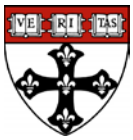

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The Effect of Childhood Measles Vaccination on School Enrollment in Matlab, Bangladesh

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Abstract

There is increasing evidence that early childhood health interventions have long term effects on cognitive development, educational achievement, and adult productivity. We examine the effect of measles vaccination on the school enrollment of children in Matlab, Bangladesh. An intensive measles vaccination program was introduced in two areas of Matlab in 1982, and extended to two more areas in 1985. Using this staggered rollout as an instrument for vaccination, we find that age appropriate vaccination raises the probability that a boy has enrolled in school by 9.5 percentage points but appears to have no effect on girls' enrollment.

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1. Introduction

There is increasing evidence that early childhood health and nutrition have long term benefits in the form of improved physical and cognitive development, better educational outcomes, and higher productivity and earnings as an adult. Miguel and Kremer (2004) find that deworming in Kenya improved school attendance. Field et al. (2009) show that iodine supplementation improved educational attainment in Tanzania. Clarke et al. (2009), Lucas (2010) and Cutler et al. (2010) find that malaria interventions that protect young children can increase cognitive test scores and educational attainment. There is reason to think these educational and cognitive gains from improved childhood health have a long term economic impact. There is a strong correlation between child health and adult health (Barker (1992)). In terms of long term economic outcomes, Case et al. (2005) and Smith (2009) find evidence of large effects of early childhood health on adult economic outcomes in Britain and the United States. Alderman et al. (2006) and Bleakley (2010) find similarly large long term effects on adult earnings for early childhood nutrition and malaria eradication that reduces childhood exposure.

Evidence of the educational and economic impact of vaccines is more limited. Bloom et al. (2005) argue that measles vaccination has large effects on child mortality and morbidity and could potentially have large educational and economic benefits. Results from the Philippines using a propensity score matching approach to control for non-random take-up suggests that vaccination with the basic six childhood vaccines (protecting against measles, polio, diphtheria, pertussis, tetanus and tuberculosis) increases cognitive ability (Bloom et al. (2011)), while evidence from a randomized trial finds an effect of maternal tetanus vaccination prior to birth on children's school attainment in Matlab, Bangladesh (Canning et al. (2011)). We add to the

evidence base on this theme by examining the effect of a measles vaccination intervention on school enrollment in Matlab.

Measles is a respiratory viral infection (see Brenzel et al. (2006) for an overview). Childhood infection with measles is common in unvaccinated populations. Children usually acquire antibodies from their mothers that protect against clinical measles until they are around five months of age. Infection may lead to complications such as pneumonia, diarrhea, encephalitis (swelling of the brain), and blindness (Perry and Halsey (2004)), sometimes causing death. Complications are more serious in young children, under 5 years of age, and in adults. Our hypothesis is that the morbidity associated with measles and its complications in children under 5 years of age may lead to deficits in physical and cognitive development in children who survive that are reflected in school enrollment.

Vaccination is protective against the disease, lowering incidence and lowering the case fatality rate if an infection occurs, substantially reducing child mortality rates (Koenig et al. (1990)). Case fatality rates of around 3% are common in developing countries though this rate has been improving over time (Wolfson et al. (2009)) . Incidence of the disease has been declining rapidly in developing countries over the last two decades due to the expansion of vaccination coverage (Centers for Disease Control and Prevention (2009)).

It is difficult to identify causality between health and income due to two way causality (Smith (2009), Thomas and Frankenberg (2002)). When we study the effect of childhood health interventions on schooling we also have the problem that parents who take up the intervention for their child may also be more likely to encourage schooling. We use the staggered rollout of measles vaccination in Matlab, Bangladesh over time and across areas, in the period 1980 to 1988, as an instrument to identify the effect of measles vaccination.

Incidence of measles in the Matlab area before age 5 was 43 % in the 1980s, with age specific incidence rates being low for children under 6 months (immunity is passed on in utero) and then being roughly equal for children between six months and 5 years of age (De Francisco et al. (1994)). In addition to the reduction in measles mortality, the Matlab vaccination program may have reduced mortality from other causes (Aaby et al. (2003)). The mortality reduction effect of the intervention was larger for children from low socioeconomic backgrounds. (Koenig et al. (2001)). In Matlab measles has been found to frequently be followed by diarrhoea, leading to weight loss, and weight for age often does not fully catch up to pre-infection levels over time. Koster et al. (1981) suggests long term health consequences for children who survive measles.

A complication of our study is that the treatment area in Matlab has seen a number of interventions over time, including a child and maternal health and family planning program, antenatal care including maternal tetanus vaccination, iron supplementation for pregnant women, vitamin A supplementation for children, and the rollout of the other childhood vaccinations. This makes distinguishing between the effects of the different interventions difficult. Barham and Calimeris (2008) look at the effect on children's cognitive development of being exposed to a high level of interventions versus a low level of interventions, essentially evaluating the effect of a package of interventions. We try to separate out the effect of measles vaccination by controlling for exposure to other interventions. Most interventions took place at different times, and different areas, and we can therefore use the differential exposure of different cohorts of children to identify their independent effects. However, measles vaccination was instituted at almost exactly the same time, and in the same areas, as the antenatal care program that included maternal tetanus vaccination. We control directly for maternal tetanus vaccination prior to delivery as an indicator of mother's take-up of this antenatal care program.

2. The Intervention

The Matlab demographic surveillance site was established in 1966. The population of the area is about 200,000, divided into an intervention region (blocks A, B, C, and D) and a control region (block E). Interventions take place in the intervention region and while the control area is monitored it receives only the usual government-provided health services. In March 1982, measles vaccination was introduced into blocks A and C, and was expanded to include blocks B and D in December 1985. Measles vaccination was not available in block E, the control area, until the 1990s. Our potential data set is all 63,910 children born in the site between 1980 and 1988, with about half these children being in the intervention blocks and the other half being in the control block.

We combine information on children born in the area between 1980 and 1988 from four different datasets. Data on the children's family backgrounds comes from the 1982 Matlab Socioeconomic Census. The children's date of birth (and death or out-migration if this occurs) comes from routine demographic surveillance, usually carried out monthly. Vaccinations are recorded as they are carried out and maintained in a vaccination database. Data on the children's school enrollment comes from the 1996 Matlab Socioeconomic Census.

We have data on the whether a child receives the measles vaccine, as well as the date of vaccination. The date of vaccination is particularly important, as it allows us to distinguish between age-appropriate and age-inappropriate vaccination. Measles vaccination is recommended for children between 9 months and 12 months of age. However, the initial rollout of the vaccination program also targeted children up to five years of age. For unvaccinated children in Matlab, there was substantial measles infection at young ages after the first six

months of life (when children have some protection acquired from their mother in utero), though the incidence of measles declines after age five years (Fauveau (1994)). This means that late vaccination is likely to be less protective; children who have already had measles, and suffered the health consequences, may be vaccinated at older ages despite having acquired natural immunity.

Our vaccination measure is a continuous variable indicating the proportion of time between the ages of 1 and 5 years that the child was protected by vaccination. This means that for all individuals who are vaccinated as recommended, before one year of age, this variable takes on a value of one. This variable decreases linearly in value with late vaccination, taking a value of zero if the individual is not vaccinated or is vaccinated after five years of age. A justification for this is that incidence rates for this age range are roughly constant, meaning that the probability of acquiring measles is proportional to the time not covered by vaccination. The experience of a measles infection may affect the likelihood that older children take up vaccination; our instrumental variables approach controls for this endogeneity as well as the issue that vaccination take up and school enrollment may be correlated with unobserved family preferences. We construct two instruments for time covered by vaccination. One is a dummy for full exposure to the intervention, that is, being in an area with measles vaccination being available before the age of one year. The second is a dummy for partial exposure, where measles vaccination is introduced to the area where the child lives when the child is between one and five years old.

Table 1 shows the distribution of measles vaccination by block and year of administration. This table shows higher vaccination rates in blocks A and C, which received the early intervention, than in blocks B and D, where the intervention was delayed. The vaccination

rate in block E, the control area, lags far behind. Table 2 shows the rate of vaccination in the recommended age range (9-12 months) by birth year and block. In Table 2 we see a pronounced jump in age recommended vaccination rates that occurs for 1981 births in blocks A and C, and for 1984 births for blocks B and D, matching the rollout of the intervention, while vaccination rates in block E remain low throughout. Table 3 shows the percentage of children with late vaccination, between 1 year and 5 years old, by birth year and block. In the intervention blocks there is substantial late vaccination for those children born in the four years prior to the intervention, and even for children born after the intervention occurs. We do not have a dichotomous treatment variable; rather we have unvaccinated children, those with age appropriate vaccination, and a group with late vaccination and partial protection. There is little vaccination at any age in block E, indicating that the rollout of measles vaccination through government services in the 1990s had little effect on children born before 1989.

In our analysis we control for child, maternal, family, and neighborhood characteristics. For the child we control for year of birth and sex. We control for the mother's years of schooling and age at the time of the child's birth. For the family we control for the father's years of schooling and the number of living children in the family at the time of the child's birth. We include dummies for which block the child was born in and year dummies.

Two intervention studies were undertaken in the site prior to 1980. A mother and child health and family planning initiative was undertaken in the treatment blocks starting in 1977 (Joshi and Schultz (2007)) and an oral rehydration theory for diarrhea was initiated in some areas in 1979 and expanded in 1980. These interventions should already be captured by our block dummies since they are present, or not, in each area over the full time period we are using.

We control for exposure to three other interventions that took place in the treatment area during the period 1980-1988: iron supplementation for pregnant women, vitamin A distribution to children, and the other basic childhood vaccinations (oral polio vaccine, diphtheria, pertussis and tetanus vaccination (DPT), and Bacillus Calmette-Guérin (BCG) vaccination for tuberculosis). Iron supplementation for pregnant women was made available in blocks A and C in January 1985 and extended to blocks B and D in January 1986. We add a dummy for children born in these blocks after the introduction of the supplementation to control for their exposure. Vitamin A distribution to children began in January 1986 in blocks A-D; again we add a dummy controlling for this exposure for children born from January 1986 on in these blocks. Oral polio vaccination, DPT vaccination and BCG vaccination for tuberculosis for children became available in blocks A-D beginning in March 1986. We add a dummy from March 1986 to control for exposure to these vaccines.

Maternal tetanus toxoid vaccination during pregnancy was made available to women in blocks A and C from December 1981, and in blocks B and D from December 1985. Antenatal care for pregnant women was introduced in September 1982 in blocks A and C, and expanded to blocks B and D in January 1986. The introduction of these two measures in each block is almost coincident with each other and with the introduction of measles vaccination. The fact that these interventions occur in the same blocks at almost exactly the same time makes it difficult to identify their separate effects. Rather than add dummies for exposure to tetanus toxoid vaccination and antenatal care we instead control directly for whether the mother received a tetanus toxoid vaccination in the period up to five years before birth[1]. Maternal tetanus toxoid

[1] We assume women would receive tetanus toxoid as part of the antenatal care package. Protection from tetanus toxoid may carry over into subsequent pregnancies.

immunization prior to birth is passed to children in utero and reduces infant mortality in the first month of life (Black et al. (1980)) and its effectiveness in newborns lasts for at least five years (Koenig et al. (1998)) while its associated reduction in morbidity increases educational attainment in children (Canning, et al. (2011)).

Summary statistics for the variables we use in our analysis are show in Table 4. Our outcome measure is whether the child has had any schooling by the time of the 1996 survey. Most children in our sample are still in school in 1996 and may go on to acquire more schooling. This means that years of schooling attained in 1996 is a severely truncated measure of eventual schooling. Table 4 shows that about 77% of our sample children have enrolled at some point prior to the 1996 survey. The enrollment rates for boys and girls are very similar. Figure 1 shows the enrollment rate by age. Young children (later birth cohorts) have low enrollment rates and may not yet have entered school. Children may delay entry to school beyond the normal age of six years. There is gradually declining ever-enrolled rates for older children, reflecting an upward trend in enrollment over time. Figure 1 implies that our results may be working on two margins. The first is that better health may encourage the enrollment of children at younger ages and prevent delayed entry, the second is that it may increase the proportion ever enrolling. Grira (2004) looks at the impact of child nutritional status on school enrollment in Matlab.

The main explanatory variable we are interested in is the proportion of the life between the ages of one and five years the child was immunized. For children vaccinated before age one year this proportion is one. For children never vaccinated, or vaccinated after age five years, this proportion is zero. For children vaccinated between ages one and five years this is proportion is five, minus the age of vaccination, all divided by four. The average proportion of the age range spent immunized in our sample is 0.356.

We have two exposure dummies that we use as instruments. The first is living in an area with measles vaccinations being provided at age 12 months. The second is not having measles vaccination available at age 12 months but living in an area where it was available between the ages of one and five years. About 33.5% of our sample had measles vaccination available through the intervention at age 12 months; we would expect to see high levels of measles coverage in this group. About 12.5% of the sample did not have measles vaccination available at 12 months but did live in an intervention area between ages of one and five years. These are children who were already more than one year old when the vaccination program was introduced into their area. We expect to see some of these children being vaccinated after age one but before age five.

Table 5 shows that about 52% of our sample is male. Mothers have about 1.4 years of education on average in our sample, while fathers have on average about 2.9 years. The average age of mothers was around 26 years. About 37.6% of the women received tetanus vaccination in the five years before their child's birth. Fairly small numbers of children were exposed to the later vaccination, vitamin A and iron supplementation programs.

Out-migration will result in missing data on outcomes for those born in Matlab between 1980 and 1988 but who migrate out before 1996. Out-migration is tracked as part of the Matlab surveillance; both the date of migration and the reason for migration are recorded. Barham and Calimeris (2008) find that migration is more common among poorer families. However, out migration only produces a bias in our estimates if it is correlated with the outcome variable (Fitzgerald et al. (1998)), in our case school enrollment, after conditioning on our explanatory variables. Concern about the influence of migration prompted us to use school enrollment data from the 1996 census rather than school attainment from a later census in 2005 when much more

out-migration had occurred. School enrollment in 1996 is predictive of school attainment in 2005. Figure 2 shows years of schooling completed by enrollment status in 1996. Those not enrolled in 1996 frequently have zero years of schooling completed in 2005, but the majority of them do acquire some schooling. However for this group that were not enrolled in 1996 but proceeded to school the modal achievement is 5 years, corresponding to completing primary school, as opposed to a mode of 9 years, corresponding to completing secondary school, for those who were enrolled in 1996. The mean difference between the years of schooling for the two groups is 2.7 years.

For young adults, over age 16, we see a significant correlation of migration with high level of schooling (Canning, et al. (2011)). This makes using data from 2005 problematic. Table 5 shows the status of children born in the site between 1980 and 1988 in the 1996 census. For children born in 1988 just over 10% have died and just over 10% have migrated out by 1996. For the sample born in 1980 the corresponding figures are both just under 20%. The older cohorts in our sample are 16 in 1996, but we do not yet see the acceleration of out-migration that occurs in young adults. Table 6 shows the stated reasons for migration by age. The dominant reason for migration is "familial" for all age groups. In the 1996 census children in our sample are between 8 and 16 years old and endogenous outmigration due to the child's own choice is probably very low. We therefore assume that outmigration is random, conditional on observed family characteristics, and analyze the data on children who remain in the study area assuming that migration is not dependent on schooling outcomes. If there is a positive dependence of migration on schooling even at these young ages it will tend to bias our results towards the null.

3. Estimation and Results

The dependent variable in our model is ever enrolled in school. We assume that the probability of enrollment in or before 1996 depends on the percentage of time between the ages of one and five years the child was immunized against measles. There is also the possibility of herd immunity, so that children are protected by vaccination of others in their community even if they are not vaccinated themselves. We assume a probit model:

$$\begin{aligned} y_i^* &= \alpha m_i + \beta \bar{m}_{ig} + \gamma x_i + \varepsilon_i \\ y_i &= 1 \; if \;\; y_i^* \geq 0 \\ y_i &= 0 \; if \;\; y_i^* < 0 \end{aligned} \tag{1}$$

where y_i is our enrollment outcome for child i, and takes the value 1 if the child is enrolled and the value 0 if they are not enrolled. y_i^* is an unobserved latent variable that determines enrollment. m_i is our measure of the measles vaccination status of the child, $\bar{m}_{ig}$ is the average measles vaccination status in the group of children g child i belongs to, x_i denotes the other exogenous explanatory variables in the model, and ε_i is an error term which we assume is normally distributed. The spillover effect is the lower probability of measles that occurs when others are vaccinated. This spillover clearly accrues to unvaccinated children, however even children who are vaccinated may benefit from a spillover since they will have lower exposure to measles in the gap between the exhaustion of the immunity they acquire from their mother and being vaccinated. There is significant infection from measles even before nine months of age when individual vaccination is recommended (Fauveau et al. (1991)). Goldhaber-Fiebert et al. (2010) find that 70% measles vaccination coverage reduces measles mortality by about 79% relative to no vaccination, while at 90% vaccine coverage mortality is reduced by 93%, suggesting spillover effects. As vaccination rates rise above 80% they find an increasing

probability of zero measles deaths; at this level of vaccination measles may cease to be endemic so that an outbreak requires an external source. Vaccination rates by birth cohort and block in our sample vary from a low of zero to a high of 69% for age appropriate vaccination, and 84% for vaccination before age 5 years. We assume the externality over this range is approximately linear; at higher levels of vaccination, above 80%, we may see diminishing returns since at the margin we could be vaccinating children partially protected by herd immunity.

We can rewrite equation (1) as

$$y_i = (\alpha + \beta)m_i + \gamma x_i + v_i, \quad v_i = \beta(\bar{m}_{ig} - m_i) + \varepsilon_i \tag{2}$$

where we have an error term v_i that includes the difference between the child's measles vaccination status and its group average $\bar{m}_{ig} - m_i$.

Since measles vaccination is endogenous and may be correlated with other health seeking behavior and child investments by the family that also affect schooling we instrument the measles vaccination status of the child using our two exposure dummies, which are based on whether the child was exposed to treatment before age 12 months, between one and five years, or only later than five years (including never). Our identifying assumption is that these exposure dummies are uncorrelated with the error term ε_i. This essentially means that there were no other factors that we are not controlling for that affected children in these areas at precisely the dates of the measles vaccination intervention.

The intervention exposes all children of the same age in the same area to vaccination and defines three groups, the fully treated (exposed to vaccination before age 12 months), partially treated (exposed between ages one and five years) and the control (not exposed before age five years). By definition this intervention is uncorrelated with that difference between individual vaccination status and the group average $\bar{m}_{ig} - m_i$ provided the reference group whose

vaccination status matters for the child's educational outcome is strictly contained within one of the groups affected by the intervention. Provided the reference group affecting the child is smaller than groups defined by the intervention the differences $\bar{m}_{ig} - m_i$ sum to exactly zero for all children within each intervention group. In this case our group level instrumental variable approach estimates the total effect of vaccination on the child, $\alpha + \beta$, including both the direct effect and any spillover from the vaccination of others. The assumption that the reference group affecting the child lies completely within a group defined by the intervention (treated, partially treated, or control) seems reasonable provided that the spillover of measles only occurs within geographical areas and between neighboring birth cohorts. As in Miguel and Kremer (2004), the group level intervention essentially identifies the total effect of the intervention on the individual plus any spillovers that operate within the same group. Overlaps between the reference group that affect a child and the treatment groups will tend to reduce the size of our estimated effects; for example unvaccinated children in the control area may get some benefit from the lower prevalence of measles in the treatment areas. If this occurs our estimates place a lower bound on the effect size.

An important issue is that our instrument is defined at the group level, so all children born at the same time in the same block have the same value of the instrument, while our data is for individual children. Shore-Sheppard (1996) shows that for group level instruments the usual standard errors from instrumental variable regression may be understated if we fail to take account of correlation between outcomes for children within the group. We therefore cluster our standard errors, allowing correlation between outcomes for children born in the same year in the same block (this gives us 45 groups, 9 years of births times 5 blocks).

Given our model we have that

$$P(y_i = 1) = \Phi((\alpha + \beta)m_i + \gamma x_i) \quad (3)$$

Where Φ is the cumulative normal distribution. We are particularly interested in the marginal effect of vaccination on the probability of enrollment given by

$$\left.\frac{dP(y_i = 1)}{dm_i}\right|_{\bar{m},\bar{x}} = (\alpha + \beta)\Phi'((\alpha + \beta)\bar{m} + \gamma\bar{x}) \quad (4)$$

Where the size of the effect is calculated at the sample means $\bar{m}, \bar{x}$. As well as using the probit model for the outcome we report results from a linear probability model. The linear probability model can be thought of as an approximation to the true, more complex limited dependent variable model that gives direct estimation of the marginal effect of the treatment (Angrist (2001)). There is also an advantage in that we can have tests for weak instruments and over identification with clustered standard errors in the linear case.

Table 7 reports our results of the estimation of the effect of estimation of vaccination on school enrollment using the probit model. The first column of Table 7 gives simple probit results not controlling for the possible endogeneity of measles vaccination. We find a significant effect of measles vaccination on school enrollment, with vaccination before 12 months being associated with an increase in the probability of enrollment of 0.024. We find that father's and mother's schooling and maternal tetanus vaccination are associated with higher levels of enrollment for children. The magnitude of the results for maternal tetanus vaccination are similar to the findings in Canning, et al. (2011) based on a 1974 randomized trial involving vaccination of women for tetanus. The finding of a positive effect of parental education agrees with the results in Maitra (2003) who studies the determinants of enrollment for young children in Matlab. We do not find significant effects of the child's sex, the mother's age at the birth of the child, the number of living children in the household, or of exposure to other interventions, iron

and vitamin A supplementation and the other five of the basic six vaccines. We find that the intervention areas A,B,C, and D have lower school enrollment than the control area E, while the pattern of the birth year dummies follows the inverted U shape shown by Figure 1.

The results in column 1 of Table 7 are subject to the caveat that measles vaccination may be endogenous and may reflect that some households emphasize both health and educational investments in their children. To control for this we instrument our measles vaccination variable with instruments reflecting full or partial exposure to the measles vaccination initiative. Column 2 of Table 7 reports a linear model in which we use full and partial exposure to the measles interventions as instruments to explain the fraction of time between ages 1 and 5 years the child is vaccinated. As expected we find that our dummies for full and partial exposure to the measles intervention are highly predictive of measles vaccination, with full exposure having a larger effect than partial exposure. We also find that being vaccinated against measles is positively associated with being exposed to other interventions; the other interventions tend to be in the same treatment areas as the measles vaccination but were introduced later. This highlights the importance of controlling for these additional interventions.

In column 3 of Table 7 we report results showing our estimate of the effect of measles vaccination on school enrollment, instrumenting vaccination status with our measures of exposure to the measles vaccination intervention. The regressions reported in columns 2 and 3 of Table 7 are estimated jointly by maximum likelihood. The coefficient on measles vaccination rises to 0.045 but is not statistically significant.

In Table 8 we repeat the analysis in Table 7 using a linear probability model for school enrollment. The estimated coefficients are therefore approximations of the average effect of

measles vaccination on school enrollment and are directly comparable with the marginal effects reported in Table 7. As expected, the results are very similar to those reported in table 7. The Kleibergen-Paap statistic for weak instruments has a value of 57.4, substantially above the cutoff of 19.9 for a maximal bias of 10% relative to the OLS estimate. This implies that our instruments are not weak and being exposed to the intervention was highly correlated with vaccination for measles. The J test of the over identifying restrictions is not significant, so we do not reject the validity of our instruments.

In Tables 9 and 10 we repeat the analysis in Tables 7 and 8 for boys. As shown in Table 10 the weak identification and over identification tests remain satisfactory. In Table 9, the probit model for boys, we find that, when we instrument, vaccination raises the probability of enrollment by 0.095 and the effect is statistically significant at the 5% level. The estimated effect of vaccination on enrollment is larger when we instrument, in column 3 of Table 9, than in column 1, when we do not instrument.

Given that families who choose to have measles vaccination for their children may also be investing in other health and educational inputs we would expect the coefficient on vaccination to fall when we correct for endogeneity. However, as is made clear by equation (2), when we instrument using a group level variable we derive the total effect including spillovers. The increase in the coefficient when we instrument is consistent with a positive spillover effect.

In Tables 11 and 12 we report the results of the same analysis undertaken for girls. Again the test statistics for weak instruments and over identification, reported in Table 12, are satisfactory. In column 1 of Table 11 we see that when we do not instrument the estimated effect of measles vaccination on the enrollment of girls is positive and significant. However, in column

3, when we instrument vaccination with our intervention, the estimated effect for girls is no longer significant.

Attanayake et al. (1993) estimate that in 1988 the Matlab measles program cost about $2.10 per vaccinated child - about $3.82 in 2011 prices adjusting for inflation. Taking the effect on the probability of enrollment as 0.095 for boys, and zero for girls, this gives us a cost of about $80 per child enrolled. Usually the cost effectiveness of school enrollment interventions is expressed in terms of cost per additional years of schooling completed. Kremer (2003) gives estimates for the cost of an extra year of schooling of $3.50 for deworming, $36 for a school feeding program, and $99 for free uniforms. Canning, et al. (2011) estimate that maternal immunization against tetanus that is passed on to the child in utero increases the child's school attainment at a cost of about $16 per year of schooling. The average difference in completed years of school in 2005 between those enrolled in 1996 and those not enrolled (see Figure 2) was 2.7 years. This gives us an estimate of about $27 per year of schooling gained for measles vaccination, which is substantially more than the estimate for deworming and more than that found for maternal tetanus immunization but which compares favorably with school based interventions reported by Kremer. The main rationale for measles vaccination is to reduce child mortality and morbidity. However our results indicate a substantial additional benefit in the form of schooling enrollment.

4. Conclusion

Our findings show that childhood measles vaccination appears to increase the school enrollment of boys, but not of girls, in Matlab, Bangladesh. Our results strengthen the argument for investment in vaccines, based on the gains in cognition, schooling, and eventually adult earnings,

as part of the benefits in a cost effectiveness analysis of vaccines (Bärnighausen et al. (2011)). A natural extension of this research would be to undertake a follow-up study of the income of the children born in Matlab over the period 1980-1988 to see if there are effects on earnings.

Our study finds effects on school enrollment as a result of measles vaccination for boys, but not for girls. There are two possible explanations for this. One is the health effects of measles vaccination are different in boys than in girls. Aaby et al. (2004) and Veirum et al. (2005) find a much larger reduction in mortality from measles vaccination for girls than for boys, and speculate that measles vaccination has non-specific health benefits that differ across the sexes.

A second possible explanation is that boys and girls have similar health benefits but family preferences for education differ across boys and girls. There was extensive son preference in rural Bangladesh and in Matlab in this period affecting fertility, nutrition, medical care, and child mortality (Chowdhury and Bairagi (1990), Hossain and Glass (1988)). While school enrollment rates were similar overall for boys and girls in our sample, families may be more sensitive to health and cognitive development in deciding to send boys to school than in sending girls to school. Canals-Cerda and Ridao-Cano (2004) find that working, as an alternative to school, is much more common for school age boys in Matlab than for school age girls. This may mean that for girls social norms mean there is little alternative to school. However for boys there is a choice between school and work, even at young ages, and physical and cognitive development related to childhood health may affect this choice. This differential result for boys and girls implies that while there may a biological mechanism linking measles to a child's physical and cognitive development the way this is manifested in schooling outcomes may depend on cultural norms and the social setting.

Table 1. Vaccination Status by Block

Block	Age-Appropriate Vaccination	Other Vaccination	No Vaccination	Total
A	3044	2564	1815	7423
B	2195	2347	3273	7815
C	3151	3027	1273	7451
D	1489	2309	2134	5932
E	28	127	35134	35289
Total	9907	10374	43629	63910

Table 2. Age-Appropriate Vaccination by Year of Birth and Block (%)

Year	A	B	C	D	E
1980	0.0	0.0	0.0	0.0	0.0
1981	37.0	0.0	38.3	0.0	0.0
1982	38.5	0.0	29.0	0.0	0.0
1983	43.3	0.1	36.4	0.0	0.0
1984	35.0	4.8	41.0	7.4	0.0
1985	42.0	48.1	49.5	54.6	0.1
1986	43.9	46.3	52.6	52.3	0.1
1987	50.3	63.9	59.6	52.3	0.1
1988	60.7	68.6	65.4	57.5	0.3

Age appropriate is after 9 months before 12 months of age.

Table 3. Other Vaccination by Year of Birth and Block (%)

Year	A	B	C	D	E
1980	52.4	1.6	83.5	5.5	0.1
1981	25.9	31.9	41.3	46.2	0.2
1982	34.0	38.3	45.6	51.5	0.1
1983	26.8	45.6	38.8	61.9	0.2
1984	28.8	67.1	33.3	69.2	0.2
1985	37.1	31.3	32.3	25.4	0.5
1986	37.1	22.9	29.0	26.0	0.5
1987	31.0	16.3	25.8	31.7	0.7
1988	21.7	10.1	19.6	24.4	0.8

Other vaccination is before 9 months or after 12 months of age but before 5 years.

Table 4. Summary Statistics

Variable	Mean	Std. Dev.	Min	Max
Educational enrollment	0.773	-	0	1
· Boys	0.772	-	0	1
· Girls	0.774	-	0	1
Fraction of years 1-5 with vaccination	0.356	0.456	0	1
· Boys	0.351	0.454	0	1
· Girls	0.362	0.458	0	1
Entered treatment area by 12 months of age	0.335	-	0	1
Entered treatment area after 12 months and before 5 years of age	0.125	-	0	1
Child is male	0.520	-	0	1
Number of living children in family	2.383	2.068	0	13
Father's years of education	2.881	3.635	0	16
Mother's years of education	1.374	2.336	0	16
Maternal tetanus vaccine received in last 5 years	0.376	0.484	0	1
Other vaccine intervention available	0.199	-	0	1
Vitamin A intervention available	0.152	-	0	1
Iron intervention available	0.145	-	0	1
Mother's age at birth of child	26.956	6.550	12	60

Note: N= 32,319

Table 5 Status in 1996 by Year of Birth (%)

	1980	1981	1982	1983	1984	1985	1986	1987	1988
Present	61.37	61.45	63.44	66.28	68.88	72.48	74.04	75.45	77.46
Migrated	19.32	17.76	16.76	15.69	14.85	12.89	13.25	12.29	10.93
Dead	19.31	20.79	19.79	18.03	16.27	14.62	12.71	12.26	11.62

Table 6 Reason for Out Migration by Year of Birth (%)

	1980	1981	1982	1983	1984	1985	1986	1987	1988
Familial	52.53	63.45	71.31	77.91	76.54	79.37	79.77	81.15	80.26
Marital	4.15	1.95	1.25	1.04	1.13	0.84	0.32	0.79	0.74
Economic	15.54	13.03	11.42	10.96	11.73	8.90	6.99	4.40	2.40
Educational	3.45	3.59	2.74	2.78	2.16	1.57	2.97	1.02	1.48
Other	0.21	0.55	0.23	0.26	0.21	0.31	0.74	0.23	0.00
Involuntary	0.14	0.39	0.16	0.09	0.41	0.63	0.11	0.45	0.92
Missing	23.98	19.03	12.90	6.96	7.82	8.38	9.11	11.96	14.21

Table 7: Impact of measles vaccination on school enrollment: Probit model

	Probit	IV Probit First Stage	IV Probit
Dependent Variable	School Enrollment	Measles Vaccination: Ratio of age 1-5 years covered	School Enrollment
Fraction of years 1-5 with vaccination	0.024*		0.045
	(0.013)		(0.037)
In a treatment area by 12 months of age		0.879***	
		(0.086)	
In a treatment year after 12 months and before 5 years of age		0.478***	
		(0.093)	
Child is male	-0.006	-0.001	-0.006
	(0.006)	(0.002)	(0.006)
Number of living children	-0.002	0.001	-0.002
	(0.004)	(0.001)	(0.004)
Father's years of education	0.020***	0.0001	0.020***
	(0.001)	(0.000)	(0.001)
Mother's years of education	0.030***	0.001	0.030***
	(0.001)	(0.001)	(0.001)
Other vaccine intervention available	0.011	0.053	0.006
	(0.011)	(0.033)	(0.015)
Vitamin A intervention available	0.009	0.086***	0.004
	(0.014)	(0.026)	(0.016)
Iron intervention available	-0.015	-0.056**	-0.011
	(0.013)	(0.029)	(0.014)
Maternal tetanus vaccine received in last 5 years	0.029***	0.063***	0.027***
	(0.009)	(0.013)	(0.010)
Mother's age at birth	-0.001	0.0003	-0.001
	(0.001)	(0.000)	(0.001)
Block A	-0.045***	-0.086	-0.060**
	(0.015)	(0.089)	(0.025)
Block B	-0.018	-0.136	-0.027*
	(0.012)	(0.083)	(0.016)
Block C	-0.107***	-0.019	-0.126***
	(0.020)	(0.091)	(0.034)

Block D	-0.064***	-0.096	-0.075***
	(0.020)	(0.088)	(0.025)
Born in 1981	0.029**	-0.153	0.028**
	(0.014)	(0.097)	(0.014)
Born in 1982	0.043***	-0.124	0.041***
	(0.011)	(0.082)	(0.011)
Born in 1983	0.060***	-0.082	0.057***
	(0.010)	(0.076)	(0.009)
Born in 1984	0.032***	-0.016	0.028**
	(0.012)	(0.097)	(0.012)
Born in 1985	-0.039***	-0.075	-0.043***
	(0.013)	(0.077)	(0.012)
Born in 1986	-0.126***	-0.098	-0.128***
	(0.016)	(0.079)	(0.015)
Born in 1987	-0.294***	-0.075	-0.298***
	(0.018)	(0.078)	(0.017)
Born in 1988	-0.485***	-0.068	-0.489***
	(0.019)	(0.078)	(0.018)
Constant		0.073	
		(0.077)	
N	32319	32319	32319
Pseudo R-squared	0.185		
Log pseudo-likelihood	-14108		-5941.6
Wald test of exogeneity of measles (chi-sq)			0.472
p-value of Wald Test			0.492

For school enrollment (columns 1 and 3) marginal effects on probability of enrollment estimated at the means of explanatory variables are reported.
Robust standard errors clustered at group level (year of birth x block).
***, **, and * indicate significance at the 1%, 5%, and 10% levels, respectively.

Table 8. Impact of measles vaccination on school enrollment: Linear probability model

	OLS	IV First Stage	IV
Dependent Variable	School Enrollment	Measles Vaccination: Ratio of age 1-5 years covered	School Enrollment
Fraction of years 1-5 with vaccination	0.030**		0.058
	(0.013)		(0.036)
In a treatment area by 12 months of age		0.879***	
		(0.086)	
In a treatment year after 12 months and before 5 years of age		0.478***	
		(0.093)	
Child is male	-0.003	-0.001	-0.003
	(0.005)	(0.002)	(0.005)
Number of living children	-0.002	0.001	-0.002
	(0.004)	(0.001)	(0.004)
Father's years of education	0.016***	0.0001	0.016***
	(0.001)	(0.0003)	(0.001)
Mother's years of education	0.019***	0.001	0.019***
	(0.002)	(0.001)	(0.002)
Other vaccine intervention available	0.006	0.053	-0.002
	(0.010)	(0.033)	(0.014)
Vitamin A intervention available	0.014	0.086***	0.008
	(0.015)	(0.026)	(0.015)
Iron intervention available	-0.011	-0.056*	-0.006
	(0.014)	(0.029)	(0.017)
Maternal tetanus vaccine received in last 5 years	0.029***	0.063***	0.026**
	(0.009)	(0.013)	(0.010)
Mother's age at birth	-0.001	0.0003	-0.001
	(0.001)	(0.0002)	(0.001)
Block A	-0.051***	-0.086	-0.070***
	(0.015)	(0.089)	(0.024)
Block B	-0.020*	-0.137	-0.031**
	(0.011)	(0.083)	(0.013)
Block C	-0.100***	-0.019	-0.120***
	(0.017)	(0.091)	(0.029)
Block D	-0.059***	-0.096	-0.071***
	(0.017)	(0.088)	(0.022)

Born in 1981	0.024**	-0.153	0.023**
	(0.012)	(0.097)	(0.012)
Born in 1982	0.035***	-0.124	0.033***
	(0.010)	(0.082)	(0.009)
Born in 1983	0.050***	-0.082	0.047***
	(0.009)	(0.076)	(0.009)
Born in 1984	0.027**	-0.016	0.022**
	(0.011)	(0.097)	(0.010)
Born in 1985	-0.031***	-0.075	-0.035***
	(0.010)	(0.077)	(0.009)
Born in 1986	-0.109***	-0.098	-0.111***
	(0.012)	(0.079)	(0.011)
Born in 1987	-0.270***	-0.075	-0.273***
	(0.013)	(0.078)	(0.012)
Born in 1988	-0.447***	-0.068	-0.451***
	(0.014)	(0.078)	(0.014)
Constant	0.810***	0.073	0.814***
	(0.016)	(0.077)	(0.016)
N	32319	32319	32319
R-squared	0.188	0.830	0.188
Weak identification test: Kleibergen-Paap (KP) F-stat			57.4
KP critical value for 10% maximal bias			19.9
Over identification test: Hansen J statistic Chi-sq(1)			0.444
p-value for J statistic			0.505

Robust standard errors clustered at group level (year of birth x block).
***, **, and * indicate significance at the 1%, 5%, and 10% levels, respectively.

Table 9: Impact of measles vaccination on school enrollment of Boys: Probit model

	Probit	IV Probit First Stage	IV Probit
Dependent Variable	School Enrollment	Measles Vaccination: Ratio of age 1-5 years covered	School Enrollment
Fraction of years 1-5 with vaccination	0.017		0.095**
	(0.015)		(0.044)
In a treatment area by 12 months of age		0.869***	
		(0.088)	
In a treatment year after 12 months and before 5 years of age		0.474***	
		(0.092)	
Number of living children	-0.004	0.001	-0.004
	(0.005)	(0.001)	(0.005)
Father's years of education	0.019***	-0.0001	0.019***
	(0.001)	(0.0004)	(0.001)
Mother's years of education	0.028***	0.002**	0.028***
	(0.002)	(0.001)	(0.002)
Other vaccine intervention available	0.025	0.052	0.006
	(0.016)	(0.035)	(0.019)
Vitamin A intervention available	0.008	0.104***	-0.009
	(0.019)	(0.028)	(0.020)
Iron intervention available	-0.014	-0.066**	0.001
	(0.022)	(0.032)	(0.023)
Maternal tetanus vaccine received in last 5 years	0.018	0.056***	0.012
	(0.013)	(0.013)	(0.014)
Mother's age at birth	-0.001	0.0004	-0.001
	(0.001)	(0.0003)	(0.001)
Block A	-0.049**	-0.068	-0.108***
	(0.020)	(0.092)	(0.037)
Block B	-0.006	-0.128	-0.039*
	(0.018)	(0.084)	(0.022)
Block C	-0.076***	-0.002	-0.145***
	(0.020)	(0.094)	(0.042)
Block D	-0.063***	-0.098	-0.103***

	(0.024)	(0.087)	(0.036)
Born in 1981	0.024	-0.147	0.021
	(0.019)	(0.095)	(0.019)
Born in 1982	0.043***	-0.126	0.038**
	(0.017)	(0.083)	(0.016)
Born in 1983	0.058***	-0.082	0.049***
	(0.016)	(0.077)	(0.015)
Born in 1984	0.052***	-0.025	0.039**
	(0.019)	(0.095)	(0.018)
Born in 1985	-0.029	-0.075	-0.041**
	(0.022)	(0.078)	(0.019)
Born in 1986	-0.105***	-0.103	-0.112***
	(0.024)	(0.080)	(0.022)
Born in 1987	-0.284***	-0.075	-0.296***
	(0.028)	(0.079)	(0.025)
Born in 1988	-0.467***	-0.068	-0.480***
	(0.026)	(0.079)	(0.024)
Constant		0.070	
		(0.078)	
N	16801	16801	16801
Pseudo R-squared	0.170		
Log pseudo-likelihood	-7477.315	-3050.693	-3050.693
Wald test of exogeneity of measles (chi-sq)		4.429	4.429
p-value of Wald Test		0.035	0.035

For school enrollment (columns 1 and 3) marginal effects on probability of enrollment estimated at the means of explanatory variables are reported.
Robust standard errors clustered at group level (year of birth x block).
***, **, and * indicate significance at the 1%, 5%, and 10% levels, respectively.

Table 10. Impact of measles vaccination on school enrollment of Boys: Linear probability model

	OLS	IV First Stage	IV
Dependent Variable	School Enrollment	Measles Vaccination: Ratio of age 1-5 years covered	School Enrollment
Fraction of years 1-5 with vaccination	0.023		0.102**
	(0.015)		(0.044)
In a treatment area by 12 months of age		0.870***	
		(0.088)	
In a treatment year after 12 months and before 5 years of age		0.474***	
		(0.092)	
Number of living children	-0.003	0.001	-0.003
	(0.005)	(0.001)	(0.005)
Father's years of education	0.016***	-0.000	0.015***
	(0.001)	(0.000)	(0.001)
Mother's years of education	0.018***	0.002**	0.018***
	(0.002)	(0.001)	(0.002)
Other vaccine intervention available	0.021	0.052	-0.000
	(0.015)	(0.035)	(0.017)
Vitamin A intervention available	0.016	0.104***	-0.003
	(0.019)	(0.028)	(0.019)
Iron intervention available	-0.008	-0.066**	0.009
	(0.023)	(0.032)	(0.026)
Maternal tetanus vaccine received in last 5 years	0.020	0.056***	0.014
	(0.012)	(0.013)	(0.013)
Mother's age at birth	-0.001	0.000	-0.001
	(0.001)	(0.000)	(0.001)
Block A	-0.054***	-0.068	-0.107***
	(0.019)	(0.092)	(0.032)
Block B	-0.010	-0.128	-0.041**
	(0.016)	(0.084)	(0.019)
Block C	-0.074***	-0.002	-0.133***
	(0.018)	(0.094)	(0.034)
Block D	-0.058***	-0.098	-0.091***
	(0.021)	(0.087)	(0.029)
Born in 1981	0.022	-0.147	0.019

	(0.018)	(0.095)	(0.016)
Born in 1982	0.039**	-0.127	0.033**
	(0.016)	(0.083)	(0.014)
Born in 1983	0.051***	-0.082	0.042***
	(0.016)	(0.077)	(0.013)
Born in 1984	0.048**	-0.025	0.034**
	(0.018)	(0.095)	(0.017)
Born in 1985	-0.023	-0.075	-0.035**
	(0.018)	(0.078)	(0.014)
Born in 1986	-0.093***	-0.103	-0.098***
	(0.019)	(0.080)	(0.016)
Born in 1987	-0.265***	-0.075	-0.275***
	(0.019)	(0.079)	(0.016)
Born in 1988	-0.437***	-0.068	-0.447***
	(0.018)	(0.079)	(0.016)
Constant	0.807***	0.070	0.816***
	(0.021)	(0.078)	(0.019)
N	16801	16801	16801
R-squared	0.177	0.832	0.175
Weak identification test: Kleibergen-Paap (KP) F-stat			52.83
KP critical value for 10% maximal bias			19.93
Over identification test: Hansen J statistic Chi-sq(1)			0.337
p-value for J statistic			0.561

Robust standard errors clustered at group level (year of birth x block).
***, **, and * indicate significance at the 1%, 5%, and 10% levels, respectively.

Table 11: Impact of measles vaccination on school enrollment of Girls: Probit model

	Probit	IV Probit First Stage	IV Probit
Dependent Variable	School Enrollment	Measles Vaccination: Ratio of age 1-5 years covered	School Enrollment
Fraction of years 1-5 with vaccination	0.030*		-0.012
	(0.017)		(0.045)
In a treatment area by 12 months of age		0.888***	
		(0.085)	
In a treatment year after 12 months and before 5 years of age		0.481***	
		(0.094)	
Number of living children	0.0001	0.001	0.0002
	(0.005)	(0.001)	(0.005)
Father's years of education	0.022***	0.0003	0.022***
	(0.001)	(0.0004)	(0.001)
Mother's years of education	0.032***	-0.001	0.032***
	(0.002)	(0.001)	(0.002)
Other vaccine intervention available	-0.002	0.055*	0.009
	(0.012)	(0.032)	(0.018)
Vitamin A intervention available	0.008	0.067***	0.015
	(0.016)	(0.024)	(0.017)
Iron intervention available	-0.016	-0.046*	-0.024
	(0.014)	(0.026)	(0.016)
Maternal tetanus vaccine received in last 5 years	0.040***	0.071***	0.044***
	(0.009)	(0.016)	(0.010)
Mother's age at birth	-0.001	0.0002	-0.001
	(0.001)	(0.0003)	(0.001)
Block A	-0.040**	-0.105	-0.011
	(0.020)	(0.087)	(0.027)
Block B	-0.032***	-0.145*	-0.013
	(0.012)	(0.083)	(0.019)
Block C	-0.141***	-0.037	-0.102**
	(0.028)	(0.088)	(0.041)
Block D	-0.065***	-0.093	-0.042*
	(0.020)	(0.089)	(0.022)

Born in 1981	0.035**	-0.159	0.036***
	(0.015)	(0.099)	(0.014)
Born in 1982	0.042***	-0.121	0.045***
	(0.013)	(0.082)	(0.011)
Born in 1983	0.061***	-0.081	0.066***
	(0.011)	(0.076)	(0.010)
Born in 1984	0.007	-0.006	0.015
	(0.012)	(0.099)	(0.012)
Born in 1985	-0.053***	-0.074	-0.046***
	(0.013)	(0.077)	(0.011)
Born in 1986	-0.151***	-0.093	-0.146***
	(0.021)	(0.078)	(0.018)
Born in 1987	-0.308***	-0.074	-0.300***
	(0.022)	(0.077)	(0.018)
Born in 1988	-0.508***	-0.068	-0.500***
	(0.024)	(0.077)	(0.023)
Constant		0.075	
		(0.077)	
N	15518	15518	15518
Pseudo R-squared	0.205		
Log pseudo-likelihood	-6601.1		-2829.698
Wald test of exogeneity of measles (chi-sq)			1.249
p-value of Wald Test			0.264

For school enrollment (columns 1 and 3) marginal effects on probability of enrollment estimated at the means of explanatory variables are reported.
Robust standard errors clustered at group level (year of birth x block).
***, **, and * indicate significance at the 1%, 5%, and 10% levels, respectively.

Table 12. Impact of measles vaccination on school enrollment of Girls: Linear probability model

	OLS	IV First Stage	IV
Dependent Variable	School Enrollment	Measles Vaccination: Ratio of age 1-5 years covered	School Enrollment
Fraction of years 1-5 with vaccination	0.039**		0.009
	(0.016)		(0.041)
In a treatment area by 12 months of age		0.888***	
		(0.085)	
In a treatment year after 12 months and before 5 years of age		0.481***	
		(0.094)	
Number of living children	0.0001	0.001	0.0002
	(0.005)	(0.001)	(0.005)
Father's years of education	0.017***	0.0003	0.017***
	(0.001)	(0.0005)	(0.001)
Mother's years of education	0.019***	-0.001	0.019***
	(0.002)	(0.001)	(0.002)
Other vaccine intervention available	-0.010	0.055*	-0.002
	(0.010)	(0.032)	(0.016)
Vitamin A intervention available	0.011	0.067***	0.017
	(0.017)	(0.024)	(0.019)
Iron intervention available	-0.014	-0.046*	-0.019
	(0.015)	(0.026)	(0.018)
Maternal tetanus vaccine received in last 5 years	0.038***	0.071***	0.041***
	(0.010)	(0.016)	(0.011)
Mother's age at birth	-0.001	0.0002	-0.001
	(0.001)	(0.0004)	(0.001)
Block A	-0.049***	-0.105	-0.030
	(0.018)	(0.087)	(0.027)
Block B	-0.032***	-0.144*	-0.020
	(0.010)	(0.083)	(0.016)
Block C	-0.127***	-0.037	-0.105***
	(0.021)	(0.088)	(0.035)
Block D	-0.061***	-0.093	-0.047**
	(0.017)	(0.089)	(0.019)
Born in 1981	0.025*	-0.159	0.026**

	(0.013)	(0.099)	(0.011)
Born in 1982	0.029**	-0.121	0.032***
	(0.012)	(0.082)	(0.010)
Born in 1983	0.047***	-0.081	0.051***
	(0.011)	(0.076)	(0.009)
Born in 1984	0.003	-0.006	0.009
	(0.011)	(0.099)	(0.011)
Born in 1985	-0.042***	-0.074	-0.037***
	(0.010)	(0.077)	(0.010)
Born in 1986	-0.128***	-0.093	-0.126***
	(0.015)	(0.078)	(0.014)
Born in 1987	-0.277***	-0.074	-0.273***
	(0.016)	(0.077)	(0.015)
Born in 1988	-0.460***	-0.068	-0.456***
	(0.019)	(0.077)	(0.019)
Constant	0.812***	0.075	0.808***
	(0.027)	(0.077)	(0.026)
N	15518	15518	15518
R-squared	0.203	0.828	0.203
Weak identification test: Kleibergen-Paap (KP) F-stat			62.01
KP critical value for 10% maximal bias			19.93
Over identification test: Hansen J statistic Chi-sq(1)			0.567
p-value for J statistic			0.451

Robust standard errors clustered at group level (year of birth x block).
***, **, and * indicate significance at the 1%, 5%, and 10% levels, respectively.

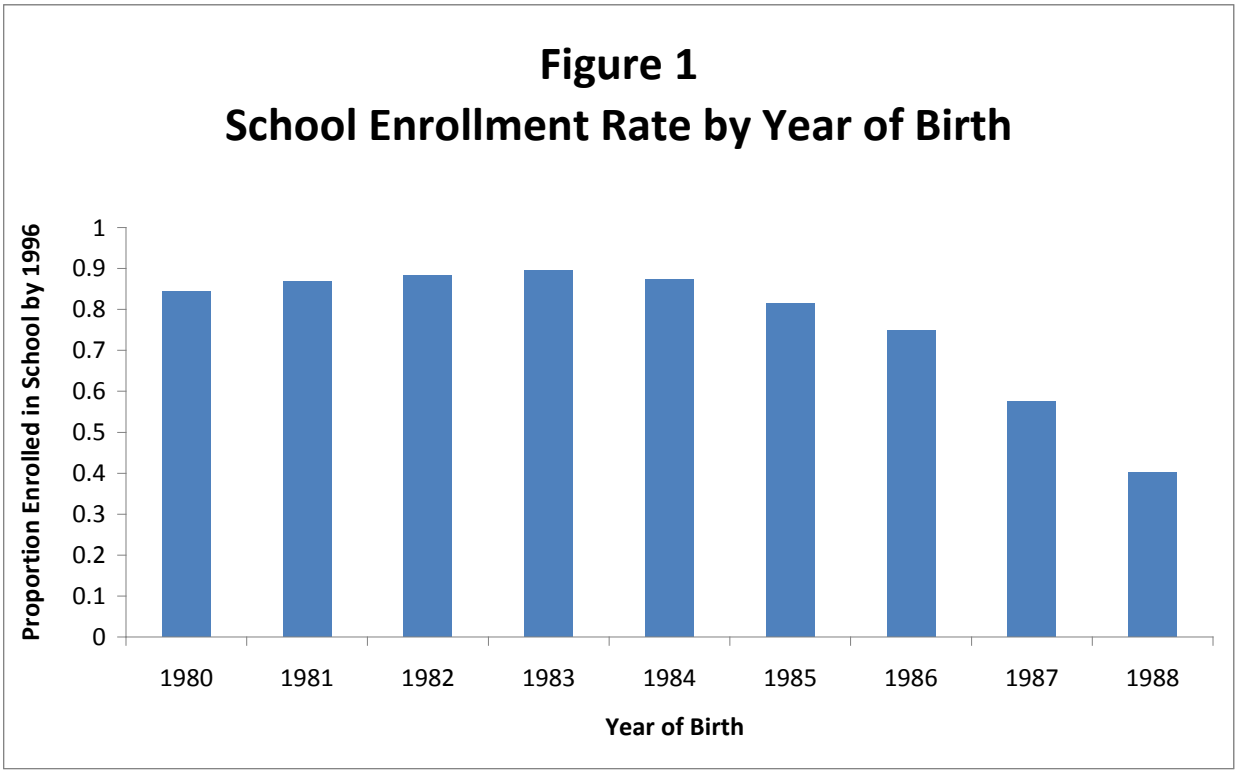
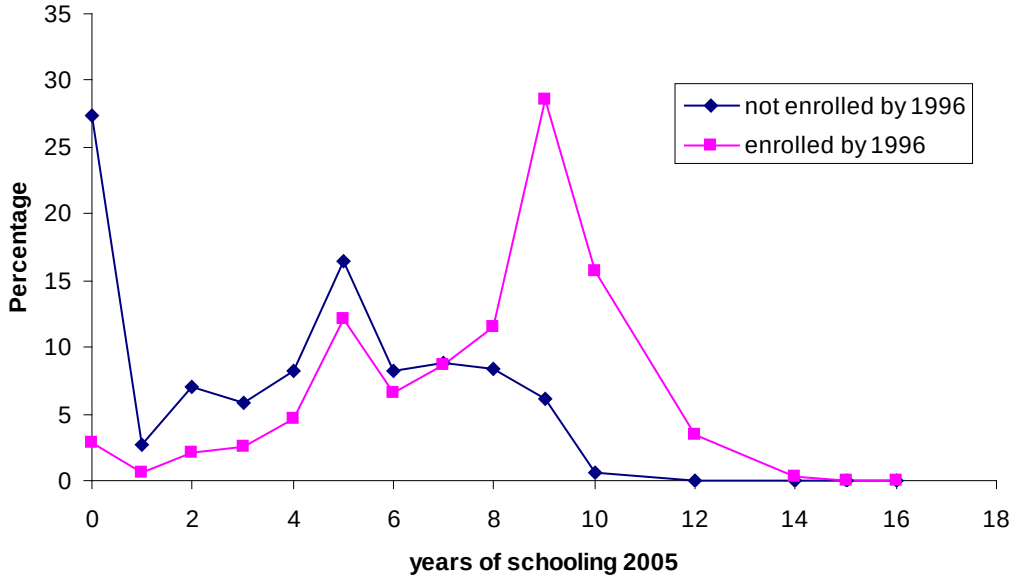


Figure 1
School Enrollment Rate by Year of Birth
Proportion Enrolled in School by 1996
1
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
1980
1981
1982
1983
1984
1985
1986
1987
1988
Year of Birth

Figure 2
Years of Schooling Completed in 2005 by Enrollment in 1996



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