ESSAYS ON EDUCATION AND INSTITUTIONS IN DEVELOPING COUNTRIES

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This study is based on the doctoral dissertation titled “Essays on Education and Institutions in Developing Countries” selected as the award winning entry for the Exim Bank BRICS Economic Research Annual Award (BRICS Award) 2019. The dissertation was written by Dr. Tushar Bharati, currently Assistant Professor of Economics at University of Western Australia Business School, under the supervision of Professor John Strauss and Professor Jeff Nugent. Dr. Bharati received his doctoral degree in 2018 from the University of Southern California, USA.

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EXECUTIVE SUMMARY

Since the seminal works of Schultz (1961) and Denison et al. (1962) that started the “human investment revolution in economic thought” (Bowman (1966)), economists have become increasingly interested in the process of human capital formation. Accumulation of human capital is considered crucial for the diffusion of modern economic growth to the developing regions of the world (Counts (1931); Inkeles (1969); North (1973); Davis et al. (1971); Rosenberg et al. (1986)). Higher levels of human capital are also associated with the evolution of better institutional infrastructure and are desirable in their own right (Pigou (1952); Adelman (1975); Grant (1978); Streeten et al. (1981); Sen (1984); Easterlin (2009)). Despite large investments in education, educational attainments remain low in much of the developing world. The series of studies examines the factors influencing the demand for education in developing countries and the role of education and information in shaping the political institutions that might feedback in the form of more efficient legislation and execution of policies aimed at improving educational attainments.

The first chapter examines the extent to which a supply-side intervention aimed at improving access to schools helped individuals recover from an early-life shock. Using variation in an Indonesian primary school construction program, the study shows that individuals who experienced low rainfall in the first year of life but were later exposed to the school construction program recovered completely from the educational deficit caused by the early- life shock. For individuals who did not experience the adverse rainfall shock, the school construction had no impact. This was, in part, a result of deteriorating school quality and increased competition to get into middle schools that affected the high-rainfall individuals disproportionately.

The second chapter examines the joint effect of two public policy programs in Tanzania- the Iodine Supplementation Program (ISP) and the Primary Education Development Pro- gram (PEDP). The study evaluates the joint impact of two policies using information on a sample of 10 to 13 years old school aged children from the Kagera region in Tanzania. It finds that individuals who received iodine supplementation in-utero but did not benefit from the abolition of school fees under PEDP (ISP exposed group) started school later and had completed fewer years of education by the time of the survey than those who did not benefit from the supplementation or fee abolition (control group). Those who did not receive the iodine supplementation but benefited from the fee abolition (PEDP exposed group) started school earlier and had completed more years of than the control group individuals. Those who received both the iodine supplementation and benefited from the fee abolition started school the latest and had completed the least amount of schooling by the time of the survey. Using the ratio of the impact of the two policies and their interaction on completed schooling and primary school starting age, the study shows that those who were exposed to ISP were more productive in converting one extra year in school into completed years of schooling. This evidence in favor of dynamic complementarity between years in school and iodine supplementation. The study provides suggestive evidence that this delay in enrollment for those exposed to ISP was due to their worse health and higher likelihood of working before enrollment.

The first two chapters make a case for policy intervention to promote education. The quality of political institutions can affect the efficient implementation of these policies. Elected representatives can have a significant role to play in implementing such policies. Studies have found that the implementation of public policy is often fraught with corruption. An interesting follow up question is why do voters in these regions elect corrupt and inefficient candidates to office. In the final chapter, the role of co-ethnic voting in the election of bad quality representatives, who, allegedly, undermine the effectiveness of such policies, is examined. Unlike previous studies that take a candidate's ethnicity as exogenous, this chapter introduces an asymmetric information candidate choice model a`la Hotelling where political parties internalize voters' co-ethnic political preferences and choose candidates of different ethnicity strategically to maximize their vote profits. The model predicts that a party's choice to field a candidate of an ethnicity-type depends on the ethnic composition of the constituency's voters and the ethnicity of other rival candidates running for office. Data from parliamentary and assembly elections from the states of Bihar and Uttar Pradesh in India support the model predictions. Using exogenous changes in information flow proxied by geographical connectedness via all-weather roads, the study shows that lower information cost or greater connectedness implies a lower level of strategic differentiation of candidates along ethnic lines. Evidence suggests that parties disregard potential candidate's involvement in crime to be able to differentiate along ethnic lines. As a result, worse candidates get elected to office.

Together, the chapters verify that households respond to both changes in costs and benefits and changes in the quality of schooling. Higher education might not always translate into higher earnings due to low quality of education or low returns to education in the local economy. As a result, a reduction in cost of schooling might not be sufficient to secure an increase in living standards. However, quality education might have non-pecuniary benefits in the long term in the form of better institutions. Better institutions might improve the efficiency of all government policies and contribute to overall welfare. Therefore, the cost-benefit analysis of such education policies should take into consideration the long-run rewards of these policies.

1. Recovery From An Early Life Shock Through Improved Access To Schools: Evidence From Indonesia[1]

1.1 Introduction

Early life environment can have long lasting impact on health, ability, and well-being of individuals (Almond et al. (2017))[2]. Two observations stand out. First, from diseases to weather, from pollution to maternal stress, many dimensions of early life experiences matter. And second, even mild and brief shocks can have sizable effects. A question that then naturally follows is whether the negative effect of such adverse shocks can be ameliorated with corrective investment[3].

Parental investments that follow an early life shock not only depend on parental preferences and their access to information, investment technology, and resources, but they also respond to the nature and severity of the shock. Therefore, comparing differences in the endogenous levels of these investments by parents across children where some are affected by early life shocks and other are not will generate biased estimates of the level of remediation possible. Therefore, to identify the possibility and extent of remediation, two sources of exogenous variation bare required - exposure to an early life shock followed by a corrective policy or investment affecting the same population. In other words, it requires "... 'lightning to strike' twice: two identification strategies affecting the same cohort but at adjacent developmental stages" (Almond and Mazumder (2013a)).

Against this background, the study examines the extent to which the Indonesian primary school construction (hereon, INPRES) program of the 1970s, that improved access to primary schools, helped individuals overcome an early life resource shock as proxied by low rainfall in the first year of life. Combining individual level information on educational attainment, time and place of birth and other demographics from the fifth wave of the Indonesian Family Life Survey Wave (IFLS, 2014) with the district-month-year level rainfall and the district level intensity of school construction data from Duflo (2001), the study investigates the

[1]Coauthored with Dawoon Jung and Seungwoo Chin

[2]Also, see Almond and Currie (2011) and Currie and Almond (2011). See Gillman (2005) and Heindel and Vandenberg (2015) for recent reviews from epidemiology.

[3]Since shielding or insuring all vulnerable individuals against shocks to these different dimensions of early life environment is unfeasible, the question of mitigation is pertinent even from the standpoint of public finance.

joint effect of rainfall shocks in the first year after birth and of a large scale school construction program, the INPRES program, on educational attainment of the exposed individuals in Indonesia. Consistent with the findings in Maccini and Yang (2009) and Duflo (2001), the study finds that both high rain in the first year of life and the primary school construction program had positive effect on education separately. In terms of recovery from early life shock, individual who experienced less than historical median level of rainfall in the first year of life, but received the median number of schools in her district under the INPRES program, recovered completely from the early life shock, catching up to those who experienced more than the historical median level of rainfall in the first year of life (See figures 1.1 and 1.2). Additionally, there is no impact of school construction for those who experienced good rain in the first year of life. Evidence suggests that the school expansion may have been accompanied by deteriorating school infrastructure and increased competition to get into middle and high schools. Findings suggest that, even for cohorts not exposed to the INPRES school construction program, above-median levels of rainfall in the first year after birth were associated with higher probability of going to school and higher levels of education. Once the INPRES program was rolled out, the high rainfall individuals, who would have been more likely to be in school even without the program, suffered more due to deteriorating quality and increased competition than low rainfall individuals. Consistent with the deteriorating quality argument, the study finds that as schools got more time to respond to the situation, the difference in the impact of INPRES vanished.

The study builds on the large literature around the later-life impacts of early-life shocks and, using two well-established identification strategies, takes a step further to provide causal evidence on the effectiveness of public policy in mitigating the adverse impact of such shocks[4]. This is an important result as it speaks optimistically to the problem of not being able to shield all individuals from all kinds of mild early-life shocks. Nurturing can counteract differences that result from nature playing dice. The evidence on recovery from early shocks, especially from developing countries where these shocks are more frequent and severe and the avoidance mechanism less developed, is limited and somewhat conflicting. Aguilar and Vicarelli (2011) examine the extent to which Mexico's conditional cash transfer Progresa program mitigated the negative impacts of rainfall shocks due to El-Niño around birth. They find

[4]Almond et al. (2011), Løken et al. (2012), Hoynes et al. (2015), Hoynes et al. (2016), and Aizer et al. (2016) also find larger impacts of public policy on the more disadvantaged populations. But they are careful in not interpreting it as a remediation effect since unobservable factors could be associated with both the endogenous gradients along these indicators of disadvantage and the production of later-life outcomes of interest.

that the negative effects of the rainfall shocks were not mitigated by Progresa in the short term. Adhvaryu et al. (2018) use a similar design to look at educational outcomes at ages 12 to 21. In contrast to Aguilar and Vicarelli (2011), they find that Progresa mitigated much of the harmful effects of rainfall shocks in the year of birth.

The findings complement those of Adhvaryu et al. (2018). But this study also differs in important ways. To better understand remediation and inform policy designs, one must develop our understanding of what kinds of early-life disadvantages can be mitigated, which policies are more cost-effective in facilitating recovery, and what are the mechanisms by which remediation is accomplished. For example, while Progresa attempted to incentivize the demand, INPRES was a supply-side intervention. This is important difference since demand-side subsidies tend to have an “anchoring” or a “background contrast effects” - individuals are unwilling to pay a higher price for a product once the subsidy ends or is reduced (Simonson and Tversky (1992); Koszegi and Rabin (2006); Simon-sohn and Loewenstein (2006)). Besides thanks to the richness of the IFLS data, the study evaluates recovery along different dimensions of well-being. The study also provides suggestive evidence on the potential pathways.

The remainder of the study is organized as follows. Section 1.2 briefly summarizes the previous literature on the topic of recovery. Section 1.3 provides a brief background of the two ‘shocks’, previous evidence on their impacts on education and the plausible pathways they propose. Section 1.4 presents a conceptual framework to understand how these shocks might have interacted and to draw testable implications. Data and the empirical strategy are discussed in section 1.6. The results are reported in section 1.7 and the possible pathways are discussed in section 1.8. Section 1.9 concludes.

1.2 Background

1.2.1 Rainfall Shocks as Proxies for Income Shocks

Agriculture is one of the most important sources of household income in Indonesia. According to World Bank indicators, during the 1970s, close to 65 percent of the country’s labor force was engaged in agriculture, mostly in rice production. Agriculture, and rice production in particular, is highly dependent on the timing and amount of rain in Indonesia (Kishore et al. (2000); Levine and Yang (2014)).

The specific monsoon trajectory varies across years and, as a result, the timing, intensity and duration of precipitation varies across the different rice growing regions in the country in any year and across years within a region. Planting of rice is done once a certain level of rainwater has accumulated in the fields. Delayed planting in the main agricultural season leads to reduced crop yields not only in that season but also reduces the secondary crop yields by delaying the harvesting of primary season crops and planting of secondary crops. Levine and Yang (2014) find that higher rainfall in Indonesia is associated with higher output of rice. Maccini and Yang (2009) find that the benefits of rainfall do not diminish even at very high levels of rainfall. Due to its equatorial location, other weather-related factors such as temperature shows little variation within years and across years.

According to statistics released by Indonesian Ministry of Agriculture, smallholder farmers account for around 90 percent of Indonesia's rice production. Given the high dependence on rice for both household consumption and income, rainfall shocks are one of the most important risk factors faced by households. Within a household, availability of food, nutrient composition of food, income availability for other consumption purposes, time allocation for adults and children, general level of stress, etc., can all be influenced greatly by rainfall shocks (Behrman and Deolalikar (1987); Bouis and Haddad (1992); Blau et al. (1996); Rosenzweig and Udry (2014)). Pregnant women and young children are particularly vulnerable to such shocks. As mentioned in the introduction, evidence in favor of the 'critical-period programming' or 'development origins of diseases' hypothesis is amassing from different disciplines. Rainfall in early years is one such shock.

Maccini and Yang (2009) find that better rainfall was associated with better health, educational and socio-economic outcomes for women born between 1953 and 1974. They argue that better rain, through higher income, improves the ability of parents to provide better 'nutrition, medical inputs, and generally more nurturing environments for infant girls. As Maccini and Yang (2009) acknowledge, other channels, like disease environment, availability of portable water, that link rainfall to child health might exist. Cornwell and Inder (2015) find that both the nutrition and disease-environment pathways are operational linking rainfall to health outcomes.

Rainfall shock in-utero serves as the early life shock to investment in the study that has implications for educational attainments of the exposed individuals. The study investigates whether improved access to primary schools through the INPRES school construction program help individuals recover from this early life shock and catch up to those who did not experience this shock in early life.

1.2.2 Primary School Construction Program

In the 1970s, the Indonesian government sought to redistribute the country's aggregate gains from the oil booms. This was carried out according to detailed presidential instructions on the process to be followed, often referred to as INPRES (Ravallion (1988)). Sekolah Dasar INPRES, the implementation of which started in 1973, was one of the flagship programs to come out of these instructions. Between 1973-74 and 1978-79, more than 61,800 primary schools were built in Indonesia, roughly about 2 schools per 1,000 children enrolled in 1971. This was an attempt to increase primary enrollment rate for children in the age group 7 to 12, which was around 69 percent in 1973. (Duflo (2001)). The program was planned to target districts with low enrollment first but did not follow the instruction perfectly. It was one of the fastest and largest primary school construction projects in the world (World Bank (1990)). Along with the construction project, the government also supplied textbooks and hired new teachers (Parinduri (2014)). The program was a success and primary school enrollment rate rose up to 91 percent in 1986 (World Bank (1990)). Duflo (2001) evaluates the program and finds an increase of around 0.2 extra years of schooling for every school constructed per 1000 children.

The timing of INPRES school construction program relative to timing of the survey makes it the perfect intervention to study to examine the possibility of recovery from early life shock. Information on education attainments of the population of interest was collected when these individuals were well over 40 years of age. Therefore, there is little possibility of a change in their completed years of formal education now. It also gets around the puzzle of finding initial effects that "fade out" by teenage but then reappear in adulthood observed in much of the literature on early intervention programs (Currie and Almond (2011)).

1.3 Interaction between Early Life Rainfall shock and Primary School Construction Program

Parental investment might have responded to the early life rainfall shock, especially if the impact of these shocks was readily visible. However, whether parents reinforced or compensated for these shocks depends not only on parental preference but also on their access to resources, information and investment technology. Evidence from the developing world finds parents reinforce initial advantages (Li et al. (2010); Yi et al. (2015); Adhvaryu and Nyshadham (2016)).

It is possible, therefore, that within households, high rainfall individuals who received better nutrition due household's improved access to resources in their year of birth, and, presumably, had better ability, ability defined broadly to include any cognitive or health advantage they had, were also given priority when it came to sending children to school. However, it is not clear if this was because parents wished to maximize total returns of their children or because they wanted to equalize outcomes but did not have suitable investment technology with decent returns available to them. As Almond et al. (2017) point out, even for parents who wish to compensate for the early life disadvantage, if they cannot afford the cost of intervening to help a disadvantaged child but can afford basic investment in a non-disabled sibling, the choice may be obvious.

As a result, a priori, it is not clear if improved access to primary schools would have had higher impact on high rainfall individuals or low rainfall individuals. For example, if due to parental preference or constraints, low rainfall individuals are less likely to be in school, such a school construction program might disproportionately benefit low rainfall if it drives them to enroll. However, if it does not increase enrollment for low rainfall children, the aggregate benefits of reduced transportation costs will be higher for high rainfall individuals. The effects are reversed if parents had been responding to the early life shock by investing more in the education of low rainfall individuals. It is, therefore, an empirical question whether the school construction program had higher or lower impact by rainfall in early life.

1.4 Data

1.4.1 Indonesian Family Life Survey (IFLS)

For the main analysis, the study uses information on schooling attainments from the fifth wave of Indonesian Family Life Survey (IFLS, 2014). IFLS is an on-going longitudinal household survey of conducted by RAND corporation that began from 1993. The survey respondents are representative of about 83 percent of Indonesian population and contains over 50,000 individuals living in 13 of the 27 provinces in the country (Strauss et al. (2016)). It contains information of a wide variety of topics at the individual, the household and the community level. Individual level information includes information on health, education, employment, migration, etc. IFLS also collects some education related information retrospectively.

1.4.2 Rainfall

The study uses University of Delaware Center for Climatic Research's "Terrestrial Precipitation: 1900-2008 Gridded Monthly Time Series (1900-2008) (Version 2.01)" rainfall that uses an algorithm based on the spherical version of Shepard's distance-weighting method to combine data from twenty nearby weather stations and come up with interpolated rainfall figures for every 0.5 latitude by 0.5 longitude grid. The study borrows the district level latitude- longitude information file from Maccini and Yang (2009) to match the districts to monthly rainfall information from all grids in a 200-kilometer radius around the district center. A weighted average of rainfall across these grids weighing rainfall information from each grid by the inverse of its distance from the district center is calculated. For every month of every year, a district level median rainfall by using the month-district specific rainfall in the previous 50 years is calculate. Next, the prior 50 year -month district specific median rainfall is deducted from the rainfall in a particular month. It is assumed that if the rainfall in a district is a particular month in a particular year is above the prior 50 year district month median, it is a positive shock to income in that month. For each individual in the sample, this difference between the district month-year specific rainfall and the district- month specific median rainfall in the past 50 years is aggregated for the 12 months after birth. Then, a dummy variable that takes value '1' if this 12 month aggregate is greater than 0, '0' otherwise is defined. This serves as the main rainfall shock, rainfall shock in the year after birth.

1.4.3 Primary School Construction Program

The number of schools constructed differed across kabupaten (Indonesian districts). The information on intensity of school construction comes from Duflo (2001). Intensity, here, is the number of newly constructed schools per 1,000 children in the district. The individual level information from IFLS 5 is matched with the school construction intensity in the district in which an individual was born. It is assumed that an individual went to school in the district where he was born. IFLS also collects information on place of residence at age 12. Using this information, it is found that around 93 percent of the individuals were in their birth districts at age 12.

While those born after 1968 got the full advantage of INPRES, given the late enrollment in developing countries, it is possible that individuals who were born not long before 1968 might have also benefited partially from the primary school construction. For this reason, the control group consists of individuals who were 13 to 17 years old in 1974 (born between 1957 and 1961) and the treatment group consists of those who were 1 to 5 years old in 1974 (born between 1969 and 1973). The cohorts in between are omitted since as the extent of exposure to INPRES for these cohorts is not known. The INPRES treatment variable is the product of the district level intensity of school construction and the treatment status of the individual based on the year of birth. The treatment variable takes value ‘0’ for all who were born in or before 1961 and is equal to the intensity of the school construction in their district for all those born in or after 1968.

1.4.4 School Infrastructure

To identify the pathways through which INPRES affected educational outcomes differently for high and low rainfall individuals, the study also makes use of information from the Indonesian Population Census (IPC) of 1971, 1980 and 1990, and the Intercensal Population Survey (SUPAS) of 1976 and 1985. One pathway of interest is the school infrastructure and quality. In order to utilize information about the number of teachers, the study employs a strategy similar to Behrman and Birdsall (1983). From each survey, the sample of individuals who report being a school teacher as their primary occupation is extracted. Using the demographic information on these selected individuals, the school infrastructure quality measures are constructed. The district survey year specific primary and secondary school pupil-teacher ratio are calculated from these surveys.

1.4.5 Summary Statistics

Table 1.1 the summary statistics by INPRES treatment status and by rainfall in the first year after birth. For the INPRES control group cohorts, high rainfall individuals complete higher years of school than low rainfall individuals. The difference, however, is almost non-existent for those exposed to INPRES. The INPRES control group, as one would expect, has a lower average educational attainment than the exposed group. The sample consists of almost an equal proportion of males and females. The individuals are mostly from Javanese Muslims from rural area and their parents tend to have some education. The exact number of completed years of schooling of an individual’s mother and father is missing for much of the sample of interest. Therefore, the study uses separate dummy indicators for whether the mother and father of an individual had any education, completed primary, completed middle school, completed high school, or had some tertiary education.

The historical monthly average rainfall across Indonesia is about 180 millimeters. However, there is plenty of variation across months and across geographical area. Individuals are categorized into high rain and low rain on the basis of rainfall amounts in the first year after birth. As is clear from the **Table 1.1**, this does not mean that high rainfall individuals also experienced higher than average rain before and during pregnancy. It seems that there is a fair degree of variation in each of these rainfall variables that is independent of the rainfall variables in other periods. INPRES intensity is ‘0’ for the control group by construction and is over two schools per 1,000 children on average for both high and low rain individuals in the treatment group. The difference between the intensity in high and low intensity region is around one extra school per 1,000 children.

1.5 Empirical Strategy

The identification relies on the variation in INPRES intensity and rainfall in the first year after birth at the district-year and district-year-month level. The independent impact of INPRES is identified by comparing treatment and control cohorts from districts with varying levels of intensity of school construction. The independent impact of rainfall in the first year after birth is estimated by comparing the outcomes for high rainfall individuals and low rainfall individuals across month-year of birth and district of birth. The interaction of the two shocks is estimated by comparing individuals with varying levels of month-year district rainfall in the first year after birth from the control group with individuals with varying levels month-year district rainfall in the first year after birth from the treatment group and subtracting from that the independent impact of the two treatments. The identification strategy is, basically, one of difference-in-difference-in-difference. More precisely:

$$S_{ijmt}= \alpha +\beta_1 \cdot R_{jmt}+\beta_2 \cdot I_j * T_t+\beta_3 \cdot R_{jmt} * I_j * T_t+\gamma X_{ijmt}+\delta_t+\nu_j+\mu_m+s_{ijmt} \quad (1.8)$$

where Rjmt is a dummy that takes value ‘1’ if the rainfall for month m in year t in a kabupaten j is greater than the historical mean of rainfall of that season in that kabupaten, ‘0’ otherwise. I_j represents the INPRES intensity in kabupaten j and T_t represents if the cohort born in year t was exposed to the INPRES program. Those born between 1969 and 1973 form the treatment group for INPRES and those born between 1957 and 1961 form the control group. δ_t are year fixed effect, v_j are kabupaten fixed effect, and μ_m is month fixed effect. Kabupaten fixed effects absorb any unobservable time-invariant differences across districts and account for endogenous program placement and intensity of INPRES across kabupatens. X_{ijmt} is a vector of controls that includes rainfall controls for nine months before pregnancy, during pregnancy, type of residence (urban or rural), parental education, gender dummy, a dummy each for whether the individual belongs to the majority ethnicity and religion. In addition, following Duflo (2001), the interaction of the year of birth with the population aged 5 to 14 in 1971, the enrollment rate in the district in 1971 and the allocation of the water and sanitation program, the second largest INPRES program at the time, are included to account for omitted time-varying and region- specific effects correlated with the school construction program. Standard errors are clustered at the province level.

Our main outcome variable of interest is completed years of schooling. β_1 captures the effect of high rainfall in the first year after birth for individuals not exposed to INPRES, β_2 is the effect of INPRES program for low rainfall individuals? To ascertain the extent of recovery, one needs to compare the positive effect of INPRES on those who were exposed to low rain in the first year of their life (a negative shock) but benefited from INPRES to the positive effect of high rain for those who were not exposed to INPRES later. That is, at pointed out in A1, the extent of recovery is to be deduced from the relative magnitudes of β_1 and β_2. If at the median level of rain in the first year of life and the median level of school construction intensity, $\beta_1 = \beta_2$, it implies that for a median individual, INPRES brought about full recovery from the early life shock of low rainfall. The coefficient of the interaction term, β_3, captures the heterogeneous effect of INPRES by rainfall in the first year after birth. The impact of higher than average levels of rainfall in the first year after birth for those exposed to INPRES is the sum of β_1 and β_3. Similarly, the impact of INPRES for high rainfall individuals is given by the sum of β_2 and β_3. A positive β_3 is an indication of synergies between the two shocks at different stages in life. On the other hand, a negative β_3 will suggest that low rainfall individuals made better use of the opportunities provided by the INPRES program than high rainfall individuals.

1.6 Results

Table 1.3 examines the effect of above median rainfall in the first year of life and the INPRES primary school construction program, separately. Column (1) presents the impact of above median rainfall in the first year of life. Those who experience above median rainfall in the first year after birth attain 0.26 extra years of schooling. The estimates are very close to those reported by Maccini and Yang (2009). The mean level of rainfall in the first year after birth is 2160.97 mm and 2682.46 mm for low rainfall and high rainfall individuals, respectively. Therefore, a movement from the category of below median rainfall in year one to above median rainfall in the first year of life roughly amounts to a little over 20 percent increase in rainfall, on average. Maccini and Yang (2009) find a gain of 0.22 years of schooling for a 20 percent increase in rainfall in the first year after birth. Column (2) presents the impact of one more school construction per 1,000 children under the INPRES program. As expected, school construction led to an increase in the educational attainment of the exposed cohorts. One more school per 1,000 children increased an individual's years of schooling by 0.18 years on average. Even though the estimate is not statistically significant, the magnitude is strikingly close to that reported by Duflo (2001). Duflo (2001) reports an increase of 0.19 years of schooling for each school built per 1000 children. As is clear from column (3), including both the rainfall shock and the INPRES school construction variable in the same specification leaves the results virtually unchanged, suggesting that the variation in rainfall shock is orthogonal to the variation in intensity of the school construction program.

Column (4) examines the joint impact of above average rainfall in the first year after birth indicator, INPRES intensity and their interaction. The independent impacts of the two treatments are significant and their magnitudes are around two to three times the magnitudes in column (1) and (2). The interaction, too, is significant. Those who experienced high rainfall in the first year of life did considerably better than those in the omitted category with a negative rainfall shock and no INPRES program treatment; they attended 0.73 extra years of schooling, on average. Some of those who experienced low levels of rainfall in the first year of life were later exposed to the INPRES school construction program. Compared to the omitted category, they completed 0.37 more years of schooling for every school constructed per thousand children. Considering that the median number of schools per 1000 children in the district in the sample was 1.9, this meant 0.70 extra years of schooling for the median child affected by the negative rainfall shock in early life but exposed to the INPRES school construction program later on. Comparing this magnitude with the impact of above median rainfall in the first year of life, improved access to primary schools due to the INPRES primary school construction program facilitated full recovery from the education deficit created by low rainfall in the first year of life.

β_3 captures the heterogeneity in the effect of INPRES school construction program by rainfall in the first year of life. **Table 1** also reports the impact of INPRES school construction program on those who had did not experience the early life shock ($\beta_2 + \beta_3 = 0.01$) and the F-stat for the joint significance β_2 and β_3. For ease of comprehension, column (1) of **Table 1.4** presents the results from column (4) of **Table 1.3** using a fully interacted specification. The impact of school construction on those who experienced above median rainfall in the first year of life is very small in magnitude and insignificant. Columns (2-4) report how this result changes under specification changes to the regression specification or sample. The coefficient for the impact of school construction on high rainfall individuals remains virtually unchanged across specifications. One can safely conclude that the INPRES school construction had no impact on those who did not experience the early life shock.

Figure 1.2 depicts the relationship between years of schooling and INPRES school construction intensity after controlling for all the variables discussed in section 1.6. The figure reiterates the observation of **Figure 1.1** and **Table 1.3**. INPRES helped low rainfall individuals to recover from the adverse experience but had no effect for high rainfall individuals. As a result of the no impact of INPRES school construction program on those who did not experience the early life shock, those who experienced the early life shock not only recovered but also caught up to those who did not experience the shock. To see this, note that the joint impact of above median rainfall in the first year of life and the median number of schools constructed per 1000 children in the district is 0.77 extra years of schooling (0.73+ (0.37-0.35) * 1.9 = 0.77). Since the impact of above median rainfall in the first year of life for those who were not exposed to INPRES later was 0.73 extra years of school, the average difference between the educational attainment of those who experienced higher than median level of rainfall in the first year of life and those who had lower than median rainfall in the first year and were not exposed to INPRES, the omitted category in the specification, is a weighted average of 0.77 and 0.73 extra years of schooling. However, as explained above, the independent impact of INPRES program for the median child is 0.70 extra years of schooling, suggesting that those who experienced the negative early life shock but were exposed to the INPRES program caught up to those who did not experience the early life shock.

Such a catchup effect has been observed earlier in Indonesia and elsewhere along dimensions of education and health. It is consistent with the findings of Adhvaryu et al. (2015) about Mexico and of Rossin-Slater and Wust (2015) about Denmark. Mani (2012) used earlier rounds of IFLS survey to track cohorts who were 3 months to 6 years old in 1993 over the next seven years and found that there is partial recovery from effects of childhood malnutrition on adolescence height for children who benefited from health care services in Indonesia. Alderman et al. (2006) and Hoddinott and Kinsey (2001) find some evidence of catch up from the adverse effect of droughts in Zimbabwe. Against the backdrop of these findings from different countries and time periods, the results from **Table 1.3** suggest that recovery from early life shocks may be possible, at least along the dimension of educational attainments, provided that the right investments are made at the right time.

At first glance, the negative interaction effect, or, alternatively, the zero impact of INPRES school construction program on those who did not experience the early life rainfall shock is puzzling. If better rainfall in the first year of life did improve ability, why did the more able individuals fail to benefit from the school construction program? However, given the developments that accompanied INPRES, the lack of an effect of INPRES for those who experienced above median rainfall in the first year of life is not surprising.

1.7.1 Increased Competition and School Infrastructure

Figure 1.4 presents the primary school pupil teacher ratio in the survey years from 1971 until 1990[5]. There was a marked increase in the primary school pupil teacher ratio between 1971 and 1976, after which it came down. The line presents the primary school pupil teacher ratio for each year between 1971 and 1990 as per the data collected by UNESCO. While the primary school pupil teacher ratios calculated from the IPC and the SUPAS waves are slightly higher than that from UNESCO data, the trend over time is similar in data from both these sources. Another observation that stands out is the rapid decline in the pupil-teacher

[5]Card and Krueger(1992) use pupil-teacher ratio as a measure of quality and find that a decrease inpupil-teacher ratio from 30 to 25 in public schools in the United States is associated with a 0.4 percentage point increase in the rate of return to education.

ratio between 1976 and 1980 to levels below that of 1971. This is consistent with the rapid hiring of teachers around this period (**Figure A6**). It is conceivable that the teacher quality suffered due to this rapid hiring. The study finds weak evidence of deterioration in the qualities of teachers, measured by their educational attainment and whether or not they taught in the region of their birth.

According to **Figure 1.4**, the number of secondary school teachers could not keep pace with the numbers of primary school graduates and secondary school enrollments[6]. The pupil-teacher ratio in secondary school (depicted by the blue bars) increased from less than 20 in 1971 to over 40 in 1980. And unlike the primary school pupil-teacher ratio, it did not fall rapidly below its 1971 level soon after. Also, not all those who completed primary school could enroll for secondary school. Assuming that a fixed proportion of those who were enrolled in primary school would have otherwise gone on to enroll for secondary school, the ratio of primary school students to secondary school teachers (depicted by the red bars) is investigated. The results are more pronounced. The ratio of primary school students to secondary school teachers more than doubled between 1971 and 1980. While the both these pupil-teacher ratios came down over the following decade, in 1990 they were still higher than their level in 1971.

However, these pictures aggregate the information from districts with low and high intensity INPRES school construction. What is of interest is whether the schooling infrastructure deteriorated more in districts where the intensity of school construction program was higher. The pupil teacher ratio across low and high intensity INPRES districts before and after the INPRES program, controlling for initial differences between the regions and differences in these outcomes across year of the survey, are compared. The results are presented in **Table 1.7**. The primary school pupil teacher ratio is not significantly different across intensity regions. This is consistent with the rapid hiring of primary school teachers for the newly constructed primary schools. However, the secondary school pupil teacher ratio and the ratio of primary school pupil to secondary school teachers is higher in the high intensity INPRES regions than in the low intensity regions post INPRES. This suggests that the secondary school infrastructure could not keep pace with the expanding number of primary schools and primary school graduates leading to increased competition to get into middle and high school and worse infrastructure for those who got in.

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[6]Unfortunately, the data on teachers in IPC and SUPAS does not categorize them into middle and high school teachers. Instead, they are aggregated as secondary school teacher

As an additional check, in **Table 1.8**, the effect of above median rainfall in the first year of life, INPRES school construction program and their interaction on completion of primary and middle school are examined. Above median levels of rainfall in the first year was positively associated with the probability of completion of primary and middle school. Improved access to primary schools due to the primary school construction program had a strong and positive impact on the probability of primary school completion but not so much on the probability of middle school completion. This is as expected since there was an increase in primary schools but no proportionate increase in the number of middle schools. The negative interaction effect, however, was significant even at the level of middle school. This is consistent with there being a congestion and crowding at the middle school level. Taken together, these results suggest that individuals who experienced high rainfall in the first year of life and would have been in school more often even in the absence of INPRES might have suffered due to the deterioration in school infrastructure along these dimensions[7].

Also, as is clear from the findings, some of these infrastructure quality indicators improved over time. Schools, with more time to hire and fire, might have been able to ensure a higher number of teachers. More middle and high schools might have been established due to the increased demand. Assuming that the deterioration explains the negative interaction coefficient, the recovery of these quality indicators over time should imply that the magnitude of the interaction coefficient must be smaller for the later exposed cohorts than for the earlier exposed cohorts. That is, the difference in the impact of INPRES between individuals born in above and below average levels of rainfall in the first year after birth should have diminished with time. If the negative interaction effect was due to some other factors, there is no a priori reason to believe that the negative interaction should fade away. To test for this, the interaction effect separately for each exposed cohort is estimated. The estimated interaction effected coefficients are plotted in **Figure1.6**. There is a clear trend towards a zero-interaction effect. The interaction effect did not persist suggesting that deterioration in primary school teacher quality and secondary school infrastructure might indeed be the reason behind lower gains from INPRES school construction program for those who did not experience the early life low rainfall shock.

[7]This is consistent with the finding from Bound et al. (2010) who find that that the increased pressure on collegiate resources was the main factor behind a decline in college completion rates in the United States between 1970-1990. This is also consistent with the findings of Currie and Thomas (2000) for the United States that effect of the Head Start program, a pre-school education program for age between three and five, faded out for children who went on to attend worse quality schools.

1.7.2 Other Mechanisms

There is a possibility that the school construction program had no benefit for those with relatively higher rainfall in the first year of life because most of these individuals were completing primary school even before the program. There was, therefore, not enough scope for improvement due to improved access to primary schools. The mean rate of primary school completion before the program, reported in column (3) of **Table1.6**, was 62 percent. For those with relatively high rainfall in the first year of life, the primary school completion rate was 65 percent. Therefore, there appears to have been a reasonable margin for improvement due to the school construction program. The impact of high rainfall, the school construction program, and their interaction on gross rates of primary school enrollment further adds to the evidence against the hypothesis. If the was indeed not a big margin for the school construction program to affect the education decision, that would have been more visible in a lack of impact of the school construction on the primary school enrollment decision. In column (1) of **Table1.8**, the impact of school construction on the enrollment of both low rainfall individuals (β_2) and high rainfall individuals ($\beta_2 + \beta_3$) is insignificant. That there was not enough scope of improvement here is a possibility. The interaction of high rain and INPRES school construction, however, is negative and significant, and its magnitude double that of the impact of the impact of school construction on the enrollment of low rainfall individuals. This suggests that the impact of school construction on primary school enrollment of high rainfall individuals was about as large as the impact on low rainfall individuals but in the opposite direction. There is no reason why the impact of the school construction program would have been different for the two groups and, specifically, negative for the high rain individuals unless, as in the model, the quality deterioration affected them differently. The no scope for improvement hypothesis is also inconsistent with the trend observed in **Figure 1.6**. Of course, it is impossible rule out that the lack of impact of school construction on high rainfall individuals is due to a lack of scope of improvement. But evidence suggests it is less likely to be an explanation, let alone the only explanation.

Another mechanism that might have been operational is that through peer effect. Before the school construction program, classes were smaller and, on average, the high rainfall individuals, who were, most likely, of higher ability, formed the majority of the class. After the school construction program, there was an increased proportion of low-ability low rainfall individuals in the class room. The deterioration of peer quality, especially in the absence of good educational infrastructure, might also have affected the educational outcome of the high rainfall individuals. This would be consistent with **Figure 1.6**. With improvement in school infrastructure, the negative effect of deterioration in peer quality might have gotten weaker. Moreover, if school infrastructure improved the peer quality of low rainfall individuals over time, the negative impact of poor peer quality would have vanished. Unfortunately, the relevant data to test this mechanism explicitly, is missing and, therefore, this possibility cannot be ruled out.

1.8 Conclusions

Shocks early in life have long lasting impacts. This is an even bigger concern in developing countries where these shocks are often more severe and frequent and the ability of parents to shield their children from such shocks or to make corrective or compensatory investments limited. Most of the corrective investments are, therefore, carried out by the state through public policies. It is, therefore, of immense importance from a policy standpoint to understand if the negative effect of these early life shocks can be mitigated and to what extent this compensation works. Against this backdrop, the study leverages two exogenous treatments, an early life shock in the form of access to resources proxied by level of rainfall in the first year of life and a policy aimed at improving access to primary schools, to examine the possibility and extent of remediation. The encouraging findings suggest that almost complete recovery is possible, at least along the dimension of education attainments, if adequate investment crucial for mitigating the negative effect of such shocks are made. Using information from wave 5 of the IFLS, the study documents that the negative effect of early life rainfall shock was mitigated completely if individuals received improved access to primary school during childhood.

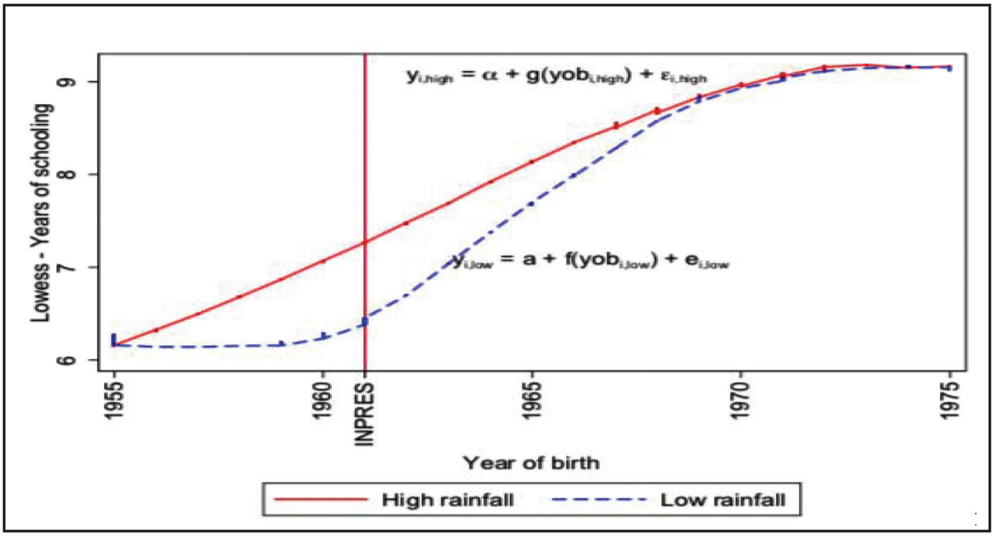
While recovery was driven by the positive effect of improved access on the disadvantaged individuals, the catchup was partly a result of the inability of individuals who did not experience the early life shock to benefit from improved access to schools. The study provides suggestive evidence from IPC and SUPAS that this resulted from deteriorating school infrastructure and teacher quality and increased competition that hurt individuals who did not experience the early life shock disproportionately. Consistent with the observation of quality indicators improving over time, the study finds that the difference in the impact of INPRES for high and low rain individuals vanishes over time.

Considering that the immediate goal of INPRES was to increase primary school enrollment, it was, arguably, a big success. However, the analysis provides a good exposition of some of the major trade-offs and challenges faced by almost all policies implemented at such a large scale. Often such immediate goals are set in pursuit of bigger goals of a better educated populace and economic development. INPRES is redistributive in more than one way in that it increased the educational attainment for one group (those who started school because of INPRES) at, perhaps, a small cost to another group (those who were already in schools). While such redistributions, given the overall gain, might still be well justified and even desired, understanding the heterogeneity in its impact is beneficial for future policy planning. It is important to realize that the benefits of the intervention could have been bigger had it been accompanied by other improvements in infrastructure. Proper personnel training and simultaneous expansion of middle and secondary school infrastructure might have mitigated the negative effect of deteriorating quality and infrastructure on children already in school and would have resulted in higher gains from INPRES.

This study, however, leaves a few important bigger issues unanswered. First, the remediation the study finds is along the dimension of educational attainment. A question that future research should focus on is to what extent INPRES corrected the possible negative effect of early life rain shock along other dimensions of well-being, such as health and cognition. Second, one cannot be sure that the corrective effect of improved access to schools would hold if it benefited individuals at a different point in their life. For example, one would expect the effect to be smaller for a high school construction program since disadvantaged individuals would have dropped out disproportionately before entering high school. This is of immense importance from a policy perspective. If remediation efforts early on in life are more effective than those later on, it might be a pareto improvement to transfer resources from policies that increase investment in later years to those that focuson early years. Third, the results cannot be generalized to other intervention policies and contexts. While improved access to schools worked in Indonesia in the 1970s, it might not have worked towards recovery from the harmful effects of being exposed to nuclear fallout radiation on cognition in Sweden. In fact, the findings from this study should motivate the examination of the remediation effect of various investment in a variety of setting. Future research should aim towards developing an understanding of investments that work in varied settings against a large number of early life negative shock as this will greatly streamline policy aimed at tackling such disadvantages.

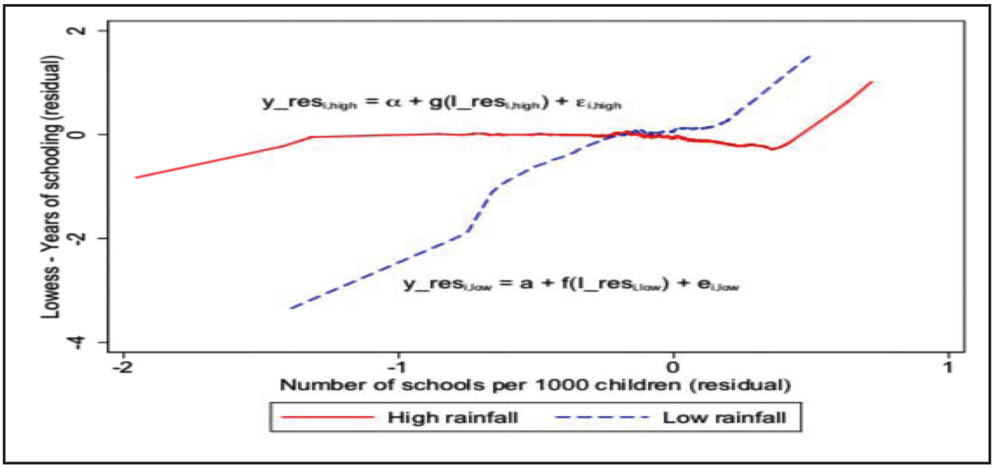
1.9 Figures and Tables

Figure 1.1: Educational Attainments across Birth Cohorts



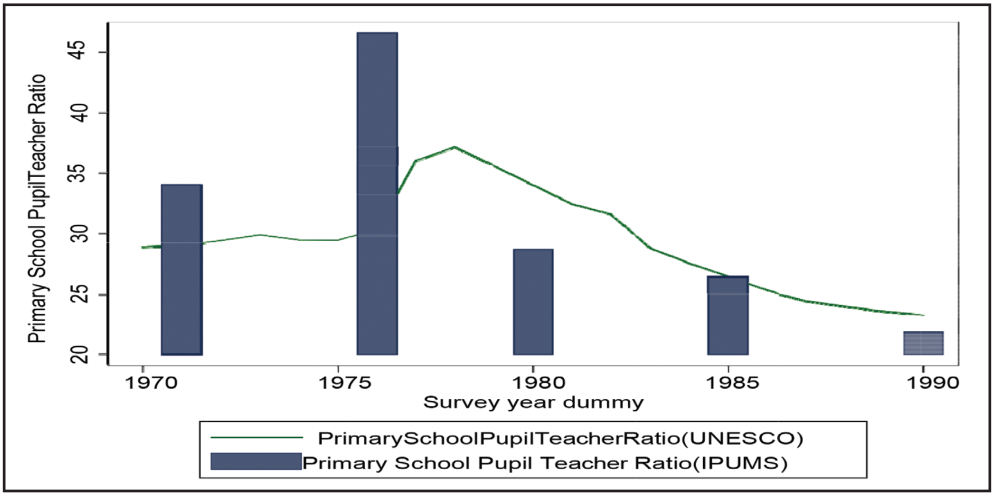
Data source: IFLS

Figure 1.2: Educational Attainment and INPRES Treatment Intensity



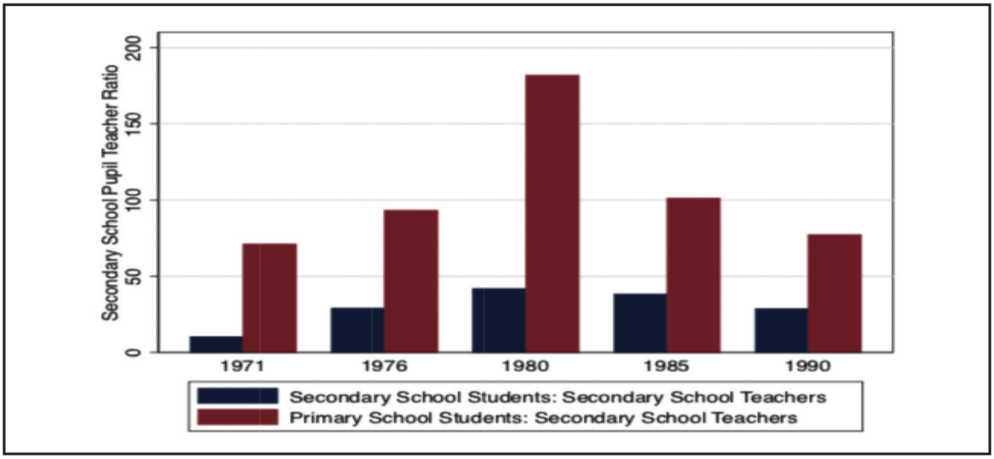
Data source: IFLS

Figure 1.3: Pupil Teacher Ratio in Primary School



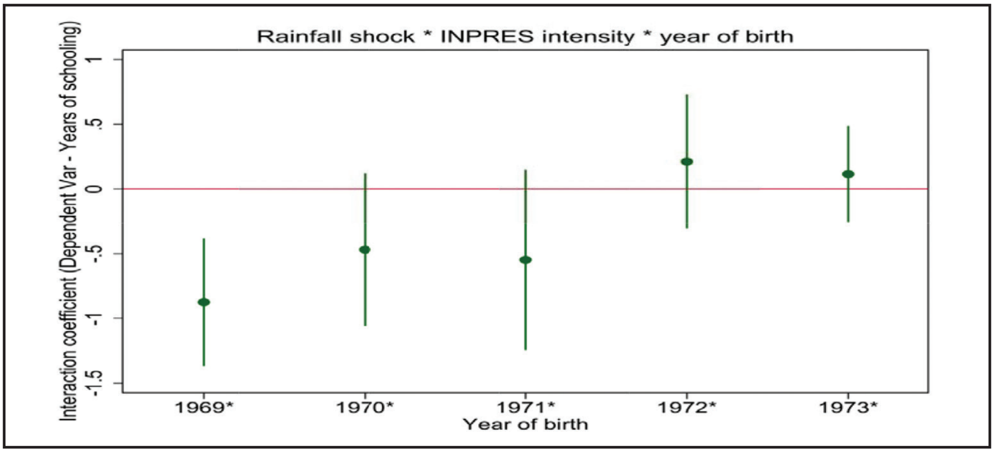
Data source: IPC and SUPAS

Figure 1.4: Pupil Teacher Ratio in Secondary School



Data source: IPC and SUP

Figure 1.5: Coefficient of the Interaction of Dummy Indicating High Rain in the Birth Month * INPRES Treatment Intensity * Year of Birth



Data source: IFLS

Table 1.1: Summary Statistics

	Not exposed to INPRES				Exposed to INPRES			
	Low Rain		High Rain		Low Rain		High Rain	
VARIABLES	Mean	S.D.	Mean	S.D.	Mean	S.D.	Mean	S.D.
Demographics *N*	551		540		796		1,205	
Years of Education	6.626	4.506	7.150	4.500	9.397	3.919	9.399	3.935
percent Enrolled in Primary School	0.960		0.978		0.992		0.993	
percent Completed Primary School	0.586		0.639		0.881		0.883	
percent Completed Middle School	0.323		0.350		0.613		0.611	
percent Completed High School	0.207		0.241		0.445		0.425	
Gender (percent Male)	0.474		0.481		0.511		0.503	
Father has any education	0.711		0.769		0.813		0.813	
Mother has any education	0.519		0.563		0.691		0.675	
percent Urban	0.281		0.293		0.260		0.300	
Religion (percent Muslim)	0.853		0.902		0.896		0.899	
Ethnicity (percent Javanese)	0.457		0.493		0.413		0.507	
Rain (unit: mm) Rain 9 months prior to pregnancy	1,769	540.6	1,971	463.9	1,983	463.3	1,745	576.0

Rain during pregnancy	1,834	482.0	1,990	507.5	1,983	425.3	1,749	566.2
Rain in the month of birth	156.6	124.7	202.0	127.7	189.0	130.8	193.3	130.7
Rain in the first year after birth	2,102	439.6	2,765	468.9	2,202	448.8	2,645	456.2
Rain in the second year after birth	2,263	489.8	2,483	517.5	2,626	450.7	2,472	486.2
Rain in the third year after birth	2,103	489.9	2,440	527.7	2,516	487.4	2,478	510.9
Rain in the fourth year after birth	2,143	542.3	2,299	460.5	2,560	432.5	2,434	561.5
Rain in the fifth year after birth	2,121	506.6	2,337	495.4	2,469	535.0	2,514	485.1
Rain in the sixth year after birth	2,139	476.5	2,275	517.1	2,525	511.3	2,520	536.5
Rain in the seventh year after birth	2,132	566.6	2,429	542.2	2,661	536.3	2,343	551.6
Rain in the eighth year after birth	2,444	671.8	2,313	483.2	2,507	604.0	2,520	499.4
Rain in the ninth year after birth	2,266	563.9	2,533	588.4	2,512	514.9	2,627	490.5
Rain in the tenth year after birth	2,371	498.3	2,602	580.2	2,680	485.8	2,370	507.5
INPRES Intensity (All regions)								
N	47		53		67		48	
Intensity					2.275	1.130	2.258	1.101
INPRES Intensity (Low intensity regions)								
N	20		26		33		27	
Intensity	0		0		1.626	0.559	1.850	1.054
INPRES Intensity (High Intensity regions)								
N	27		27		34		21	
Intensity	0		0		2.904	1.193	2.783	0.944

Data source: IFLS

Table 1.2: Summary Statistics: Teacher Characteristics

VARIABLES	Low Intensity Regions		High Intensity Regions	
	Mean	.S.D	Mean	.S.D
Teacher Characteristics				
N	22,159		19,096	
Age	33.40	15.59	31.86	13.20
(Gender (% Female	0.473		0.395	
(%) Urban	1.380		1.254	
(%) Completed High School	0.845		0.860	
(%) Completed Diploma 4	0.083		0.051	
(%) Completed Diploma 3	0.047		0.028	
(%) Teaching in birth province	0.890		0.916	
Years spent in the current locality	29.79		28.96	
(%) Previous residence in a different province	0.123		0.093	
(%) In a different province 5 years back	0.025		0.035	
Primary School characteristics				
N	597		471	
Primary School Pupil Teacher Ratio	29.28	21.65	31.57	24.74
Secondary School characteristics				
N	523		385	
Secondary School Pupil Teacher Ratio	28.99	23.96	35.60	30.00

Data source: IPC and SUPAS

Table 1.3: Impact of Rainfall and Primary School Construction on Completed Years of Schooling

	Years of Schooling			
Above median rainfall in year 1	0.26* (0.15)		0.25 (0.15)	0.73*** (0.22)
INPRES schools per 1000 children		0.18 (0.20)	0.18 (0.20)	0.37* (0.21)
Above median rain * INPRES schools per 1000 children				-0.35*** (0.11)
INPRES school per 1000 high-rain individuals				0.01
F-test p-value				(0.97)
Median schools per districts		1.90	1.90	1.90

Mean of dependent variable	8.29	8.29	8.29	8.29
Observations	3,399	3,399	3,399	3,399
R-squared	0.40	0.40	0.40	0.41

*Notes: *** p<0.01, ** p<0.05, * p<0.1. Robust standard errors in parentheses. The standard errors are clustered at the district level. All columns include controls for month of birth, year of birth, kabupaten of birth, gender, ethnicity, religion, urban community, rain during pregnancy, rain in nine months prior to pregnancy, and dummy indicators each for whether the mother of the individuals had some schooling, completed primary school, completed middle school, completed high school, or had some tertiary level education. The specification also controls for year of birth interacted with the number of children of school going age in 1971, enrollment rate in 1971 and the water and sanitation program in the district during the time of school construction program.*

Data source: IFLS

Table 1.4: Impact of Rainfall and Primary School Construction (Fully- Interacted Model)

	(1)	(2)	(3)	(4)
	Years of Schooling			
Above median rainfall in year 1	0.73*** (0.22)	0.59** (0.24)	0.69*** (0.22)	0.73*** (0.24)
INPRES school per 1000 low-rain individuals	0.37* (0.21)	0.32 (0.21)	0.38* (0.21)	0.34 (0.20)
INPRES school per 1000 high-rain individuals	0.01 (0.21)	0.03 (0.21)	0.02 (0.21)	0.01 (0.21)
Median schools per districts	1.90	1.90	1.90	1.90
Mean of DV	8.29	8.29	8.29	8.17
Specification change	Main	Month X Year FE	Years 1-5	Non-movers
Observations	3,399	3,399	3,399	3,146
R-squared	0.41	0.43	0.41	0.41

*Notes: *** p<0.01, ** p<0.05, * p<0.1. Robust standard errors in parentheses. The standard errors are clustered at the district level. All columns include controls for month of birth, year of birth, kabupaten of birth, gender, ethnicity, religion, urban community, rain during pregnancy, rain in nine months prior to pregnancy, and dummy indicators each for whether the mother of the individuals had some schooling, completed primary school, completed middle school, completed high school, or had some tertiary level education. The specifications also control for year of birth interacted with the number of children of school going age in 1971, enrollment rate in 1971 and the water and sanitation program in the district during the time of school construction program. Here, β_1, β_2, and β_3, reported in the table, are the impacts of above median rainfall in the first year of life, school construction program for those who experienced below median rainfall in the first year of life, and school construction program for those who experienced above median rainfall in the first year of life, respectively.*

Data source: IFLS

Table 1.5: Impact of Rainfall and Primary School Construction on Cognition

VARIABLES	(1)	(2)	(3)	(4)
	Serial 7 questions		Word recall	
	Answered	Correct	Immediate	Delayed
Above median rainfall in year 1	0.1507** (0.0706)	0.2777** (0.1190)	0.2294** (0.0896)	0.0583 (0.0963)
INPRES schools per 1000 children	0.0264 (0.0506)	0.0858 (0.0804)	0.0441 (0.1153)	0.0780 (0.1078)
Above median rain * INPRES schools per 1000 children	-0.0701** (0.0316)	-0.0278 (0.0533)	-0.1134** (0.0478)	-0.0457 (0.0471)
INPRES school/1000 high-rain individual	-0.04	0.06	-0.07	0.03
F-test p-value	0.40	0.52	0.51	0.77
Mean of DV	4.67	2.71	4.70	3.53
Observations	3,632	3,510	3,613	3,613
R-squared	0.1199	0.1537	0.2080	0.1825

*Notes: *** p<0.01, ** p<0.05, * p<0.1. Robust standard errors in parentheses. The standard errors are clustered at the district level. All columns include controls for month of birth, year of birth, kabupaten of birth, ethnicity, religion, urban community, rain during pregnancy, rain in nine months prior to pregnancy, and dummy indicators each for whether the mother of the individuals had some schooling, completed primary school, completed middle school, completed high school, or had some tertiary level education. The specifications also control for year of birth interacted with the number of children of school going age in 1971, enrollment rate in 1971 and the water and sanitation program in the district during the time of school construction program.*

Data source: IFLS

Table 1.6: Impact of Rainfall on Control Cohorts (1957-1961)

	Highest grade	Enrolled in primary	Completed primary	Completed middle	Completed high
Above median rainfall in year 1	1.09*** (0.34)	0.04*** (0.01)	0.11*** (0.03)	0.07* (0.03)	0.06* (0.04)
Mean of DV	6.61	0.96	0.62	0.39	0.26
Observations	1,287	1,439	1,439	1,439	1,439
R-squared	0.38	0.11	0.25	0.23	0.23

*Notes: *** p<0.01, ** p<0.05, * p<0.1. Robust standard errors in parentheses. The standard errors are clustered at the district level. All columns include controls for month of birth, year of birth, kabupaten of birth, gender, ethnicity, religion, urban community, rain during pregnancy, rain in nine months prior to pregnancy, and dummy indicators each for whether the mother and the father of the individuals had some schooling, completed primary school, completed middle school, completed high school, or had some tertiary level education.*

Data source: IFLS

Table 1.7: Primary School Construction and Pupil-Teacher Ratio

	(1)	(2)	(3)
	Pupil – Teacher ratio in		Primary pupil:
VARIABLES	Primary school	Secondary school	Secondary teachers
High intensity dummy * Survey 1976	-4.7522 (7.5060)	6.6542 (6.9226)	36.4285 (30.4713)
High intensity dummy * Survey 1980	-3.8968 (3.9178)	10.3165** (4.2582)	98.7938*** (25.9944)
High intensity dummy * Survey 1985	-4.7114 (4.2985)	9.1068** (3.6759)	34.6810** (16.2590)
High intensity dummy * Survey 1990	-3.2665 (3.7086)	6.1162 (3.8529)	28.4008 (17.4169)
Mean of DV	30.29	31.79	111.46
Observations	1,068	908	908
R-squared	0.12	0.17	0.19

*Notes: *** p<0.01, ** p<0.05, * p<0.1. Robust standard errors in parentheses are clustered at the district level. Other controls include survey year fixed effects, a dummy for gender of the teacher and a dummy for the type of residence, rural or urban.*
Data source: IFLS

Table 1.8: Impact on School Completion

	(1)	(2)	(3)
	Enrolled in	Completed	
VARIABLES	Primary School	Primary School	Middle School
Above median rainfall in year 1	0.018** (0.009)	0.062** (0.024)	0.046* (0.026)
INPRES schools per 1000 students	0.004 (0.005)	0.057*** (0.020)	0.023 (0.027)
Above median rain-fall in year 1 * INPRES schools/1000	-0.007* (0.004)	-0.031** (0.012)	-0.028** (0.013)
INPRES school per 1000 high-rain individual	-.002	0.03	-0.01

F-test p-value	.47	0.25	0.85
Mean of DV	.98	0.78	0.52
Observations	3,632	3,632	3,632
R-squared	0.080	0.230	0.254

*Notes: *** p<0.01, ** p<0.05, * p<0.1. Robust standard errors in parentheses. The standard errors are clustered at the district level. All columns include controls for month of birth, year of birth, kabupaten of birth, gender, ethnicity, religion, urban community, rain during pregnancy, rain in nine months prior to pregnancy, and dummy indicators each for whether the mother of the individuals had some schooling, completed primary school, completed middle school, completed high school, or had some tertiary level education. The specifications also control for year of birth interacted with the number of children of school going age in 1971, enrollment rate in 1971 and the water and sanitation program in the district during the time of school construction program.*

Data source: IFLS

2. Is 1+1 more than 2? Joint Evaluation of Two Public Programs in Tanzania[8]

2.1 Introduction

In-utero and early life investments in health and education have been found to have long run impacts on educational attainments (Almond et al. (2017)). However, not much is known about how early life investments in health and in education interact in determining the education attainment of individuals. The study furthers this discussion by investigating the joint impact of a health policy and an education policy in Tanzania on the educational attainments of individual exposed.

Cunha and Heckman (2007) propose a theoretical framework that considers the formation of human capital as a dynamic process with the complementarity between investments at different stages of life. They suggest that investments in human capital later in life are likely to be more productive for individuals who receive higher investments in early life than for those who received lower investments in early life. They term this 'dynamic complementarity' in the production of human capital. A major empirical challenge in testing the model of dynamic complementarity is the endogeneity of investments at different points in life. As a result, the empirical evidence in favor of this model of complementarity is limited. A small number of studies that evaluate the joint causal impacts of two public programs or shocks affecting individuals at different stages in their lives fail to find any evidence in favor of 'dynamic complementarity' (Adhvaryu et al. (2015); Rossin-Slater and Wu¨st (2015); Gunnsteinsson et al. (2014); Malamud et al. (2016)). However, as is discussed in detail ahead, it mostly due to their data or methodological limitations.

The study uses information from Kagera Health and Development Survey (KHDS) to examine the joint effects of two public programs, the Iodine Supplementation Program (ISP) and the Primary Education Development Program (PEDP), on the grade attainment of children who were 10 to 13 years old at the time of the survey. The study finds that exposure to ISP, a health policy that targeted pregnant women and, consequently, their in-utero babies, was negatively associated

[8] Co-authored with Dawoon Jung and Seungwoo Chin

with completed schooling of those exposed. PEDP abolished all primary school fees and, as expected, had a positive impact on educational attainment. There is also evidence of a significant negative interaction effects of ISP and PEDP on educational attainments of individuals who were exposed to both ISP and PEDP had lower educational attainments by the time of the survey than individuals not exposed to either or one of the two programs. The findings show that the two programs and their interaction have impacts on primary school starting age that mirror their impacts on grade completed by 2004. ISP exposure is associated with a delay in primary school starting age. PEDP had a negative effect on starting age. The interaction of the two programs is positively correlated with starting age. The association of the two programs and their interaction with educational attainments almost vanish when primary school starting age is controlled for. Individuals who delay entering school spend more time working on the family farm and doing household chores suggesting that delayed entry is most likely due to positive returns from pre-school training (Bommier and Lambert (2000)).

Next, the ratio of the impacts of the two programs and their interaction on educational attainment by the time of the survey and on primary school starting age provides a measure of the rate at which individuals convert years in school into completed years of schooling. The study finds that in comparison to individuals exposed to PEDP but not ISP, those exposed to ISP are better at converting years in school into completed years of schooling. This is consistent with Field et al. (2009) claim that those exposed to ISP saw an improvement in their cognition. This is also an indirect evidence of dynamic complementarity - ISP exposure improves the productivity of each year spent in school.

This study contributes to the literature in two ways. First, the study re-evaluates the impact of ISP on schooling attainments for individuals in Kagera region of Tanzania and present results that help reconcile the divergent findings of two previous studies (Field et al. (2009) and Bengtsson et al. (2013)) on the impact of ISP on schooling. It underlines the importance of careful consideration of behavioral responses to ISP exposure to better understand the reduced form impact of ISP. Second, it contributes to the methodological discussion around identifying ‘dynamic complementarity’ by illustrating the need for more cautious interpretation of the reduced magnitudes of the interaction of two exogenous shocks as evidence for or against complementarity. Consequently, it uses an alternative strategy to present the first piece of evidence in favor of ‘dynamic complementarity’ from developing countries.

The remainder of the study is organized as follows. Section 2 provides a brief background of ISP and PEDP. Section 3 discusses the existing literature. Section 4 describes the data and the empirical strategy. Section 5 presents the main results and robustness checks. Section 6 concludes.

2.2 Background

2.2.1 Iodine Supplementation Program (ISP)

Lack of proper nutrient in utero or during early life is detrimental to the physical and cognitive development of individuals (Barker (1990); Cao et al.(1994); Barker (1995); Barker et al.(2002); Zimmermann et al. (2005)). One such important nutrient is iodine, essential for the synthesis of thyroid hormones. Adequate levels of these thyroid hormones in pregnant mothers are important for physical and mental development of foetus. Especially, sufficient stock of iodine in a pregnant mother's body in the first trimester of her pregnancy is extremely crucial for the cognitive development of the baby in-utero. Brain development during this period is sensitive to minor adjustments in thyroid hormone and mild maternal iodine deficiency can impair the full cognitive development of an individual (Dugbartey (1998); Pop et al. (1999)).

People from Tanzania, like those from many African countries, traditionally suffered from high rates of Iodine Deficiency Disorder (IDD). According to a Tanzania nationwide survey of iodine levels in the early 1970s, about 40 percent of the Tanzanian population lived in iodine deficient areas and 25 percent of the population was estimated to have had IDD. The prevalence among pregnant and lactating women was as high as 52 percent (Van der Haar et al., 1988). In response, beginning in 1986, the Tanzania Food and Nutrition Center (TFNC) started distributing Iodized Oil Capsules (IOC) to individuals in districts where more than 10 percent of school children had some symptoms of goiter. The program, known as the Iodine Supplementation Program (ISP), was expanded to 27 districts covering 7.3 million population by 1994 (Peterson et al. (1999)).

This program was one of the largest and most intensive iodine supplementation programs in the world (Peterson (2000)). The program was scheduled to begin in 1988 and planned to distribute iodized oil capsules containing 400 mg of iodine amongst males and females aged 2 to 45 years and a dose of 200 mg for children aged 12 to 23 months (Peter- son et al. (1999)). However, the time line was not strictly followed. Four districts received the supplementation in 1986 and only 10 had received it by 1988 while two districts did not receive it until 1992. The coverage rate was never perfect in any district and the average coverage rate was 64 percent (See Table A1). The delays in the program start date, in all cases, were due to administrative issues arising from the logistical challenges of distributing IOC throughout the district (Peterson (2000)). However, despite the delays, according to a conservative estimate from Peterson et al. (1999), the program protected 12 million individuals from iodine deficiency (ID).

The program was considered a success, with several previous evaluations finding reduction in visible and total goiter rate (VGR, TGR) attributable to ISP (Peterson et al. (1999)). In the early 1990s, a success of ISP led to the Universal Salt Iodization (USI) program initiated by Tanzanian government. After the USI was introduced, ISP was used to complement USI, focusing on districts not yet reached by the USI. Thus, during this period, the absence of the ISP program in a district does not necessarily indicate that the individuals in the district are unprotected from IDD.

Field et al. (2009) analyze the impact of ISP on grade attainment of the children of treated pregnant mothers using the Tanzania Household Budget Survey 2000 (THBS 2000). They find that ISP had significant positive impact on completed years of schooling of treated children by the time of the survey. They find that treated children, who were still in school at the time of the survey, had completed 0.345 more years of education. This, they conjecture, must have been due to the improvement in cognition of those who received the iodine supplementation. In contrast, using information from the 1999, 2004, and 2010 waves of Demographic and Health Survey, the 2008 wave of National Panel Survey, and the 2000 wave THBS, Bengtsson et al. (2013) find that the estimated impact of ISP on grade attainment is not consistent across datasets and often negative in sign. The impact is positive and significant for only the THBS 2000 sample. They use a slightly different model of iodine depletion over time than the one in Field et al. (2009) and find much smaller magnitudes for the impact of ISP on grade attainments. They explore the robustness of their findings across different definitions of ISP treatment and across different criteria for selecting the sample and find no evidence of a significant consistently. They investigate the attenuation bias that might result from selective migration and incomplete birth information and conclude that these would not explain the differences between their results and that in Field et al. (2009).

The main purpose of the study is to document the existence of dynamic complementarity in the production of human capital and the evaluation of ISP is not directly comparable to either to these studies. However, the findings help in reconciling the apparently contradictory findings from Field et al. (2009) and Bengtsson et al. (2013).

2.2.2 Primary Education Development Program (PEDP)

Tanzania school system consists of seven years of primary school, four years of secondary school and two years of upper secondary school. There are two national examinations in primary school - one at the end of the 4th and another, primary school leaving exam (PSLE), at the end of the 7th grade (Government Report, 2005). Students need to pass the examination at the end of 4th grade four to progress to 5th grade and the PSLE to advance to secondary school. Children are expected to enroll in primary school at the age of seven and complete primary school by the age of 13 (Ministry of Education and Culture, 1995). However, delays in enrollment, dropouts and grade repetitions are common.

In January 2002, Tanzanian government launched the Primary Education Development Program (PEDP) where in tuition fees and other mandatory cash contributions to schools were abolished (Tanzania Education Report, 2006). The primary purpose of PEDP was to ensure the enrollment of all 7 to12 years old by 2005. The net enrolment rate in primary school in the year preceding the launch of the Primary Education Development Plan (PEDP) was less than 50 percent. The program began by targeting those who were seven to eight years old in 2002, individuals born in 1993 or 1994. The coverage of the program was extended to 11 and 12 years old in 2004 (9 and 10 years old in 2002). However, the effort and impact for these children was substantially lower and delayed. As a result, individuals born in 1993 and 1994 were fully exposed to PEDP while those born before 1993 were partially or never exposed to PEDP. Due to PEDP, net enrollment rates went up significantly from 66 percent in 2001 to 97.3 percent in 2007.

The program worked towards bringing down the cost of primary education by abolishing all tuition fees. Moreover, a US$10 capitation grant was also introduced and controlled by school committees. This was intended to cover some of the additional school-based costs. However, substantial indirect costs, such as an expense for instructional materials, remained, the provision of which has not been sufficient to date.

2.2.3 Interaction of ISP and PEDP and the Question of Dynamic Complementarity

If the ISP treated individuals indeed had higher cognitive ability than the untreated individuals, this could imply both a higher benefit and a higher opportunity cost of schooling for the treated children. In the light of the possibility, the reduction of schooling cost due to PEDP could potentially have differential impact on the ISP treated and untreated individuals. Since there was a fair degree of overlap between the two programs in terms of the cohorts treated, a careful examination of interaction between these two programs is warranted.

Of late, there has been a rising interest in studying interactions between two shocks to human capital formation in developing countries. The primary motivation for studying such interactions is to shed light on the production function of human capital in developing countries. In particular, many studies examine if inputs at different points in life into the production of human capital exhibit any complementarity. However, as mentioned before, endogeneity of the level of inputs at different points in life is a major empirical challenge. A small number of studies have employed the 'lightning strike twice' (Almond and Mazumder (2013b)) identification strategy - exogenous variation in the exposure to two public programs or shocks that affect individuals at different stages in their lives (Adhvaryuet al. (2015); Gunnsteinsson et al.(2014); Malamud et al. (2015))

Adhvaryu et al. (2015) examine the interaction between early life adverse rainfall conditions and PROGRESA conditional cash transfer in Mexico. They find that the conditional cash transfer enabled individuals, who were otherwise lagging behind due to adverse rainfall shocks in early life, to catch up. Malamud et al. (2016) estimate the joint effect of access to abortion facilities at the time of conception and access to better school later on. Although they find no significant interaction effect, they acknowledge that their results do not count as evidence against dynamic complementarity as behavioral responses by individuals or their parents between first intervention and second intervention could dampen the joint effect.

In addition to assuming that the two sources of variations in investments are orthogonal to each other, these studies also assume that an individual's uptake or compliance or avoidance or mitigation efforts in response to the second shock does not depend on her first program's treatment status. This second assumption might easily be violated. The analysis uses an empirical specification similar to the ones in these studies to study the interactions between the two programs, ISP and PEDP. However, the sign of the interaction is not interpreted as evidence for or against dynamic complementarity. Instead, a comparison of the ratio of the impact of ISP and PEDP on completed schooling by 2004 and primary school starting age is used to shed light on the dynamic complementarity in the production of education.

2.3 Data and Empirical Strategy

2.3.1 Data

The study uses information from the Kagera Health and Development Survey (KHDS), a survey representative of the population of the Kagera region from Tanzania. Located in the north- western corner of Tanzania, Kagera is one of Tanzania's 30 administrative regions. Kagera is Tanzania's fifteenth largest region and accounts for more than 3 percent of the country's area (CIA (2010)). During 1980s, Kagera suffered from high rates of IDD. As a result, four of its seven districts were targeted by ISP, the first one starting in 1989. Next, the timeline of the KHDS survey waves overlap favorably with the high prevalence of IDD and subsequent high intensity of ISP. KHDS households were originally interviewed in four waves from 1991 to 1994. Follow-up surveys were then carried out in 2004 and 2010. Therefore, it covers the implementation phase of both ISP and PEDP and still allows analysis of short and medium run outcomes like height and educational attainment. KHDS is one of the longest-running African panel data set with an impressive tracking rate of around 90 percent. (Beegle et al. (2006a); De Weerdt et al. (2012)). Due to the overlap between the program and the survey timelines, KHDS is a suitable survey to study the programs and their impact. The analysis used the 1991-1994 and 2004 waves for information on individual's educational attainments, primary school starting age, parental investments in the child and a variety of covariates.

To calculate iodine exposure intensity, the district-year coverage rates from Field et al. (2009) is used. The coverage rate for each year for each district is matched with the corresponding observation from KHDS using the year and name of the district information contained in KHDS. The study follows Field et al. (2009) in their calculation of the probability that an individual benefited from the supplementation. An individual's probability exposure depended on whether and when the iodine supplementation program was implemented in the district vis-a`-vis her mother's first trimester of pregnancy. In that, the study assumes that mothers, throughout their pregnancy, lived in the district where they delivered their child. The details about the method followed are provided in the next section. The sample is restricted to the cohorts born between 1991 and 1994. Cohorts born after 1994 are not included because nation-wide iodine supplementation (USI) began in late 1994. In addition, since PEDP (started in 2002) fully affected both 7 years-old and 8 years-old, cohorts born after 1992 were treated by PEDP and those born in 1991 and 1992 were not treated. Cohorts born before 1991 are not included to avoid more serious recall bias in the 1991-1994 waves and to balance then number of PEDP treatment and control group across cohorts. Consequently, while the variation in ISP treatment is at the level of cohorts and districts, the PEDP treatment varies only across cohorts. However, since the information used comes from a small number of adjacent cohorts in a period with no other major government program in the region, the bias due to time-variant unobservable will be minimal.

The main reason for not using the information from other nationally representative surveys like the Tanzanian Demography and Health Surveys (TDHS) or the Tanzania Household and Budget Surveys (TBHS) is that the relevant waves from these surveys do not have information on the district of birth of individuals. Internal migration across regions in Tanzania is common (Kudo (2015)). Kagera region is an ideal setting in this context because migration outside Kagera is relatively low. Moreover, KHDS boasts of a high tracking rate of individuals even when they move. The information allows the study to restrict attention to individuals who report not having moved in the last ten years and report being a part of the household in preceding years. This helps minimize the attenuation bias from migration. While children born in 1991 and 1992 were born twelve and eleven years before the 2004 wave, respectively, the probability that they moved in the first two years of their birth is relatively small.

2.3.2 Iodine Exposure

As described before, sufficient levels of iodine are most crucial in the first trimester. Therefore, the child of an iodine deficient mother who received an iodized oil capsule in the first month of any year would not be protected unless the child was born in the eighth month of that year or later. Following Peterson et al. (1999) and Field et al. (2009), it is assumed that the timing of the distribution was uniform over the months of any year that the district received the supplementation. The study also maintains the assumption in Field et al. (2009) that, conditional on the starting month, it took three months to complete the distribution of these capsules. Therefore, for a district that received the supplementation program in the first month of the year t, children born in the first seven months in that district were not protected by the supplementation program. Research shows that the body stock of iodine depletes at a certain rate after every such iodine supplementation. To account for this depletion, the study uses the method used in Field et al. (2009). For those born in the eighth month or later, protection, therefore, depended on whether the program started early enough to have reached their mothers in time (first trimester or earlier) and whether their mothers had retained adequate amounts of iodine throughout their first trimester after accounting for the depletion of body iodine stocks with time.

2.3.3 Empirical Specification

The study follows Field et al. (2009) and Bengtsson et al. (2013), where treatment is considered to vary exogenously at the district-birth year level

$$Y_{1idb}=\alpha_1+\beta_{11}*ID_{1idb}+\gamma*X_{1idb}+\tau_{1b}+\omega_{1d}+s_{1idb} \qquad (2.1)$$

where Y_{1idb} is the years of schooling completed by an individual *i* born in district *d* in year *b* by 2004. It depends on ID_{1idb}. the probability that individual *i*'s mother was treated by the ISP program in the first trimester of her pregnancy. This treatment probability is calculated as explained in the previous section. X_{1idb} is a vector of covariates that include a dummy each for whether the mother and father have some education or not, a dummy for gender of the individual, a dummy each for whether the individual belongs to the majority tribe or religion, and total land ownership of the household to which individual *i* belongs.[9]

[9]Land in rural areas were regulated by the Tanzanian government under the Village Land Act beginningin 1999. To check for robustness, the land ownership variable is replaced with the value of livestock owned in an alternative specification. The results, not presented here, remain very similar.

Our specification is closer to that used in Bengtsson et al. (2013) and differs from Field et al. (2009) in that it is more parsimonious with respect to the control variables used. Since the treatment occurred before birth, many of the potential controls run the risk of being impacted by the treatment. For example, as pointed out by Becker and Tomes (1986) and empirically verified by Rosenzweig and Wolpin (1980), fertility decisions are endogenous to the quality of children, a dimension that ISP treatment might have affected. Therefore, the analysis excludes controls for birth order, number of children, distance to secondary school and health clinic, food security measures, home ownership, housing quality, as used in Field et al. (2009), and a dummy for household's urban residence, as used in Bengtsson et al. (2013).

Unlike Field et al. (2009), the study does not use household fixed effect specification in the main analysis. Households where mothers gave birth twice within a span of four years are different than those with one birth during the period and excluding household with only one child born during this period will lead to substantial selection biases. While using the month of birth information for the assignment of treatment probability would lead to more accurate assignment, information on the month of birth is missing for a fairly large number of individuals in the sample. Therefore, the analysis follows Field et al. (2009) and assigns treatment probabilities on the basis of month of birth.

Since the treatment status of the PEDP program is based on the year of birth, birth year fixed effects cannot be used in specifications that look to evaluate the impact of PEDP in addition to ISP. Instead, fixed effects in year of birth are replaced by a quadratic term in age. To show that this quadratic term approximates the year of birth fixed effects closely, equation (1) is re-estimated with the birth year fixed effect replaced by a quadratic in age. The combined impact of ISP and PEDP on completed years of schooling are examined using the specification:

$$Y_{2idb}=\alpha_2+\beta_{21}*ID_{2idb}+\beta_{22}*P_{2idb}+\beta_{23}*ID_{2idb}*P_{idb}+\gamma_2*X_{2idb}+\tau_2*age+\delta_2*age^2+\omega_{2d}+s_{2idb} \quad (2.2)$$

For individual *i*, living in district *d* and born in year *b*, ID_{2idb} represents the probability that individual *i's* mother received iodine supplementation during the first trimester of her pregnancy. P_{2idb} indicates individual *i's* exposure to PEDP and takes value '1' if the individual was born in 1993 or 1994, '0' otherwise. The specification includes district fixed effects (ω_d), a quadratic in age, a dummy each for whether the mother and father have some education or not, a dummy for gender of the individual, a dummy each for whether the individual belongs to the majority tribe or religion, and total land ownership of the household to which individual *i* belongs. β_{21} and β_{22} represent the independent impacts of ISP and PEDP on the schooling attainments, respectively. Coefficient β_{23} is a measure of heterogeneity in the impact of PEDP by ISP exposure status.

To provide suggestive evidence for the mechanism, the study shows that the ISP and PEDP treatment statuses and their interaction affected the primary school start age and individual's involvement in household work or work on family farm in a manner that is consistent with the impact of these three variables on years of schooling. For a specification that is similar to (2) is used, except now the outcome variable is the age at which the individuals start primary school, probability that the individual worked on-farm or at home in the last week, or the number of hours worked on-farm or at home in the last one week.

The rate at which children treated by one or both of these programs convert years at school into completed years of schooling is calculated by taking a ratio of estimated impact of these two treatments and their interaction on completed years of schooling and primary school starting age. These rates measure of the dynamic complementarity. A higher value of this ratio for those exposed to ISP compared to those not exposed to ISP would imply that the former group makes better use of each year spent in school.

2.4 Results

2.4.1 School Grade Attainment and Primary School Starting Age

Table 2.2 presents the impact of ISP exposure on completed schooling by 2004. The columns differ in the controls used in the specification. For example, columns (1), (3), (5), and (7) include age or birth year fixed effects to account for time varying unobservable factors that might have impacted schooling levels in those years. Columns (2), (4), (6), and(8) replace the birth year fixed effect with a quadratic term in age. It is clear from the comparison of the coefficient across columns that a quadratic term in age closely approximates year of birth fixed effects in the analysis. Both the ISP coefficient magnitudes and the R-squared fit of the model remains virtually unchanged. Controlling for tribe, religion and total land makes almost no difference to the estimated impact of ISP on grade attainment. When discussing the results, the coefficient estimates from the specification with the full set of controls and quadratic in age, similar to the one used in column (8), are preferred. According to the estimates, ISP exposure is associated with 0.70 fewer years of completed schooling. Conditional on non-zero probability of exposure, the average probability of exposure to ISP is 0.31. Therefore, those exposed to ISP, on an average, had completed 0.21 (0.70 * 0.31) fewer years of school.

At a first glance, the negative impact of ISP on grade attained is puzzling. There is no a priori reason to expect a negative impact on grade attainment of a supplementation which is expected to improve the cognition of those exposed. It also seems to contradict the results from Field et al. (2009) that those exposed to ISP had completed more schooling. However, the behavioral responses to ISP exposure are examined, the negative association between ISP exposure and grade attainment in no longer a puzzle. But since the primary objective of the study is to examine how the two policies interacted, the joint impact of these two policies are examined first.

Table 2.3 examines the joint impact of the two programs and their interaction on years of schooling completed by the time of the survey in 2004. The coefficient estimates in column (3) suggest that for those who were not exposed PEDP the impact of ISP remained comparable to the estimates from **Table 2.2**. However, there was a significant level of heterogeneity in the impact of PEDP by the ISP exposure status. Those not exposed to ISP but exposed to PEDP had completed 0.18 extra years of education by the time of the survey compared to those not exposed to either of the two programs. However, those exposed to ISP and PEDP had, on average, completed 0.19 years of schooling (-0.71 * 0.31 + 0.18 -0.47 * 0.31 = -0.19). They were comparable to those exposed to only ISP and not PEDP who were lagging behind those who did not get exposed to either of the two programs by 0.22 years (-0.71 * 0.31).

The negative interaction effect is equally perplexing. Why will a reduction in the cost of schooling hurt those who, most likely, have better cognition. One advantage of using KHDS for the analysis is that it contains information on primary school starting age. By examining the primary school starting age, a choice variable for individuals or their parents, one can investigate if there were any behavioral responses to the policies. **Table 2.4** reports the impact of the two policies and their interaction on primary school starting age. The estimated coefficients seem to mirror the impact of the two policies and their interaction on completed schooling. Those exposed to PEDP alone start school at a younger age than those not exposed to either of the two programs. Those exposed to ISP only or both the programs enter school later than those in the omitted category. On comparing **Table 2.3** and **2.4**, it is clear that the association of ISP exposure, PEDP exposure, and their interaction with completed schooling is, at least, partly explained by changes in primary school starting age in response to these treatments. The next section provides suggestive evidence to further explain why such a response might have arisen.

To be able to interpret the interaction coefficient as evidence in favor of or against dynamic complementarity, one has to assume that in the absence of dynamic complementarity, the impact of the second policy on those who were exposed to the first policy must be equal to the independent impact of the second policy on those who were not exposed to the first policy. However, since ISP changes the primary start school age, the cost and benefit from PEDP for those exposed to ISP might no longer be same as for those who were not exposed to ISP. The difference in cost and benefits from PEDP might, therefore, also invoke different behavioral response. However, since coefficient estimates of the impacts of these two programs and their interaction on completed schooling and primary school starting age from **Tables 2.3 and 2.4**, respectively, are still unbiased, a ratio of coefficient estimates for each of these policies and their interaction will be an indicator of how productive a particular subgroup is in school.

The conversion rate for the subgroups in presented in **Table 2.5**. If those exposed to PEDP but not to ISP started school one year earlier, they would have attained 0.39 extra years of completed schooling. In comparison, those exposed to ISP alone would have attained 0.99 extra years of school. This suggests that ISP exposure makes individuals more productive at school. If one considers years in school as an input in the production function of human capital, the productivity of this input is higher for those who benefit from the in-utero iodine supplementation. This is an evidence of dynamic complementarity. One has to be careful when trying to make a similar deduction for those who were exposed to both the programs. Their rate of conversion should be a weighted average of the three conversion rates calculated in the table. However, what should be the weights is not clear. However, for any combination of non- trivial weights, their conversion rate will be better than those who were exposed to PEDP but not ISP, lending further support to the dynamic complementarity argument made above.

2.4.2 Delay in Starting Primary School

But why might those exposed to ISP delay start of primary school more than those not exposed? Late entry into primary school is very common in Tanzania (Burke (1998); Bommier and Lambert (2000)) and elsewhere in Africa (Glewwe and Jacoby (1993); Glewwe and Jacoby (1995); De Vreyer et al. (1998)). Several hypotheses have been proposed to explain this delay in enrolment - existence of liquidity constraints (Jacoby (1994)), malnutrition problems (Glewwe and Jacoby (1995)), considering children too young to be in school (Burke (1998)), and pre-school training (De Vreyer et al. (1998)).

There is no reason to believe that ISP exposure of child was correlated with credit constraints that her family faced, especially because ISP exposure depended on the timing of first trimester of pregnancy vis-a-vis supplementation and not on supplementation alone. Therefore, the next two most important hypothesis, malnutrition problem and pre-school labor force, are focused upon.

Delay due to Worse Health

If those exposed to ISP delay starting school because they are malnourished, one might expect it to be reflected in their height-for-age. Low height-for-age is an indicator of stunted growth reflecting a process of failure to reach linear growth potential is often associated increased risk of early exposure to adverse conditions such as illness and/or inappropriate feeding practices. Column (1) of **Table 2.6** presents the association between an individual's ISP exposure status and height for age. Those exposed to ISP, indeed, are shorter in 2004. However, it is not clear why those exposed to ISP had worse growth. In-utero iodine supplementation, especially in such low doses, has no adverse impacts on physical growth (Isa et al. (2000)). Most individuals from the sample were interviewed at least once during the first four waves of KHDS between 1991 and 1994. Height measurements were also taken. Unfortunately, the number of individuals from each wave that the dataset contains information on height is small. However, since the selection for being interviewed during any of these years was unrelated to ISP exposure status, examining association between ISP exposure status and height during these waves might still be informative. Columns (2-4) present the association between ISP and height for age during these waves. Even though the standard errors are too large to interpret these coefficients without caution, the height for age during the early years for individuals exposed to ISP seems to be higher than for those not exposed. If the ISP exposure had an adverse impact on the physical health of those exposed, one might expect to see an effect on height for age early on.

A second explanation for lower height attainment that seems to be consistent with the trend in height differences across waves is that parents of those not exposed to ISP responded, either to their exposure status or to their lower cognition, by making compensatory investment in them. That might explain how the initial height advantage of those exposed to ISP was reversed by 2004. However, previous studies from developing countries have mostly found that parental response in such scenarios is often to reinforce the advantage that one of their children might have (Rosenzweig and Schultz (1982), Li et al. (2010), Adhvaryu and Nyshadham (2014)). Most of these studies use a sibling fixed effects specification to check for reinforcement or compensation within families. The main sample consists of children born from 1991 to 1994. Households where mothers gave birth twice or more within a span of four years are different than those with one birth during the period. Therefore, excluding household with only one child born during this period will lead to substantial selection biases. Therefore, the results of sibling fixed effects analysis must be taken with a grain of salt.

The results are presented in **Table 2.7**. Column (1) and (3) look at the association of ISP exposure status with years of completed schooling by 2004 and height for age in 2004, respectively. Since, here, the object of interest is the impact of ISP alone and including those born earlier than 1991 could, potentially, reduce some selection bias, in columns (2) and (4), the sample consists of all those born between 1989 and 1994[10]. However, the results do not indicate any compensatory response within the household. Most of estimated coefficients, even though not significant, are positive, consistent with reinforcement and not compensation. This suggests the negative impact of ISP exposure on education and height are identified from individuals with differential exposure to ISP born to households where there was a single birth during this period (Table B5). The results in **Table 2.7** do not rule out the possibility that households with one child born during this period and not exposed to ISP, tried to compensate for the lack of ISP exposure.

Delay due to Child Labor

Next, the hypothesis of child labor or pre-school training is examined. According

[10]Kagera first received the program in one of its districts in 1989

to the 2013 US Department of Labor Report on worst forms of child labor, as of 2011, over 25 percent of the Tanzanian children aged 5 to 14 were engaged in the worst forms of child labor. A little over 20 percent of the children aged 7 to 14 were combining work and school. Using information from the 2000 wave of the Tanzania Household and Budget Survey, Kondylis and Manacorda (2012) find over 60 percent of children aged 7-14 engaged in some form of productive activity and around 40 percent combining work and school. Children worked on the family farm or did household chores. The average number of hours worked every week was a little over 25 and around 20 percent of those who did not attend school reported the reason as work or perceived uselessness of schools. Beegle et al.(2006 b) use information from the 2004 wave of KHDS and find that children aged 7 to15 were found to have worked a little over 18 hours in the week prior to their interview. Burke and Beegle (2004) find the 10 to15 years old were working close to 9 hours on farming activities and between 11 to 15 hours on household chores.

These findings are consistent with 2000-2001 integrated labor force and child survey by the Tanzanian Ministry of Labor, Youth Development and Sports under International Labor Organization's International Program on Elimination of Child Labor. According to the re- port, of the total number of children aged 5 to17, 39.6 percent were involved in economic activities and 47.8 percent were engaged in housekeeping activities. Amongst those engaged in economic activities, more than three quarter of them (78.8 percent) worked as unpaid family members in their family farm or shamba and another 17.99 percent work as unpaid family members in non- agricultural establishment. An estimated 34 percent of the total working children worked for more than 4 hours per day or 30 hours per week. Beegle et al.(2006 b) use crop and rainfall shocks as instrumental variables for child labor and find that child labor has negative effects on completed years of schooling. One of the ways in which child labor affects educational attainment of children in Tanzania is through delayed enrolment. Even though children in Tanzania are expected to enroll in primary school at the age of seven, enrollment is almost always delayed by two, three, or even four years (Burke (1998); Bommier and Lambert (2000)).

The returns to schooling in Tanzania are lower than other countries in the region (Knight and Sabot (1990); Mason and Khandker (1997)). Since the country agricultural practices mostly use traditional production methods, the returns to education in agriculture are low (Mason and Khandker(1997)). The findings are, therefore, not very surprising. Burke and Beegle (2004) find that children in the Kagera region were not attending school due to household demand of child labor and high opportunity cost of schooling. De Vreyer et al. (1998), Bommier and Lambert (2000), and Burke and Beegle (2004) argue that the main reason for delay in starting school in African countries, and in Tanzania in particular, is the high opportunity cost of going to school. De Vreyer et al. (1998) present a model where a household's decision is similar to a portfolio choice among three assets - physical assets, 'general' human capital accumulation for the children through schooling, and 'specific' human capital accumulation for the children through participation in family economic activities. Bommier and Lambert (2000) use information from the Human Resource Development Survey conducted by the World Bank, the Dar-es-Salaam University, and the Tanzanian government in 1992-1993 on 5000 households to test the model. They show that the parents send their children to school later and for a smaller period of time since Tanzania had high returns from accumulation of the 'specific' human capital.

From **Table 2.5**, it does seem that ISP exposure made the exposed children smarter. This, in turn, might have increased their opportunity cost of schooling more than those not exposed. As a result, the ISP treated children might have chosen to start school later. Moreover, if they were aware that they were better at converting years in school into completed years of schooling, this might have incentivized them further to delay schooling. This would imply that those exposed to ISP were working more often than those not exposed before school.

In 2004, at the time of the survey, all the individuals from the sample were in school. Information on the working status of these individuals before they started school would have been ideal. Unfortunately, KHDS collected information on involvement in market and non-market labor activities only for the week preceding the interview date. It is assumed that the number of hours worked in the week preceding the survey is correlated with the number of hours worked every week in years preceding their enrollment in primary school. Using information from THBS 2000, Kondylis and Manacorda (2012) find enrolled children from all over Tanzania spent close to forty hours in school every week. They report that hours of work among children in school was approximately half that of children out of school. The alternative assumption that ISP treated children who enrolled later worked less than those who were not exposed and enrolled at younger age is less plausible.

Most children generally work at home and on the family farm. These activities may include but may but may not be limited to working in the fields or tending to livestock (categorized as farm activities in KHDS) or collecting water, fetching firewood, cleaning the house, preparing meals, and time spent caring for other children or sick household members (categorized as household chores in KHDS). Less than 0.5 percent of the children in the sample were engaged in wage work outside the family farm. Therefore, the study focuses on work on family farm and household chores only. **Table2.8** presents the association between program exposures and number of hours worked in different activities preceding the survey. ISP exposure seems to increase the number of hours worked on both family farms and unpaid family chores. The coefficients, even though insignificant for the activities separately, are in the right direction and large in comparison to the mean number of works worked in these activities by the individuals in the sample. Moreover, when the activities are combined, those exposed to ISP are working over five hours extra more than those not exposed. The impact of PEDP exposure, even though positive, is small and insignificant. However, the coefficient for the interaction large in columns (2) and (3), and significantly so for hours spent on household chores. The results suggest that pre-school work is one of the reasons behind delayed enrollment of those exposed to ISP.

While there is suggestive evidence in favor of both worse health and more pre-school work for those exposed to ISP as possible reasons behind delayed enrollment, the evidence is rather weak. Therefore, it is difficult to claim that one or both of these as the only or even the strongest mechanism. What is clear, however, is that ISP invoked different behavioral responses from different subgroups and one needs to take those responses into consideration when evaluating ISP and its interaction with PEDP.

2.5 Conclusion

There is now a broad consensus amongst demographers, sociologists and economists alike that the diffusion of modern economic growth to the developing regions requires human capital accumulation by the population in these regions (Counts (1931); Inkeles (1969); North (1973); Davis et al. (1971); Rosenberg et al.(1986); Easterlin (1981); Easterlin (2009)). A higher level of human capital is desirable in its own right (Pigou (1952); Adelman (1975); Grant (1978); Streeten et al. (1981); Sen (1984)). However, poor access to information and quality infrastructure, low levels of incomes, and imperfect credit markets in these regions limit the possibilities of private investment in human capital accumulation. State run policies, therefore, are of extreme importance in ensuring higher levels of human capital (Easterlin (1981)). Given the limited state budget, the decision of whether or not to roll out a particular program depends a lot on the cost benefit analysis of the program. Traditionally, the cost benefit analysis of such development programs are based on the evaluation of the single program as if it was implemented in isolation. However, if two independent programs interact in important ways, a partial equilibrium analysis might greatly understate the net benefits of such programs. In such scenarios, it becomes essential to jointly evaluate the impact of the two (or more) programs, allowing for possible complementarity between the programs.

Keeping this in mind, the study evaluates the Iodine Supplementation Program and Primary Education Development Program in Tanzania. Results suggest that ISP treatment was associated with lower schooling achievements for the exposed children in 2004. The effect operated entirely through delays in enrollment. The study provides suggestive evidence that this behavioral response of delaying enrollment was because those exposed to ISP were in worse health and spent more time working on the family farm or in the house. This might have been because their improved cognition made them better at these jobs. More importantly, the study finds that those exposed to ISP were better at converting years in school into completed years of schooling - a sign of dynamic complementarity between ISP exposure led improved cognition and time spent in school.

The result that government policies interact in important ways might explain why the short run impacts of many programs dissipate in the long run. The results also underscore the need to raise the dimensionality of the policy space to be considered. However, it is impossible to evaluate the combined effect of all sort of different policy exposures and determine how they interacted. Perhaps a better combination of theoretical, non-experimental, quasi-experimental and experimental methods need to be developed to handle the situation.

2.6 Figures and Tables

Figure 2.1: Iodine Supplementation Program in Tanzania

Table 2.1: Summary Statistics

Outcomes	Control		Treatment	
	Ages 10-11			
	Mean	SD	Mean	SD
Years of Schooling	1.87	1.00	1.44	0.96
Primary school start age	7.98	1.02	8.22	1.15
School Progression	0.82	0.30	0.79	0.40
HAZ in 2004	130.50	8.99	127.77	7.61
Proportion with				
Vaccination card	0.92		0.85	
Tb vaccination	1.00		0.97	
Measles vaccination	1.00		0.92	
Tetanus vaccination	0.46		0.39	
Polio vaccination	0.52		0.55	
	Ages 12-13			
	Mean	SD	Mean	SD
Years of Schooling	3.09	1.38	2.78	1.42
Primary school start age	8.57	1.45	9.01	1.46
School Progression	0.79	0.25	0.81	0.24
HAZ in 2004	141.21	8.47	139.64	8.44
Proportion with				
Vaccination card	0.95		0.99	
Tb vaccination	0.99		0.99	
Measles vaccination	0.94		0.97	
Tetanus vaccination	0.80		0.88	
Polio vaccination	0.84		0.86	
Independent variables	**Control**		**Treatment**	
	Ages 10-11			
	Mean	SD	Mean	SD
Protection due to ISP	0	0	14.26	17.17
Age	10.34	0.47	10.13	0.34
Mother has any education	0.95	0.21	0.92	0.27
Father has any education	0.92	0.27	0.92	0.27
Household land per capita	0.48	0.53	0.55	0.47
Proportion				
Sex = Male	0.54		0.48	
Tribe = Mhaya	0.93		0.37	
Religion = Catholic	0.65		0.53	
N	133		185	

	Ages 12-13			
	Mean	**SD**	**Mean**	**SD**
Protection due to ISP	0	0	70.05	27.72
Age	12.57	0.50	12.55	0.50
Mother has any education	0.97	0.17	0.89	0.32
Father has any education	0.95	0.21	0.88	0.32
Household land per capita	0.56	0.56	0.80	0.66
Proportion				
Sex = Male	0.47		0.48	
Tribe = Mhaya	0.94		0.01	
Religion = Catholic	0.65		0.50	
N	161		87	

Data source: KHDS

Table 2.2: Impact Of Iodine Supplementation Program On Completed Years Of Schooling

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
VARIABLES	**Years of education**							
Iodine Supplementation Program	-0.70*** (0.12)	-0.70*** (0.13)	-0.69*** (0.12)	-0.70*** (0.13)	-0.69*** (0.12)	-0.70*** (0.12)	-0.69*** (0.12)	-0.70*** (0.12)
Age fixed effect	YES	NO	YES	NO	YES	NO	YES	NO
Quadratic in age	NO	YES	NO	YES	NO	YES	NO	YES
Religion dummy	NO	NO	YES	YES	NO	NO	YES	YES
Tribe dummy	NO	NO	NO	NO	YES	YES	YES	YES
Mean of dependent variable	2.20	2.20	2.20	2.20	2.20	2.20	2.20	2.20
Mean ISP treatment probability	0.31	0.31	0.31	0.31	0.31	0.31	0.31	0.31
Observations	518	518	518	518	518	518	518	518
R-squared	0.36	0.36	0.36	0.36	0.36	0.36	0.36	0.36

*Notes: *** p<0.01, ** p<0.05, * p<0.1. Robust standard errors in parentheses. The standard errors are clustered at district- year of birth groups. Other controls include a dummy each for whether the mother and father have some education or not, a dummy for gender of the individual, and district fixed effects. Data source: KHDS*

Table 2.3: Impact of ISP and PEDP on Completed Years of Schooling

	(1)	**(2)**	**(3)**
VARIABLES	**Years of education**		
Iodine Supplementation Program (ISP)	-0.70*** (0.12)		-0.71*** (0.11)
Primary Education Development Program (PEDP)		0.13 (0.15)	0.18** (0.07)
ISP * PEDP			-0.47* (0.26)
Mean of dependent variable	2.20	2.20	2.20
Mean ISP exposure probability	0.31		0.31
Observations	518	518	518
R-squared	0.36	0.35	0.36

*Notes: *** p<0.01, ** p<0.05, * p<0.1. Robust standard errors in parentheses. The standard errors are clustered at district-year of birth groups. Controls include a quadratic in age, a dummy each for whether the mother and father have some education or not, a dummy for gender of the individual, a dummy each for whether the individual belongs to the majority tribe or religion, controls for total land holdings of the household, and district fixed effects.*
Data source: KHDS

Table 2.4: Impact Of ISP And PEDP On Primary School Starting Age

	(1)	(2)	(3)
VARIABLES	Primary school starting age		
Iodine Supplementation Program (ISP)	0.77*** (0.16)		0.74*** (0.15)
Primary Education Development Program (PEDP)		-0.47** (0.19)	-0.47** (0.18)
ISP * PEDP			0.26 (0.21)
Mean of dependent variable	2.20	2.20	2.20
Mean ISP exposure probability	0.31		0.31
Observations	518	518	518
R-squared	0.17	0.16	0.17

*Notes: *** p<0.01, ** p<0.05, * p<0.1. Robust standard errors in parentheses. The standard errors are clustered at district-year of birth groups. Controls include a quadratic in age, a dummy each for whether the mother and father have some education or not, a dummy for gender of the individual, a dummy each for whether the individual belongs to the majority tribe or religion, controls for total landholdings of the household, and district fixed effects.*
Data source: KHDS

Table 2.5: Conversion of an Additional Year into Additional Years of Schooling

Treatment	School starting age	Years of schooling	Conversion rate
PEDP only	-0.47	0.18	-0.38
ISP only	0.74	-0.71	-0.96
ISP * PEDP	0.26	-0.47	-1.8

Data source: KHDS

Table 2.6: Impact of ISP on Height of the Child (Height-For-Age)

	(1)	(2)	(3)	(4)	(5)
	Height for age Z-score in				
VARIABLES	2004	1994	1993	1992	1991
ISP	-0.46**	-2.34	3.33**	1.79	3.80
	(0.21)	(1.45)	(1.40)	(151)	(2.48)
Observations	501	102	118	128	145
R-squared	0.04	0.09	0.08	0.17	0.13

*Notes: *** p<0.01, ** p<0.05, * p<0.1. Robust standard errors in parentheses. The standard errors are clustered at district-year of birth groups. Controls a dummy each for whether the mother and father have some education or not, a dummy each for whether the individual belongs to the majority tribe or religion, controls for total land holdings of the household, and district fixed effects. The WHO Child Growth Charts and WHO Reference 2007 Charts were used for the height for age analysis.*
Data source: KHDS

Table 2.7: Within Household Impacts of ISP

	(1)	(2)	(3)	(4)
VARIABLES	Years of education		Height for age in 2004	
ISP	0.24 (0.59)	0.22 (0.46)	0.78 (0.87)	-0.39 (0.47)
Observations	132	335	119	298
R-squared	0.86	0.86	0.66	0.67

*Notes: *** p<0.01, ** p<0.05, * p<0.1. Robust standard errors in parentheses. The standard errors are clustered at the level of the household. Controls include a dummy for gender of the individual, age and sibling fixed effects.*
Data source: KHDS

Table 2.8: Impact of ISP and PEDP on Hours Worked

VARIABLES	(1)	(2)	(3)
	In the last week, how many hours did you work [...]?		
	On the family farm	In unpaid work	In total
ISP	1.97 (1.46)	2.07 (1.75)	5.43*** (1.93)
PEDP	1.97 (1.18)	0.63 (1.20)	1.72 (1.08)
ISP * PEDP	-1.85 (3.07)	10.33* (5.61)	7.62 (8.69)
Mean of dependent variable	4.51	5.49	10.18
Mean ISP treatment probability	0.32	0.32	0.32
Observations	540	540	540
R-squared	0.04	0.05	0.04

*Notes: *** p<0.01, ** p<0.05, * p<0.1. Robust standard errors in parentheses. The standard errors are clustered at district-year of birth groups. Controls include a quadratic in age, a dummy each for whether the mother and father have some education or not, a dummy for gender of the individual, a dummy each for whether the individual belongs to the majority tribe or religion, controls for total land holdings of the household, and district fixed effects.*
Data source: KHDS

3. Co-ethnic Voters and Candidate Choice by Political Parties: Evidence from India

3.1 Introduction

Much has been written about the poor policy outcomes in situations where co-ethnic voting has, allegedly, been salient[11&12]. It is a more serious problem in developing countries, where the accountability mechanisms are often underdeveloped and discrimination on the basis of ethnicity often more rampant (Vicente and Wantchekon (2009)). Banerjee and Pande (2009), Vaishnav (2010), and Acharya et al. (2014) point out that ethnic voting explains much of the inefficiency and criminalization plaguing the politics in India.

Most of these studies examine the impact of ethnic voting, taking as exogenous, the ethnicity of the candidates running for elections in any constituency. However, a party's choice of their candidate to field for elections in a constituency may depend on ethnic composition of the constituency and ethnic preferences of the constituency's population[13]. The literature on how a party chooses its candidate to run for an office is scarce[14] in comparison,the literature on the related question of a political party's choice of policy position is much more voluminous. It builds on the classical works of Hotelling (1929) and Downs (1957) on spatial competition[15]. This study applies their model of spatial competition to study the selection of candidates by political parties when they internalize the ethnic preferences of the voters. In that, it replaces the policy space with an ethnicity space.

To understand better the need to study a political party's candidate selection process, consider the simple situation described in **Table 3.1**. A constituency

[11]Co-ethnic voting is when voters of an ethnic group show an affinity for candidate belonging to the same ethnic group in their voting behavior (Wolfinger (1965)).

[12]Key (1949) argues that ethnic preference limited the competition and led to rampant corruption andslowdown of economic development in the southern region of United States (Besley et al. (2005)). See also Young (1979), Bates (1983), Horowitz (1985), and Dahl (2005).

[13]In fact, the birth and rise of certain political parties in India is itself considered to be in response to the ethnic fragmentation of the state (Jaffrelot (2003)).

[14]Field and Siavelis (2011) look at the selection process of candidate by a party in which each member of the party maximizes her own profit and bargains for the position.

[15]Stokes(1963) provides a good review of the early work on spatial competition models.

is composed of voters from four ethnicities - E_1, E_2, E_3, E_4. All voters vote for co-ethnic candidates. However, conditional on their co-ethnic preferences, they prefer a candidate with lower involvement in crime. In this constituency, in terms of voters from each ethnicity, ethnicity E_4 is the biggest ethnic group, followed by ethnicity E_3, followed by E_2. E_1 is the smallest ethnic group. Two parties, X and Y, are planning to field candidates for office in this constituency. Party X has two potential candidates, X_1 and X_2, to choose from to field. Candidate X_1 hails from ethnicity E_1 and is not involved in criminal activities. Candidate X_2 belongs to ethnicity E_2 and has a high degree of involvement in criminal activities. Party Y plans to field either Y_3 or Y_4. Y_3 is from ethnicity E_3 and has some involvement in criminal activities. However, on a relative scale, she is less criminal than X_2 and more criminal than X_1. Y_4, hailing from ethnicity E_4, had the highest involvement in criminal activities. Athat the higher a candidate's involvement in crime, the worse she is as a political representative[16]. If the political parties are interested in maximizing their votes shares but do not internalize the ethnic preferences of the voters, they will choose to field candidates based on their extent of involvement in criminal activities. Party X will field candidate X_{a1} and party Y will run Y_3 for office. Since, by assumption, voters place a higher weight on ethnicity of the candidate than on other characteristics, Y_3, the worse of the two candidates,will be elected. Much of the focus in prior literature on the topic is on this inefficiency. However, if parties internalize the ethnic preference of the voters, party X will choose to run candidate X_2 and party Y will run candidate Y_4. This result, then, will be worse - the candidate with the highest involvement in crime will be elected.

This study models the second source of inefficiency pointed out above. If political parties internalize the co-ethnic preference of voters, they may, to avoid political competition, differentiate themselves along ethnic lines in their choice of candidates to field. If such strategic diversification indeed occurs, political parties might substitute favorable ethnicity for quality resulting in the selection of worse quality candidates. The study presents empirical evidence from elections in Uttar Pradesh and Bihar in favor of the model predictions. Political parties respond to both the ethnic composition of voters and ethnicity of candidates from opposition parties in selection of candidates to field for elections. A comparison of the candidates running for elections from constituencies where such diversification

[16]The assumption is supported by findings from India in Prakash et al.(2015) and Banerjee et al.(2014).

is possible with candidates from constituencies where such diversification is limited due to affirmative action laws suggests that candidate quality indeed suffers due to the strategic diversification. However, this strategic diversification is much lower in smaller, well informed, well-educated constituencies. A policy implication is to ensure that voters have detailed information about the candidates, parties and their political stances.

This study points out that inefficiencies of co-ethnic voting might be underestimated if the strategic ethnic diversification by political parties are not considered. It also suggests that the election of a worse candidate to office is often due to the voters facing a worse pool of candidates to choose from.

The study is organized as follows: Section 3.2 describes the model and its assumptions. Section 3.3 characterizes the equilibrium and discusses the empirical analogue for the model. Section 4 describes the data and the setting in which the model is tested. Section 5 presents the results. Section 6 re-examines the underlying assumptions of the model and comments on their plausibility. Section 7 concludes.

3.2 Model

Consider a representative democracy which consists of C constituencies, indexed by c. Polling occurs at the constituency level. There are P political parties, indexed by r, all or some of whom may be contesting the election in any constituency. Since the empirical section of the study uses information from Indian elections, the terminology is kept consistent with the ethnic classification in Indian politics. Affirmative action in Indian politics takes the form of candidate restrictions. In some constituencies[17], candidates from only a subset of all ethnicities can run for elections. These are 'reserved constituencies. Other constituencies where these candidate restrictions do not apply and the elections are open for candidates of all ethnicities will be called 'general constituencies'. Accordingly, the study will assume that there are two ethnic groups in the population. Individuals - citizen voters or political party members - belong to one of the

[17]The ethnic categories defined here are closely related to the caste classification in India. Each ethnic category encompasses several caste groups. However, there is no overlap - no caste can belong to more than one ethnicity. The data from elections in India contain information on ethnic identities of the candidates running for office but not on their caste identity. For this reason and to maintain consistency with previous literature, these aggregated caste group are called ethnicities. For reserved constituencies, only candidates that belong to groups officially designated as Scheduled Castes or Scheduled Tribes by the Constitution of India can run for elections.

ethnicities, ‘general’ or ‘reserved’. Individuals who belong to the ethnic groups that benefit from the candidate restriction clause in any constituency, and not necessarily in the onstituency of the voter concerned, belong to the ‘reserved’ ethnicity. Individuals who belong to the ethnic groups that cannot contest elections from reserved constituencies, regardless of the status of their home constituency, belong to the ‘general’ ethnic group.

Since observable diversification ethnic lines is not possible in constituencies where candidates from only one ethnic group can run for election, the analysis consider only the general constituencies in the model. The reserved constituencies, however, will serve as useful counterfactuals when the analysis compare the inefficiencies in outcomes due to the strategic diversification. In all general constituencies, each party can choose to field a candidate of either general or reserved ethnicity. It is assumed that parties care only about maximizing their vote shares. In any general constituency, each political party will choose to run a candidate who will maximize the votes the political party earns in that constituency. It is assumed that voters in each constituency are more likely to vote for candidates from their own ethnicity than for a candidate from the other ethnicity.

The situation is similar to firms choosing a location for their store within a market. As in a firm location model, there are two main determinants of the ethnicity of the candidate the party decides to run in the election. Similar to how a firm will want to choose a location for the store where the demand for its product is high, if the parties internalize the co-ethnic preference of the voters, they will want to run a candidate whose ethnicity is the same as that of the majority of co-ethnic voters. However, all parties will want to capitalize on the high voter population of a particular ethnicity. If all parties choose candidates of the same ethnicity, there will be increased competition for the votes from that ethnic group. The vote bank from this big ethnic group will, then, be split among the parties. Under these circumstances, it might be beneficial for a party to deviate and run a candidate of a minority ethnicity. Even though it might lose its share of votes from the majority ethnic group as a consequence, it will have all the votes from the minority ethnicity. The gains might outweigh the losses in some scenarios.

The percentage of votes that a potential candidate can fetch for its party depends, on the population percentage of co-ethnic voters of her ethnicity, the number of candidates of the same ethnicity as her own competing against her, and the number of candidates of other ethnicities competing against her[18]. It might also depend on party and constituency characteristics. For example, some parties may be more popular than others when all constituencies in a state are considered together but others might enjoy more popularity in particular constituencies. The percentage of votes won might also depend on a host of other candidate characteristics. More often than not, parties do not even know all the potential candidates being considered by any rival party, let alone having information on all the characteristics about those potential candidates that matter for the selection procedure. The characteristics of potential candidates that a party is choosing from is assumed to be private information of the party. A constituency party candidate's ethnicity specific error term is used, that is referred to as candidate's profitability type, to include all such omitted variables related to candidate characteristics.

Assumption 1 (Independent Symmetric Candidate Profitability Type): The profitability type of a candidate of ethnicity *e* from party *r* in constituency *c*, ε^c_{re}, is private information to the party and *ε's* are independently and identically distributed draws from the distribution F (.). This distribution is common knowledge.

The percentage vote profit function for party r, if it runs a candidate of ethnicity e from constituency c, can be written as

$$\Pi^c_{re} = X^c_e \beta + \xi^c + \mu_r + \tau^c_r - g(\mathbf{n}^c, \Gamma^c_e) + \varepsilon^c_{re} \qquad (3.1)$$

X^c is the population share of voters of ethnicity *e* in constituency *c*. ε^c are constituency level variables that might affect the vote profit of running a candidate. μ_r are party-specific variables, like the nation wide popularity of the political party, that might affect the votes a candidate from that political party wins in a particular constituency. τ^c are factors that affect the vote profit that are different across parties within a constituency and different across constituencies for the same party. For example, the popularity of the same party could be different across constituencies and different parties will have different levels of popularity within any given constituency. *g(.)* represents the competition dimension of the game. Γ^c captures the magnitude of competition that a candidate of ethnicity *e* in constituency *c*

[18]India follows the electoral system of first-past-the-post plurality voting where each voter is allowed tovote for only one candidate, and the candidate who receives the highest percentage of votes casted in the constituency is elected. Political parties, therefore, are interested in the percentage of votes polled for their candidate in a constituency, and not the absolute number of votes.

faces from other candidates. n^c is the vector of the number of other candidates of each ethnicity contesting against a particular candidate.

Next, it is assumed that the competition effect is linear and additive. Each additional rival candidate reduces the percentage of votes a candidate, call him candidate *X*, receives. However, since all candidates of the same ethnicity split the votes from co-ethnic voters of that ethnic group, the reduction in vote shares is higher when the new rival candidate is of the same ethnicity as candidate *X*.

All parties move simultaneously when choosing their candidate. But parties do not have perfect information about the ethnicity of the candidates that the rival's parties will choose. They form expectations about the number of rival candidates of each ethnicity.

All things constant, if there are more voters of ethnicity *e*, all of whom have co-ethnic preference, it is more profitable to run a candidate of ethnicity *e*.

The higher the number of rival candidates of ethnicity *e*, the higher is the competition for votes of the co-ethnic voters of ethnicity *e*, and, therefore, of fielding a candidate of ethnicity *e*. The impact of an increase in the number of candidates of another ethnicity, *f*, is not as clear. It depends on the percentage of voters in the constituency voting ethnically. If all voters vote for co-ethnic candidate, then a rival party's decision to field a candidate of ethnicity *f* should increase (decrease) the probability of a party running a candidate ethnicity *e(f)* to be able to diversify. However, there might voters in the constituency who do not vote co-ethnically. For the votes of these voters, any competition for a party's candidate is bad news, regardless of the ethnicity of the candidate. The net impact will depend on the interplay of these two forces. As long as the percentage of voters who vote for co-ethnic candidates is reasonably large, the competition effect of an additional candidate of some other ethnicity should be smaller than that of other candidates from the same ethnicity.

3.3 Data Setting

3.4.1 Elections in Uttar Pradesh and Bihar

India follows a dual polity. It has a union government at the center and state governments at the periphery. There is a bicameral legislature at the center, consisting of an upper house (Rajya Sabha or The Council of States) and a lower house (Lok Sabha or the House of the People). A few states have a bicameral legislature, with an upper house (Legislative Council or Vidhan Parishad) and a lower house (Legislative Assembly or Vidhan Sabha) but the majority only have the lower house. The members of the lower house at both the federal and state level are elected directly by adult universal suffrage. The elections for the Lok Sabha are called parliamentary elections while those for the Vidhan Sabha are called assembly elections.

The predictions of the model are tested using information on the parliamentary election (PE) and assembly elections (AE) from the states of Uttar Pradesh (UP) and Bihar in India. These states are chosen for two main reasons. First, ethnic rivalries and co-ethnic political preferences are much more salient for these states (Acharya et al. (2014); Vaishnav (2010); Banerjee and Pande (2009); Chandra (2007); Witsoe (2005)). Second, UP is the most populous state of India and has the largest number of parliamentary and assembly constituencies. Bihar ranks third in terms of population and fourth in terms of number of parliamentary and assembly constituencies. Together, they account for around one fourth of the country's population. More than two-thirds of the population in both states is engaged in agriculture and the literacy levels are below the country average. The population in India is diverse but UP and Bihar, arguably, are two of the best representations of the socio-economic and political climate in many parts of the country.

Elections in these two states are mostly dominated by the Hindus even though Muslim candidates have a strong political presence in a few constituencies. This study does not make a distinction between candidates or voters from different religions. The elections in the state of Uttar Pradesh at both the parliamentary and the assembly level have been dominated by four big parties - Bahujan Samaj Party (BSP), Samajwadi Party (SP), Indian National Congress (INC) and Bhartiya Janta Party (BJP). All four parties, explicitly or implicitly, appear to have affiliation or affinity to certain caste group or groups. But a clear ethnicity (caste) affiliation is not observed in their actions. This is visible in the election results of the past. The Scheduled Caste (SC's) and Scheduled Tribes (ST's) together form around one-fourth of the state's population. The Other Backward Castes (OBC's) form around 40 percent of the state's population. BSP has explicitly identified itself to be representing the SC's and ST's while the SP has been said to be targeting the OBC votes. However, In 2007 UP AE elections, BSP won 206 out of the 403 seats, a clear majority, while the SP won 97 seats to finish second. In the 2012 UP AE, SP won 224 seats while the BSP bagged 80 seats in total. Strict affiliations to the caste groups in face of ethnic voting could not have produced these results. In fact, the BSP's 2007 victory was as a result of the fact that they managed to bag a large number of votes from general ethnicity voters by running general (and in particular, brahmin) category candidates even after their historically antagonistic attitude towards the general ethnicity[19]. It is this strategic behaviour that the present model is trying to capture.

The situation in Bihar is similar. The state politics is dominated by Rashtriya Janta Dal (RJD), Janta Dal (United), INC and BJP but has considerable presence of BSP, SP, Lok Janshakti Party (LJP), National Congress Party (NCP) and Communist Party of India (Marxist-Leninist) Liberation. While LJP enjoys considerable popularity among the SC voters, RJD is popular among the OBC voters. There are 80 parliamentary and 403 assembly constituencies in the state of UP and 40 parliamentary and 243 assembly constituencies in Bihar. As a part of the affirmative action in politics, around a fifth of these constituencies are 'reserved' for the SC/ST candidates. This means that only candidates from the SC and ST ethnic groups can run for office from these constituencies. Since there is no scope for political parties to diversify along ethnic lines, these constituencies are dropped from the sample[20]. Next, the independent candidates are dropped from the sample[21]. An independent candidate has no two ethnicities to choose from and, therefore, such strategic concern[22].

The analysis uses data from the 2009 and 2014 PE, 2010 Bihar AE, and 2012 UP AE and tests the predictions of the model separately for the parliamentary and assembly elections. For each level of elections, the data from the two states are pooled together. Information from elections after the most recent delimitation of 2008 is used. The constituency boundaries before the 2008 delimitation had remained unchanged since 1976 and were based on 1971 census population figures. Since the smallest level of aggregation at which the information on the

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[19]Acharya et al. (2014) The BSP took this to an extreme in its 2002 slogan "Thrash the Brahmin, the Bania and the Rajput" (translated from Tilak, tarazu aur talwar, Inko maro joote chaar(Jain 1996, p. 215))

[20]Each of the two ethnic groups, general and reserved, are composed of several castes. A diversification along caste lines is still possible in the reserved constituencies. However, only the ethnic identity (general or reserved) is observed in the data.

[21]Independent candidates are those who are not affiliated to any party.

[22]This study abstracts away from the first stage the game presented here where people and parties decide whether or not to run the elections from a constituency.

population shares different ethnic groups is available does not fit the assembly and parliamentary constituency boundaries perfectly (See Alam (2010), and the literature it cites), it is difficult to get reliable estimates of constituency-specific population sizes of ethnic groups for elections before 2008. The 2008 delimitation was carried out on the basis of the 2001 census figures. Official reports from the Delimitation of Parliamentary and Assembly constituencies outlined the process and contain information on constituency- specific population of ethnicity groups. The election results data were obtained from the Election Commission of India's website[23]. The elections data contain, for each constituency, the ethnicity of the candidates running for office from that constituency and an identifier for the winner from each constituency. Data on candidate characteristics are obtained from a series of affidavits released as a result of a Public Interest Litigation filed with the Delhi High court. They contain information on age, assets, liabilities, education attainment and criminal cases filed against the candidate.

3.4.2 Pradhan Mantri Gram Sadak Yojana

The most widely accepted explanation for the ethnic preferences of voters is that in constituencies where voters are not fully aware of the policy stand of the candidates or candidates cannot make binding policy commitments, ethnicity serves as an imperfect signal of the policies a candidate might enact once elected (Chandra (2007); Banerjee and Pande (2009); Vaishnav (2010)). To test for the importance of information in the formation of co-ethnic preferences, the study utilizes a policy intervention that created exogenous variation in the information cost across constituencies.

The Pradhan Mantri Gram Sadak Yojna (PMGSY) is a federal mandated rural road construction program that started in 2000 and is still underway. As of 2014, the program had cost more than four billion dollars and constructed 75 thousand kilometers of all-weather roads in the states of Uttar Pradesh and Bihar combined. The program aims to connect all habitations with a population of at least 500 to the nearest link road via an all-weather road[24]. Aggarwal (2014) and Banerjee and Sachdeva (2015) describe the program in detail and evaluate the impact of the program along different dimensions of development.

[23]Sourced from Election Commission of India

[24]"A habitat is a sub-village level entity, and is defined as `a cluster of population, whose location does not change over time'" (Aggarwal (2014))

Aggarwal (2014) finds that the program reduced time, money and information cost of accessing markets. Banerjee and Sachdeva (2015) find that the program increased social interaction within and between villages. Both these studies suggest that the flow of information had improved significantly due to the program. The program, since it makes use of the exogenously determined rule, is exogenous to the process of candidate selection by political parties for each constituency. Since the program spelled out clearly that the construction was to be prioritized using aggregate, and not ethnic group-specific, population-based rules, the possibility that some favored regions received the program before others is ruled out.

Data on PMGSY road construction development are available at the habitation level from the Online Management and Monitoring System (OMMS) of Government of India. Along with the status of connectivity during the 2001 census and as of May 2016, data also list the village, the block, the district, the assembly constituency, and the parliamentary constituency to which the habitat belongs. Unfortunately, the boundaries of the assembly and parliamentary constituencies have changed since then due to the 2008 delimitation. The habitat-level data on PMGSY needs to be matched with their corresponding assembly and parliamentary constituencies.

In India, the elections data available publicly are usually at the level of constituencies. The information on socio-economic indicators, on the other hand, are available at the level of administrative units of districts and sub-districts. The administrative boundaries of the country, that is the delineation of district, sub-district and block level boundaries, do not bear a close relationship to the parliamentary and assembly constituencies' boundaries. Therefore, it is a daunting task to match the habitations with the new assembly and parliamentary constituencies[25].

An approach most similar to Brass (1975)[26] is used. The basic building block for the delimitation exercise in Bihar are 'wards' in the urban areas and community development blocks or gram panchayats in rural areas. In Uttar Pradesh, these are wards in the urban areas and tehsils, kanungo circles, or patwari circles in

[25]This 'lack of fit between the two vital maps of India', as Alam (2010) puts it, has not only caused 'administrative and political problems' (see Sivaramakrishnan (1997), Sivaramakrishnan (2000), Sivaramakrishnan (2001)), but has also created 'some major obstacles .... for students of public policy, politics and political economy' of India.

[26]There have been numerous attempts at generating socio-economic profiles of parliamentary and assembly constituencies, each with its own weaknesses and pitfalls (See Alam (2010), Bhandari (2009) and the literature cited in Alam (2010) for details.)

rural areas. These smallest rural and urban units can be made up of one or more habitations[27]. The delimitation orders contain the names of the blocks and wards that make up an assembly constituency.

There are 330,000 habitations from the two states in the PMGSY data. The information is aggregated to the ward or the block level and each ward or block, which can contain multiple villages, is assigned to a single assembly constituency. Most of the blocks in UP and Bihar are contained entirely in one assembly constituency[28]. Some blocks are split among more than one assembly constituency. These blocks are assigned to the assembly constituency which contains, within it, a larger number of villages and habitations from the block. Some habitations were certainly assigned to a constituency they did not belong to. But there is no reason to believe that the measurement error in this assignment method is systematically related to the candidate choice by political parties across constituencies. Mapping the blocks to the parliamentary constituencies is accomplished by matching their assembly constituencies to each assembly constituency's corresponding parliamentary constituencies, the details of which are contained in the Delimitation of Parliamentary and Assembly Constituencies Order, 2008.

Next, for each assembly and parliamentary constituency, the percentage of habitations that were connected to the towns via an all-weather road in 2001 and by May of 2016 is calculated. The difference between these two figures, the increase in connectivity between 2001 and 2016, is used as a proxy for the increase in availability of information within the constituencies. For each assembly (parliamentary) constituency, a dummy variable 'High connect' takes a value of '1' if the particular constituency's increase in connectivity between 2001 and 2016 is more than the median increase in connectivity across assembly (parliamentary) constituencies in the state, and '0' otherwise. If the model fits the data well, interaction of 'High connect' with the main variables of interest in (3.11) should work towards muting the role of the main variables in the equation.

3.5 Results

Table 3.2 presents the results using the 2014 and 2009 PE elections data for the

[27]While tehsils are larger than community development blocks, for the sake of brevity, the study uses 'blocks'to refer to both tehsils and community development blocks. Similarly, 'villages' refers to both patwari circles and gram panchayats.

[28]For example, in Bihar, over 80 percent of the blocks were fully contained in one assembly constituency.

two states. As per the model's prediction, the higher the percentage of general ethnicity voters in the constituency, the higher is the probability that a party will field a general candidate. 1 percent increase in the percentage population of general ethnicity voters increases the probability of fielding a general candidate by 2.5 to 5 percentage points. To test that this positive association is not as a result of the mechanical correlation that would arise even if the parties chose a candidate randomly from the voter population, the null hypothesis of whether this coefficient equal to 1 is tested. The main coefficient is larger in magnitude and test significantly different than 1 at the 1 percent level of confidence for all specifications. Later in this section, while discussing the role of information in this model, additional evidence against the mechanical correlation hypothesis is presented.

The number of general-ethnicity rival candidates significantly lowers the probability that a party will choose to field a candidate of general ethnicity. The coefficient for number of reserved-ethnicity rival candidates variable turns out to be insignificant. The direction, however, suggests that candidates from the reserved ethnicity add to the competition that general candidates face. Consistent with the prediction from the model, the magnitude of this coefficient is smaller than the competition effect from general-ethnicity rival candidates. The column (3) and (4) include only those parties who field candidates in at least two constituencies. It is possible that a party contesting election in only one constituency is too small to have potential candidates from both ethnic groups to be able to diversify strategically[29]. Overall, there is evidence in favor of the model at the parliamentary level.

Table 3.3 presents the results for the assembly elections using data from 2010 Bihar AE and 2012 UP AE. While the percentage of general-ethnicity voters is still positively and significantly related to the probability that a party will chose a general-ethnicity candidate, the magnitude is lower than for the parliamentary elections. The coefficient for percentage general-ethnicity voter is still significantly different than 1 at the 1 percent level of confidence for all specifications. The number of general-ethnicity rival candidates and reserved-ethnicity rival candidates both have a negative impact on the probability of fielding a general candidate. However, general-ethnicity rival candidates seem to have a smaller, and statistically insignificant, competition effect than reserved-ethnicity rival candidates.

It is not entirely clear why it might be so. One explanation could be that since as-

[29]Using larger cutoffs for this size variable does not affect the results.

sembly constituencies are much smaller compared to the parliamentary constituencies, voters, due to more frequent interactions with the candidates, are better informed about the policy stands of the candidates and stop relying on ethnicity as a signal. Smaller size of the constituency might also mean more accountability for the candidate elected[30]. Alternative measures to influence voter, like election campaigning, might be much more effective at the assembly constituency level due to the higher acquaintance of the candidate with the issues facing that constituency. Also, since diversity in ethnic identities exists throughout India, most of the policies that pertain to ethnic identities are debated on, formulated, and legislated at the parliament level, and not in the state assemblies. As a result, having co- ethnic representatives in the parliament might matter more than having co-ethnics in the state assembly[31].

A commonality in these explanations is the crucial role of information. To test the importance of information, the dummy variable ‘High connect’, denoting high increase in road connectivity of the constituency between 2001 and 2016, is interacted with the main variables of interest - percentage of general ethnicity voters, number of general ethnicity rival candidates, and the number of reserved ethnicity rival candidates. The results are presented in **Table 3.4**. Column (1) presents the results for the parliamentary elections. For regions with low increase in connectivity, the coefficient for rival-general ethnicity candidates drops below that for rival reserved-ethnicity candidates and is statistically insignificant. But the coefficients are in the expected direction. Interestingly, the coefficient for interaction of high connectivity dummy with the main variables suggest that the model is not a good predictor of the candidate selection process in regions that saw a large increase in connectivity. The interaction of ‘High connect’ with percentage of general voters and with rival candidates of reserved ethnicity have coefficients with signs opposite of their independent effects. If PMGSY indeed increased the extent to which the voters in the constituencies had access to relevant information, the results suggest that political parties do not utilize strategies that rely on co-ethnic voting to choose candidates in regions where voters are more informed. The results also suggest that the positive co- efficient for percentage general-ethnicity voter population variable is notthe result of the mechanical in-

[30]Heath and Kumar (2012) find that the SC and ST populations of the state of Uttar Pradesh were unsatisfied with the performance of BSP government after the 2007 assembly elections suggesting that they had some information about the workings of the state government.

[31]A similar argument has been made in Jaffrelot (2003) and Chandra (2007). They argue that the political sa lience of caste identities become more pronounced in contexts where affirmative action policies are involved. Historically, in post-independence India, question of seat reservations and quotas for people to redress caste discrimination are debated at the parliamentary level.

crease in the probability of selecting a general candidate at random due to an increase in percentage general-ethnicity voter population.

For assembly elections, results presented in column (2), the independent coefficients are in the same direction and of a similar magnitude as those in **Table3.3**. The interactions, however, are close to zero in magnitude and insignificant. This is consistent with the results from **Table3.3** parties, to attract voters, do not rely as much on choosing co-ethnic candidates in assembly elections as they do in parliamentary elections.

But does co-ethnic voting and this strategic candidate choice result in undesirable outcomes? To examine this, the outcomes in general constituencies with open elections are compared with that from reserved constituencies where there is lower degree of ethnic voting and diversification along ethnic lines. As an indicator of quality of the outcome, information on the number of criminal cases ever filed against the candidates running for office from a constituency is used. Evidence suggests that criminality affects economic activity and public good provision within the constituency (Banerjee et al. (2014); Prakash et al. (2015)). **Tables 3.5** and **3.6** present the results. Columns (1) from the tables show that constituencies where only reserved ethnicity candidates can run for office tend to have candidates with fewer criminal cases against them in both parliamentary and assembly constituencies. Consistent with the hypothesis that the strategic candidate diversification is less frequent in assembly constituency, the negative correlation between the reserved constituency dummy and the number of criminal cases is higher for parliamentary constituencies. Vaishnav (2010), too, finds that candidates are more likely to have criminal records in general constituencies.

One explanation for higher criminality of fielded candidates in general constituencies can be that voters in general constituencies prefer criminal representatives. For example, such a situation may arise if criminal candidates are better at ensuring larger benefits for their own ethnic groups (Vaishnav (2010)). This would be visible in the difference in distribution of public resources across ethnic groups in general and reserved constituencies. However, studies on the impact of affirmative action in Indian politics find no evidence of any distribution effects. Another explanation could be that since candidate diversification along ethnic lines is possible and profitable in general constituencies, political parties, in these constituencies, place a much higher weight on the ethnicity of a potential candidate. This reduces the importance of other desirable candidate characteristics in the selection process and candidates with worse criminal history get fielded. Since such a diversification is not possible in reserved constituencies, the importance of other qualities, like the absence of a criminal record, increase the probability of a potential candidate's chances of being fielded.

Column (2) of **Tables 3.5** and **3.6** examine which of the two explanations accounts for the differences in the criminal record of candidates across these two types of constituencies. The dependent variable is the number of criminal cases against the candidate finally elected to office from the constituency. The explanatory variable 'proportion of criminal candidates' captures the inefficiency that arises from a worse pool of candidates fielded by political parties in these constituencies in order to be able to diversify ethnically. The 'reserved constituency' dummy now captures any differences across who is elected to office conditional on the quality of the pool of candidates fielded from a constituency and includes differences in preference for criminal candidates. It is evident that what explains the election of a criminal candidate to office is the worse quality of the pool of candidates voters choose from. In terms of their preference for criminal candidates, voters in the two types of constituencies do not differ. Also, consistent with less frequent strategic candidate diversification in assembly constituency, association between the proportion of criminal candidates and the number of criminal cases against the winner is smaller in assembly constituencies than in parliamentary constituencies.

One characteristic of any candidate which is readily observable by all parties is whetheror not a candidate is the incumbent in an office. An incumbent is much more likely to be fielded for elections since her victory in the previous elections is evidence of her vote garnering ability. The presence of an incumbent might affect selection process considerably. For example, consider the case where party A fields the incumbent of general ethnicity from a constituency. As per the model, this should decrease the probability that other parties will field a candidate of general ethnicity. However, an incumbent of general ethnicity might have a different competition effect than other candidates of general ethnicity. It is possible that parties might perceive voters of the general ethnic group to be more loyal to the incumbent than to any other candidate of the general ethnicity. Choosing a candidate of the general ethnicity might become even less attractive in this scenario. Alternatively, it is possible that the other parties in the constituency see the win of the incumbent in the previous election as a signal of high degree of loyalty of the voters to the ethnicity of the incumbent candidate, and not to the incumbent candidate herself. It might, therefore, be more profitable to run a general-ethnicity candidate in such a constituency.

Table 3.7 examines the impact of an incumbent contesting elections. Since constituency boundaries changed in 2008, it is assumed that there were no incumbents in 2009 PE elections. For the parliamentary elections in 2014, a dummy variable is defined that takes value '1' for all candidates in a constituency if an incumbent of 2009 elections was contesting again from that constituency in 2014. All the incumbents in 2014 in the two states, it turns out, are from the general ethnicity. As a result, it is not possible to distinguish between the impact of an incumbent contesting elections and the impact of an incumbent of general ethnicity contesting elections. Column (1) of **Table 3.7** includes a dummy indicator of whether the constituency has an incumbent contesting for office. The impact is statistically insignificant and the statistical significance and magnitude of the main variables in the model do not change much. Column (2) interacts the dummy capturing the presence of an incumbent with the main variables in the model. Interestingly, the presence of a general-ethnicity incumbent candidate seems to increase the probability of parties fielding a general candidate in constituencies with a lower percentage of general-ethnicity voters. However, as the percentage of general-ethnicity voters increase, the presence of a general- ethnicity incumbent candidate is associated with a lower probability of parties fielding a general candidate from the constituency. The results suggest that parties might perceive the win of a general-ethnicity candidate in the previous elections in constituencies with a lower percentage of general-ethnicity voters as a signal of high loyalty of the general-ethnicity voters to candidates of their ethnicity. Therefore, it might be more profitable to run a general ethnicity in such constituencies. However, in constituencies with a higher percentage population of general-ethnicity voters, the presence of a general-ethnicity incumbent might mean a loyalty to the incumbent candidate. If so, fielding another general-ethnicity candidate might not be very profitable.

Taken together, the results suggest that strategic diversification of candidates along ethnic lines by political parties in response to their perceptions that voters vote co-ethnically, especially in low information settings, leads to worse electoral outcomes.

3.6 Conclusions

Corruption impedes economic growth (Shleifer and Vishny (1993); Mauro (1995)). Previous literature views the election of corrupt and criminal candidates as the failure of the voters. Banerjee and Pande (2009) argue that ethnic biases result in selection of lower quality politicians. This study suggest that strategic action of political parties might be a bigger reason for selection if low quality candidates. In constituencies with open elections, parties strategically diversify their candidates along the dimension of ethnicity and, in the process, compromise on quality. In constituencies which are reserved for SC/ST candidates, diversification along the ethnicity dimension is not possible. Therefore, the competition is more intense. As a result, parties ensure that the candidates they run are not 'tainted'. While reserving all constituency for candidates of one or the other ethnicity might be a short-run fix, it may work towards making these ethnic rivalries more pronounced. To address this inferior candidate selection, the co-ethnic political preference must be addressed. One way in which that can be done is by providing the voters with more information about the candidate. If ethnicity works as signals for the policy stand of the candidates, this will weaken the co-ethnic preferences.

The model presented in the study is by no means a complete description of the complex selection procedure for the candidates that a party uses. A more comprehensive model should allow for other forces, like religion, gender, incumbency, etc., to play a role. This study abstracts away from some of these dimensions and attempts to model the candidate selection process in the simple manner that still manages to explain certain stylized facts about elections in India. Moreover, the selection process described by the model is more of a second stage to a selection of parties into constituency, which is of great interest and should be the topic of future research. It is possible that the ethnic preferences of the voters might evolve over time. A more sophisticated model should attempt to account for these.

3.7 Tables and Figures

Table 3.1: Co-Ethnic Preference and Strategic Choice of Candidates

Party X	**Party Y**
Candidate: X_1	Candidate: Y_3
Ethnicity: E_1	Ethnicity: E_3
Criminal Cases: Lowest Criminal Cases: Low	Criminal Cases: Lowest Criminal Cases: Low
Candidate: X_2	Candidate: Y_4
Ethnicity: E_2	Ethnicity: E_4
Criminal Cases: High	Criminal Cases: Highest

Table 3.2: Parliamentary Elections

	(1)	(2)	(3)	(4)
	(PE (All): Probit)	(PE (All): Logit)	(PE (>=2):Probit)	((PE (>=2): Logit)
VARIABLES	General-ethnicity candidate selected			
General Voters (%)	0.0256*** (0.0086)	0.0502*** (0.0168)	0.0280*** (0.0094)	0.0550*** (0.0182)
Number of general-ethnicity rival candidates	-0.0407*** (0.0154)	-0.0797*** (0.0306)	-0.0318* (0.0163)	-0.0635** (0.0321)
Number of reserved-ethnicity rival candidates	-0.0266 (0.0504)	-0.0574 (0.0993)	-0.0145 (0.0555)	-0.0335 (0.1116)
Wald χ^2 for $H_0 : \beta_1 = 1$	13193.50	3258.66	11233.15	2841.60
YEAR FE	YES	YES	YES	YES
STATE FE	YES	YES	YES	YES
Observations	2,071	2,071	1,908	1,908

*Notes: *** p<0.01, ** p<0.05, * p<0.1. Robust standard errors in parentheses. The standard errors are clustered at parliamentary constituency level.*
Data source: Election Commission of India

Table 3.3: Assembly Elections

	(1)	(2)	(3)	(4)
	(PE (All): Probit)	(PE (All): Logit)	(PE (>=2):Probit)	((PE (>=2): Logit)
VARIABLES	General-ethnicity candidate selected			
General Voters (%)	0.0207*** (0.0039)	0.0427*** (0.0078)	0.0207*** (0.0039)	0.0428*** (0.0079)
Number of general-ethnicity rival candidates	-0.0088 (0.0075)	-0.0174 (0.0147)	-0.0086 (0.0075)	-0.0171 (0.0148)
Number of reserved-ethnicity rival candidates	-0.0839*** (0.0259)	-0.1617*** (0.0502)	-0.0862*** (0.0262)	-0.1666*** (0.0508)
Wald χ^2 for $H_0 : \beta_1 = 1$	62389.15	14730.55	61228.39	14456.51
STATE FE	YES	YES	YES	YES
Observations	6,117	6,117	6,053	6,053

*Notes: *** p<0.01, ** p<0.05, * p<0.1. Robust standard errors in parentheses. The standard errors are clustered at parliamentary constituency level.*
Data source: Election Commission of India

Table 3.4 PMGSY and Candidate Selection

	General-ethnicity candidate selected in	
VARIABLES	(PE)	(AE)
General Voters (%)	0.0403*** (0.0127)	0.0281*** (0.0062)
Number of general-ethnicity rival candidates	-0.0323 (0.0262)	-0.0107 (0.0113)
Number of reserved-ethnicity rival candidates	-0.0786* (0.0409)	-0.0711* (0.0380)
High increase in connectivity due to PMGSY	3.5687** (1.5184)	-0.1074 (0.8011)
General Voters (%) * High Connect (%)	-0.0413** (0.0187)	0.0008 (0.0102)
General-ethnicity rival candidates * High Connect	-0.0579 (0.0412)	0.0005 (0.0146)
Reserved-ethnicity rival candidates * High Connect	0.3758*** (0.1390)	0.0478 (0.0625)
Observations	2,002	5,326
YEAR FE	YES	NO
STATE FE	YES	YES

*Notes: *** p<0.01, ** p<0.05, * p<0.1. Robust standard errors in parentheses. The standard errors are clustered at parliamentary constituency level.*
Data source: Election Commission of India

TABLE 3.5: Criminal Candidates in PE

VARIABLES	(1) Criminal cases against candidates	(2) Criminal cases against winner
Reserved constituency dummy	-0.5046*** (0.1161)	-0.2663 (0.6463)
Proportion of criminal candidates		5.2378** (2.1388)
Observations	2,386	237
R-squared	0.1802	0.1160
STATE FE	YES	YES
YEAR FE	YES	YES

*Notes: *** p<0.01, ** p<0.05, * p<0.1. Robust standard errors in parentheses. The standard errors are clustered at parliamentary constituency level.*
Data source: Election Commission of India

Table 3.6: Criminal Candidates in AE

VARIABLES	(1) Criminal cases against candidates	(2) Criminal cases against winner
Reserved constituency dummy	-0.3946*** (0.0392)	-0.3883 (0.2931)
Proportion of criminal candidates		2.1978** (0.8639)
Observations	8,979	625
R-squared	0.0764	0.2044
STATE FE	YES	YES

*Notes: *** p<0.01, ** p<0.05, * p<0.1. Robust standard errors in parentheses. The standard errors are clustered at parliamentary constituency level.*
Data source: Election Commission of India

Table 3.7: Incumbents in Parliamentary Elections

VARIABLES	(1)	(2)
	General-ethnicitycandidate selected	
General Voters (%)	0.0486*** (0.0185)	0.1079*** (0.0230)
Number of general-ethnicity rival candidates	-0.0812** (0.0319)	-0.1175*** (0.0382)
Number of reserved-ethnicity rival candidates	-0.0592	-0.0345
Constituency incumbent of 2009 contesting elections in 2014	-0.1132 (0.2504)	9.8967*** (3.3163)
General Voters (%) * Incumbent		-0.1288*** (0.0372)
General-ethnicity rival candidates * Incumbent		0.0263 (0.0906)
Reserved-ethnicity rival candidates * Incumbent		0.1607 (0.1768)
Observations	2,071	2,071
YEAR FE	YES	YES
STATE FE	YES	YES

*Notes: *** p<0.01, ** p<0.05, * p<0.1. Robust standard errors in parentheses. The standard errors are clustered at parliamentary constituency level.*
Data source: Election Commission of India

CONCLUSIONS

Over the last fifty years, significant progress has been made in improving global primary school enrollments. The gross primary enrollment rate in Sub-Saharan Africa has gone up from a little over 50 percent in 1970 to 90 percent in 2014. South Asia has moved from around 70 percent in 1970 to 109 percent in 2014. Rates of primary school completion have gone up from around 40 percent in 1970 to close to 70 percent in Sub-Saharan Africa and over 90 percent in South Asia. However, universal primary education is still a distant goal.

The low educational attainment of those who are still left out can often be traced back to ‘development insults’, their early exposure to adverse conditions such as illness and/or inappropriate feeding practices that have long lasting impact on their educational attainment. Against this backdrop, the first chapter points out that, at least along the dimension of education, the negative impact of these early life adverse circumstances can be mitigated with timely corrective policies. This provides a new impetus to the public policy aimed at alleviating poverty of education and wealth.

However, it is worth noting that improvements in educational attainments in the last fifty years have not translated proportionately into reductions in poverty. Over 50 percent of the population of South Asia and 66.5 percent of the population in Sub-Saharan Africa were living under the US $3.20 per day PPP poverty line in 2013. Studies have found that even though children are going to school more often, many of them lack basic reading, writing, and arithmetic skills even after completing primary school (Bold et al.(2017a)). School infrastructure, like pupil-teacher ratio and teaching pedagogy, is pivotal to learning in classes (Bold et al.(2017b)). Most of the increase in enrollment in primary enrollment across the developing world in the recent years have been as a result of reduction or abolition of primary school fees or similar large-scale supply side measures. As the chapter documents, while such measures might successfully increase enrollment, they might often strain the existing school infrastructure leading to low levels of learning. Anticipating such increases in demand in advance and planning steps, like recruitment and training teachers, to be able to timely respond to these demands should be a part of the design of any such large-scale program.

The prevailing economic environment of a region also has important bearing on what and how much the education policies can achieve. The second chapter documents that, in Tanzania, the seemingly smarter individuals delayed enrollment and worked at home or on the family farm - a behavior that is not completing surprising in an economy based around traditional modes of production where returns to experience may be higher than returns to education. When educational policies are not synchronized with the demands of the local economic environment, improved educational attainments, even in places where it is achieved, may fail to translate into growth and welfare in the short-run. And the lack of returns to investment in education might depress the demand for education further. In such scenario, education policies need to be complemented with policies like introduction of subsides for modern agricultural equipment, so as to improve the returns from education even in the short-run.

Such streamlining of government policies will require capable legislators at the helm. However, developing countries often also impaired by high degree of incompetence and corruption amongst its political leaders and policy makers. The third chapter shows that political parties in these regions believe that they can win elections to an office by appealing to the ethnic preferences of voters. In an attempt to field a candidate of an ethnicity that will maximize their vote profit, they disregard the inferior qualities of the candidates and present the voters a worse pool of candidates to choose from. However, evidence suggests that parties do not engage in this strategic behavior when the constituencies aresmaller, cost of amassing information is lower, or the voters are more educated. This suggests that education might have non-pecuniary benefits in the short-run, which in turn, might improve economic welfare through more efficient planning and implementation of government policies.

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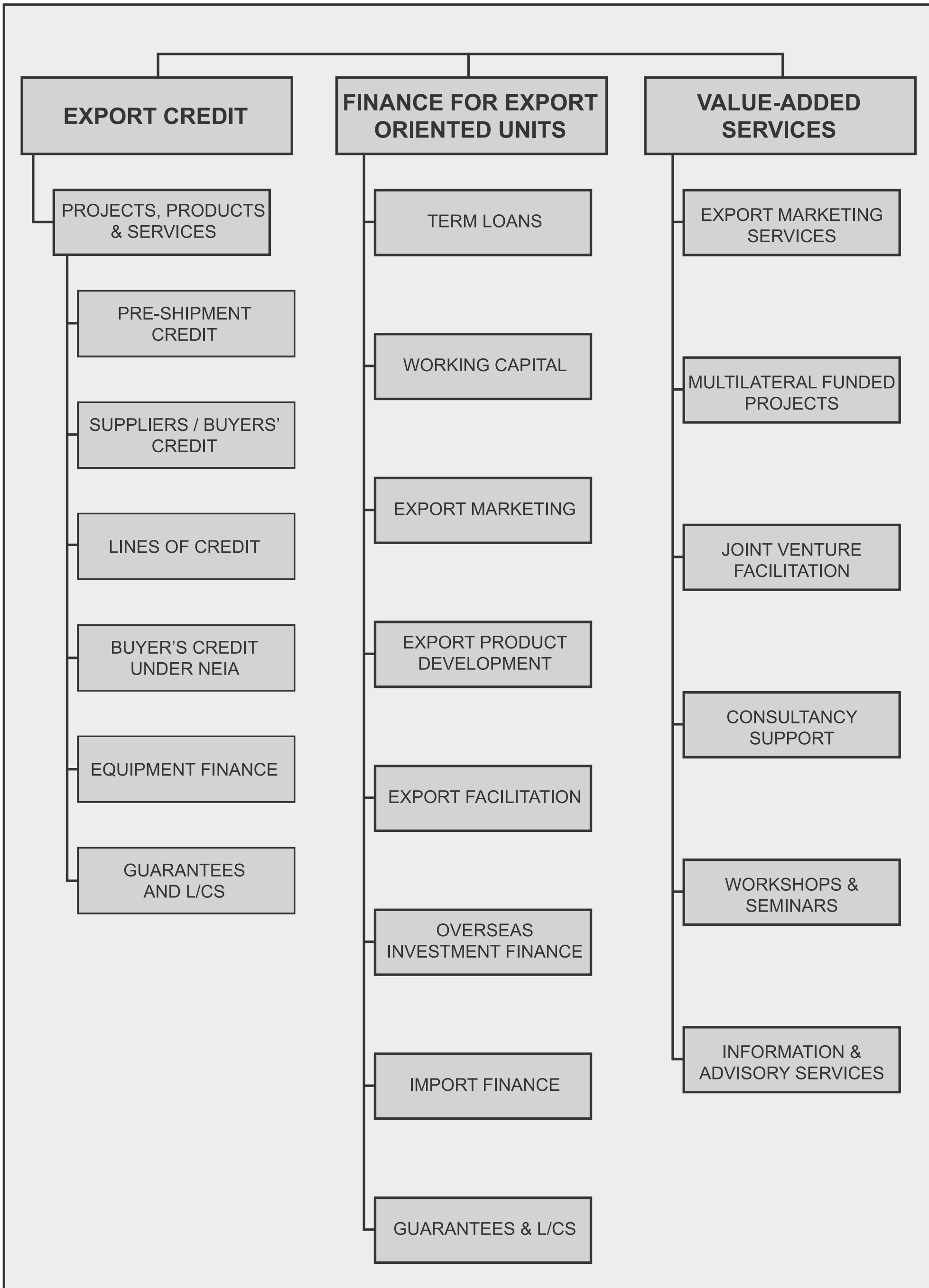

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