea method (LAM), and emergency contraception. Traditional methods include rhythm, withdrawal, and others.

appropriate in the Indian context, where the education is found to be negatively associated with fertility in general.

Finally, it is useful to emphasize that while our analysis is not able to explicitly capture factors like discrimination, attitudes towards education and returns to education across religions and communities, our results show that a significant part of the inter-community differences in participation in education can be linked to the Q–Q trade-off associated with fertility differences. The economic logic of the trade-off and the potential to reduce the fertility gap through supply side measures, or mitigate the trade-off through public investments in education, provide hope for convergence in educational participation among communities reasonably rapidly if corrective action is undertaken.

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Data availability We will be happy to submit any details of work or data, if required at any stage of the review process and thereafter. We would like to mention here that the National Family Health Survey (NFHS 4) data used in this work, are publicly available at the link cited in the paper. However, We can submit the instructions and Stata code that could be used to replicate our estimates.

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