The Effect of Treatment on the Untreated: Free Primary Education in Kenya

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PRELIMINARY - DO NOT CITE

1 Introduction

How does expansion of access to education affect students that would have enrolled in the absence of the expansion? Expanding access to education allows previously constrained children to enroll in school, potentially changing the composition of students, increasing the size of the student body and class pupil-teacher ratios. Such changes may affect the outcomes of students that would have enrolled in the absence of the policy change. This paper uses the Free Primary Education (FPE) program in Kenya to examine the long-term impact of the elimination of public school fees on the educational attainment and literacy rates of students.

The Kenyan government introduced its Free Primary Education (FPE) program in January 2003, eliminating all fees for public primary schools. Prior to the implementation of this program, public and private primary schools charged fees. On average, public school fees were approximately US$16 per year in 1997 (The World Bank, 2004), but some schools charged up to US$350 per year (Lucas and Mbiti, 2012). Fees were collected to pay for tuition, supplies, books, and facilities maintenance. After the introduction of the FPE policy, public primary schools received approximately US$14 per pupil per year from the government and parents of primary-age students faced no enrollment cost. Lucas and Mbiti (2012) documents increases in class size following the adoption of FPE; Sanders (2007) describes the rapid and extreme increase in student population at Olympic Primary School in Nairobi, where average class size reached a level nearly double its pre-FPE level by 2007.

The FPE program is likely to affect students differently based on their ease of access to primary education pre-policy. If the FPE program increases the number of economically disadvantaged students enrolled in primary school, it may change the composition of public school classes. Changes to pupil-teacher ratio and the composition of students may affect the learning outcomes of students that would have otherwise been

enrolled. Changes to the classroom environment may lead to richer or higher-ability students moving towards private schools, or of withdrawing from formal education entirely.

I estimate the impacts of Kenya's Free Primary Education program on educational attainment and literacy rates for different ethnic groups. I use cohort variation in exposure to the policy to estimate the impact of the FPE program on student literacy, and I use an individual's ethnicity to proxy for his likelihood of being a student in the absence of the FPE program. I find that for individuals belonging ethnic groups that were relatively unaffected by the policy (that is, groups that appeared to have relatively high access to primary education before the policy change), exposure to the policy has no significant bearing on educational attainment or likelihood of literacy. This finding suggests that exposure to the FPE does not significantly affect achievement for students that would have enrolled in the absence of the policy, or that the effects are not drastic enough to affect literacy rates. For individuals with relatively low pre-program enrollment rates, I find that exposure to the FPE program significantly and substantially increases educational attainment and literacy rates.

My findings are consistent with the findings of other research on free primary education programs in sub-Saharan Africa which show increased enrollment particularly among poorer children (Grogan, 2009; Lucas and Mbiti, 2012). My empirical strategy, which uses a regression kink design, does not rely on intensity of exposure, and allows for analysis of groups whose expected intensities of treatment vary. Much of the literature examining the effects of FPE programs employs difference-in-differences designs, exploiting variation in intensity of treatment; however, individuals with low expected intensity of treatment may be affected by the policy in ways that may differ from the ways in which individuals with high expected intensity of treatment are affected. Instead, I estimate the effect of a year of exposure to the policy relative to the within-group pre-policy trend.

An important caveat to my results is that the regression kink design estimates a weighted average effect on students that would and would not have been enrolled in the absence of the policy. While my results suggest that the policy had no effect on high pre-policy enrollment ethnic groups, I cannot rule out the possibility of learning effects. It's possible that there was a negative learning effect on students that would have been enrolled in the absence of the policy which is offset by a positive learning effect on students that would not have been enrolled in the absence of the policy. Similarly, my estimates include students that may have withdrawn from public school or moved to private school; if students that attended public schools post-policy experienced negative effects, those may be offset by positive effects on students that moved to private school due to the policy.

The paper proceeds as follows. Section 2 describes the theoretical mechanisms through which the FPE could impact students; Section 3 describes the data I use; Section 4 describes my empirical strategy; Section 5 describes my results; Section 6 con-

cludes.

2 Conceptual Framework

When a country expands access to education, it expands the set of students that enroll in a given affected grade. Certain groups of students that couldn't or wouldn't previously attend the grade will enroll after the policy change, and this will affect the composition of students. For example, if a given grade becomes free to parents of students, students from lower-income families that were unlikely to have enrolled before the policy change will be more likely to enroll after the policy change due to the lowered cost of enrollment and the average family income of a student in that grade will decrease. Consistent with this hypothesis, Grogan (2009) and Nishimura, Yamano and Sasaoka (2008) find that Uganda's FPE program led to earlier and higher primary enrollment among low-income children. If peer effects exist, the performance of students that would have enrolled in the absence of the policy change will be affected by a changed peer group if the new students perform differently on average. Duflo, Dupas and Kremer (2011) exploit an experiment tracking students by ability to investigate the existence of peer effects among primary school students in Kenya, among other things; the authors find a positive direct effect of high-achieving peers on student achievement.

If infrastructure and staffing investments are not made by school administrators, average class sizes will increase with total enrollment after an access expansion. Class size is a well-known input to student achievement and teaching effectiveness. Hoxby (2000) exploits exogenous variation in primary school class sizes in the United States and finds no significant effect on student achievement. However, if increased class sizes are accompanied by a more heterogeneous classroom distribution of student abilities, instructors will be less able to target classroom instruction effectively, and student achievement will suffer (Duflo, Dupas and Kremer, 2011). Bosworth (2014) demonstrates that class size reductions affect heterogeneous North Carolinian fourth- and fifth-graders differentially. In particular, the authors find that low-ability students benefit from class size reductions while high-ability students are relatively unaffected, and smaller classes tend to have smaller achievement gaps.

The change in the composition of primary students brought about by the introduction of Kenya's FPE program seems likely to be detrimental to students that would have enrolled in primary school in the absence of the program. Students that enroll as a result of the program introduction seem likely to come from relatively low-income and low-education households, and likely to perform less well than the pre-FPE average. Lucas and Mbiti (2012) finds that public school students' parents are significantly less literate on average after the introduction of the FPE program in Kenya. Further, high-ability or richer students may choose to enroll in private schools instead of public schools after the policy change (Hsieh and Urquiola, 2006). Lucas and Mbiti (2012) show that the FPE program significantly increased the number of students per teacher in Kenyan primary classrooms. This will negatively affect achievement among low-

ability students that would have enrolled in the absence of the policy, but if new students lower the class average student ability, teachers may target instruction nearer to low-ability student levels. If high-ability students do flee to private schools, the distribution will further shift towards the low-ability students. That is, the increase in class sizes may not negatively affect the achievement of low-ability students that would have enrolled in the absence of the policy change. However, the increase in class size seems likely to harm the achievement of middle-ability public primary students that would have enrolled in the absence of the policy change.

3 Data

I use data from the 2014 round of the Kenya Demographic and Health Surveys (DHS) to analyze the introduction of Kenya's FPE program. DHS is a nationally representative survey including individual-level data on an abundance of factors including educational attainment, ethnicity, age, domestic violence, and residence characteristics. For this project, I use the women's survey, which includes data on 31079 Kenyan women aged 15-49. I employ data on literacy to proxy for individual-level returns to education; educational attainment; ethnicity to proxy for intensity of treatment exposure; and year of birth to determine exposure to FPE.

Students born in 1990 or later were 13 or younger in 2003, the time of FPE introduction. Kenyan primary schools include grades 1-8, so children born in 1990 would have been able to take advantage of newly free 8th grade in 2003; children born in 1991 would be able to take advantage of free 7th grade in 2003 and free 8th grade in 2004; and so on. That is, the program's impact on students should be increasing over time. Figures 1, 2, and 3 confirm this prediction. Figure 1 presents mean birth cohort educational attainment for individuals born prior to 1996.[1] While average birth year educational attainment was rising over time prior to the policy introduction, there is an apparent discontinuity in educational attainment at birth year 1990, indicating that the FPE did expand access to education. Figure 2 shows the average attendance of at least some primary school by birth year for all individuals in my sample. Average primary school attendance is substantially higher for individuals born after 1990, and is increasing for each birth year cohort starting in 1991. Figure 3 shows average literacy rate by birth year. While each cohort's literacy rate is increasing over time prior to the introduction of the FPE policy, the rate of increase quickens for birth cohorts exposed to the FPE policy. This suggests that the expanded access to education may have had an effect on literacy rates.

Kenya's FPE program, in expanding access to education, changed the composition of Kenya's student population. Table 1 presents the ethnic makeup of individuals of different levels of educational attainment before and after the introduction of FPE.

[1] Children born in 1996 would be 18 in 2014, the period of data collection. The educational attainment of children born after 1995, then, is right-censored in that none of them can report having completed secondary school or higher.

The Kikuya group, which dominated the primary and secondary school attainers before the policy, saw their share of each attainment population fall significantly after the FPE introduction. The Mijikendu/Swahili and Somali ethnic groups, on the other hand, saw their shares of the primary and secondary attainer populations increase significantly after the policy change. It seems likely that, rather than reducing the number of Kikuya students enrolled in primary and secondary schooling, the policy increased the number of Mijikendu/Swahili and Somali students, increasing their shares of the student population and decreasing the share of Kikuya students.

4 Empirical specification

I employ a regression kink design (RKD) to analyze the effect of the FPE policy on educational attainment and literacy rates. I use this empirical strategy because the effect of the policy will be different in expectation for students exposed for one year (13-year-olds in 1990, for example) compared to students exposed for two years, and so on. Some individuals will have access to free primary education starting in first grade - these students would in expectation be more affected by the policy change - while others will have less. The design will provide an estimate for the effect of a year of policy exposure on an outcome. I estimate the change in slope at the birth year of first exposure to FPE, 1990. In particular, I estimate the following structural model.

$$I(Literate)_{ic} = \alpha + \beta I(Attainment)_i + \rho(YOB - 1990)_c + u_{ic} \tag{1}$$

In this model, $I(Literate)_i$ equals 1 if individual i belonging to birth cohort c is able to read a full sentence and equals 0 otherwise; $I(Primaryorhigher)$ equals 1 if individual i attended at least some primary school and equals 0 otherwise; and $(YOB - 1990)_i$ equals the distance from individual i's birth year to 1990, the year of the kink. The coefficient of interest is β, which provides an estimate of the effect of attending at least some primary school on probability of literacy.

The first stage of this model, which I use to estimate the effect of the policy on educational attainment, is

$$\begin{aligned} I(Primaryorhigher)_{ic} =& \pi_1 + \pi_2(I(YOB \geq 1990) \times (YOB - 1990))_c \\ &+ \pi_3(YOB - 1990)_c + e_{ic}. \end{aligned} \tag{2}$$

The coefficient of interest, π_2, is an estimate of the effect of a year of exposure to the FPE program on the probability of attending at least some primary school.

The reduced form of the model, which I use to estimate the effect of the FPE policy on literacy, is

$$I(Literate)_{ic} = \tau_1 + \tau_2(I(YOB \geq 1990) \times (YOB - 1990))_c + \tau_3(YOB - 1990)_c + v_{ic}. \tag{3}$$

The coefficient of interest, τ_2, is an estimate of the effect of a year of exposure to the FPE program on the probability of being able to read a full sentence.

The regression kink design exploits an exogenous change in slope in the relationship between assignment to treatment a forcing variable x_f and a treatment variable D to estimate the causal impact of D on a variable on interest y. In this case, the introduction of FPE causes a change in exposure to primary school (D) at birth year (x_f)1990. If the outcome variable y isn't independently affected by birth year, or has a smooth relationship with birth year, the regression kink framework will allow identification of the effect of the FPE policy on literacy and educational attainment.

To proxy for student likelihood of enrollment, I use ethnicity. In particular, I estimate the above model for Kikuya and Somali individuals separately as well as for the full sample. Kikuya children were relatively likely to be enrolled prior to the policy and thus I assume they were relatively unaffected by the introduction of FPE; Somali children were relatively unlikely to be enrolled prior to the policy and the share of primary-educated Somali individuals increased for birth cohorts exposed to the FPE, so I assume they were relatively affected by the introduction of FPE. If Kikuya primary school enrollment is unaffected by the policy change, there will be no kink in primary school attainment at birth year 1990. If Kikuya literacy is affected by the changed composition of students, there will be a kink in literacy rate at birth year 1990. In this case, if the effect on literacy is negative, the RKD estimator β will yield a negative estimated impact of exposure to primary education after the introduction of FPE on Kikuya individuals.

5 Results

5.1 Educational attainment

Figure 4 shows the results of estimating equation (2) for the full sample and Kikuya and Somali women separately. The full results of these regressions can be found in Table 2. Primary school attainment is high for Kikuya women on both sides of exposure to the FPE policy; it is slightly higher for women born after 1990. There is a modest discontinuity at the first birth cohort exposed to FPE, and a modest and insignificant change in slope. This suggests that the policy change likely did not substantially affect Kikuya primary school attainment, though I cannot rule out the possibility of counterbalancing effects originating from differential effect on subgroups within the Kikuya population. The attainment of Somali students appears to have been substantially increased by the policy; my estimates suggest that an additional year of policy exposure increases the probability of completing at least some primary school by 4.3 percentage points (28.5% increase relative to the pre-policy probability) for Somali women. Again, I am unable to rule out the possibility of heterogeneous effects among Somali women.

5.2 Literacy

Figure 5 shows the results of estimating equation (3) for the full sample and Kikuya and Somali women separately. The full results of these regressions can be found in Table 3; equation (3) corresponds with the reduced-form results in that table. Literacy

rates for Kikuya women in my sample are increasing over time, but there is no significant slope change in 1990 for this group. An additional year of exposure to the policy for Somali women, on the other hand, seems to have a significant and large positive effect on their probability of literacy. I find that a year of exposure increases a Somali woman's probability of literacy by 4.9 percentage points (52.7% increase relative to the pre-policy average probability of literacy among Somali women). As before, I am unable to rule out heterogeneous effects for either group.

6 Conclusion

I find that Kenya's 2003 elimination of public school fees through its FPE program did not substantially affect the probability of completing at least some primary school or of being able to read a full sentence by age 18 among women of ethnicities with high pre-policy primary school enrollment rates. At the same time, I find that a year of exposure to the policy increased the probability of having completed at least some primary school by 28.5% for women of ethnicities with low pre-policy primary school enrollment rates; I find that a year of exposure increases the probability of being able to read a full sentence by 52.7% among the same women.

Importantly, I cannot rule out the possibility of heterogeneous effects within these groups. It is possible for example, that a subset of Kikuya women experienced negative learning effects from the policy - due to increased class sizes, for example - while another subset of Kikuya women experienced positive learning effects - for example, due to an expansion of access to primary education. Because the RKD estimator is a weighted average, these two opposite effects could result in a null result.

Of particular interest are the potential marriage market and fertility effects of the policy. Such dramatic positive effects for low pre-policy enrollment groups suggest potential increases in bargaining power among such groups in labor and marriage markets as well as within the household. One crucial weakness of my empirical strategy is that it does not allow for controlling for age/cohort effects. The RKD strategy assumes that age/cohort effects would remain unchanged in the absence of the FPE policy; as a result, any age/cohort effects that may exist will bias the RKD estimator. This makes causal analysis of outcomes with well-known life cycle patterns like wealth accumulation, fertility outcomes, and marriage market outcomes untenable. My data includes fertility histories for each woman as well as dates of marriage; as a result, it is possible to construct fertility measures that control for age. This is an important direction for future work.

Table 1: Ethnic Composition by Educational Attainment and Exposure to Policy

	Highest level of education attained								
	None			Primary			Secondary or higher		
	Pre	Post	Diff.	Pre	Post	Diff.	Pre	Post	Diff.
Embu	0.000	0.000	-0.000	0.016	0.007	-0.008	0.019	0.016	-0.003
			(0.000)			(0.002)***			(0.003)
Kalenjin	0.049	0.037	-0.013	0.158	0.168	0.010	0.148	0.159	0.011
			(0.008)			(0.008)			(0.008)
Kamba	0.014	0.006	-0.008	0.121	0.096	-0.025	0.099	0.105	0.006
			(0.004)**			(0.007)***			(0.007)
Kikuya	0.012	0.004	-0.007	0.184	0.095	-0.089	0.261	0.196	-0.064
			(0.003)**			(0.007)***			(0.009)***
Kisii	0.005	0.003	-0.002	0.052	0.044	-0.008	0.098	0.076	-0.006
			(0.002)			(0.005)*			(0.006)***
Luhya	0.024	0.007	-0.017	0.127	0.147	0.021	0.128	0.138	0.010
			(0.004)***			(0.008)***			(0.007)
Luo	0.010	0.002	-0.009	0.117	0.128	0.011	0.094	0.114	0.020
			(0.002)***			(0.007)			(0.007)***
Maasai	0.063	0.107	0.044	0.013	0.016	0.003	0.009	0.012	0.004
			(0.013)***			(0.003)			(0.002)
Meru	0.011	0.013	0.002	0.066	0.047	-0.018	0.058	0.053	-0.006
			(0.005)			(0.005)***			(0.005)
Mijikendu/Swahili	0.109	0.060	-0.049	0.050	0.090	0.040	0.022	0.039	0.017
			(0.011)***			(0.006)***			(0.004)***
Somali	0.309	0.309	0.000	0.009	0.022	0.014	0.008	0.027	0.019
			(0.007)			(0.003)***			(0.003)***
Taita/Taveta	0.002	0.0000	-0.002	0.019	0.010	-0.010	0.019	0.013	-0.006
			(0.001)**			(0.002)***			(0.003)**
Turkana	0.100	0.010	-0.001	0.009	0.024	0.015	0.005	0.008	0.003
			(0.013)			(0.003)***			(0.002)*
Samburu	0.099	0.120	0.021	0.005	0.015	0.010	0.003	0.004	0.002
			(0.014)			(0.003)***			(0.001)
Pokomo	0.008	0.009	0.001	0.013	0.020	0.007	0.005	0.006	0.001
			(0.004)			(0.003)**			(0.002)
Iteso	0.005	0.000	-0.005	0.011	0.014	0.003	0.006	0.009	0.003
			(0.001)***			(0.003)			(0.002)
Boran	0.050	0.044	-0.006	0.007	0.014	0.007	0.004	0.005	0.001
			(0.009)			(0.002)***			(0.002)
Gabbra	0.030	0.045	0.015	0.001	0.002	0.001	0.001	0.002	0.001
			(0.009)*			(0.001)			(0.008)
Kuria	0.004	0.002	-0.003	0.008	0.011	0.002	0.001	0.005	0.003
			(0.002)			(0.002)			(0.001)**
Orma	0.016	0.018	0.002	0.001	0.003	0.001	0.000	0.000	0.000
			(0.006)			(0.001)			(0.000)
Mbere	0.011	0.034	0.022	0.001	0.002	0.001	0.001	0.001	0.000
			(0.007)***			(0.001)			(0.001)
Rendille	0.015	0.021	0.006	0.001	0.002	0.001	0.000	0.001	0.001
			(0.006)			(0.001)			(0.001)

Notes: Standard errors are reported in parentheses. * denotes significance at the 90% level; **, significance at the 95% level; and ***, significance at the 99% level. Estimates represent the share of population held by a given ethnicity at a given education level. For example, of the survey respondents born prior to 1990 with secondary-level or higher educational attainment in 2014, 1.9% were Embu; of the respondents born in or after 1990 with secondary-level or higher educational attainment, 1.6% were Embu.

Table 2: Primary school attainment RKD results

	Full sample	Kikuya	Somali
(I(YOB $\geq$ 1990) $\times$ (YOB-1990))	0.023***	-0.001	0.043**
	(0.003)	(0.001)	(0.014)
YOB-1990	-0.003**	0.001	0.014**
	(0.001)	(0.001)	(0.005)
N	16911	2581	1000

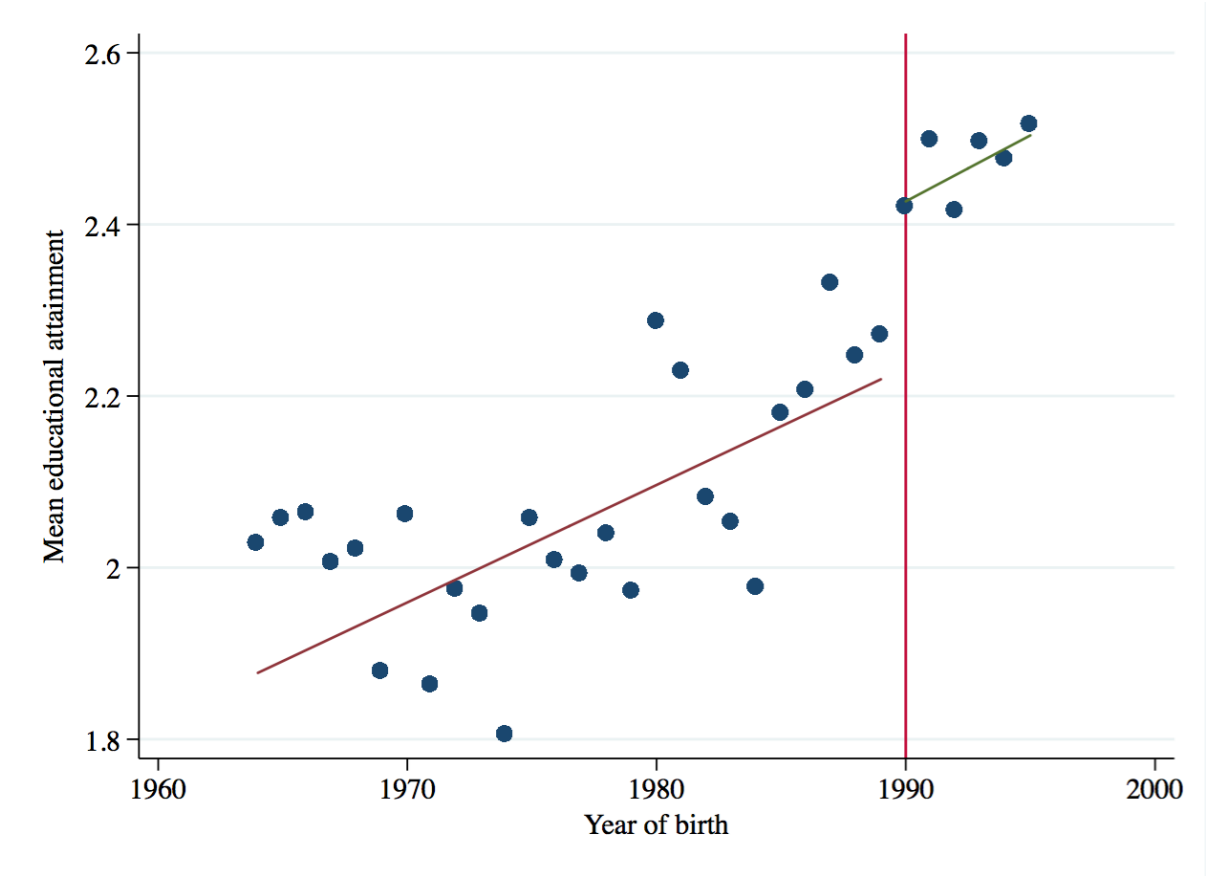
Notes: Dependent variable is ideal number of children reported by respondent. Heteroskedasticity-robust standard errors are reported in parentheses. * denotes significance at 10%, ** denotes 5%, and *** denotes 1%.

Table 3: Literacy RKD: first stage and reduced form results

	Full sample	Kikuya	Somali
First stage: attainment			
(I(YOB $\geq$ 1990) $\times$ (YOB-1990))	0.023***	-0.001	0.043**
	(0.003)	(0.001)	(0.014)
YOB-1990	-0.003**	0.001	0.014**
	(0.001)	(0.001)	(0.005)
N	16911	2581	1000
Reduced form: literacy			
(I(YOB $\geq$ 1990) $\times$ (YOB-1990))	0.024***	0.005	0.049***
	(0.003)	(0.005)	(0.013)
YOB-1990	0.001	0.004	0.009*
	(0.001)	(0.002)	(0.004)
N	16911	2581	1000

Notes: Dependent variable is ideal number of children reported by respondent. Heteroskedasticity-robust standard errors are reported in parentheses. * denotes significance at 10%, ** denotes 5%, and *** denotes 1%.

Figure 1: Educational attainment by year of birth



Notes: Attainment is a truncated variable that equals 0 if an individual received no formal education; 1 if he received some primary education; 2 if he completed primary school; 3 if he received some secondary education; 4 if he completed secondary school; and 5 if he was educated beyond the secondary level.

Figure 2: Mean primary attendance status by year of birth

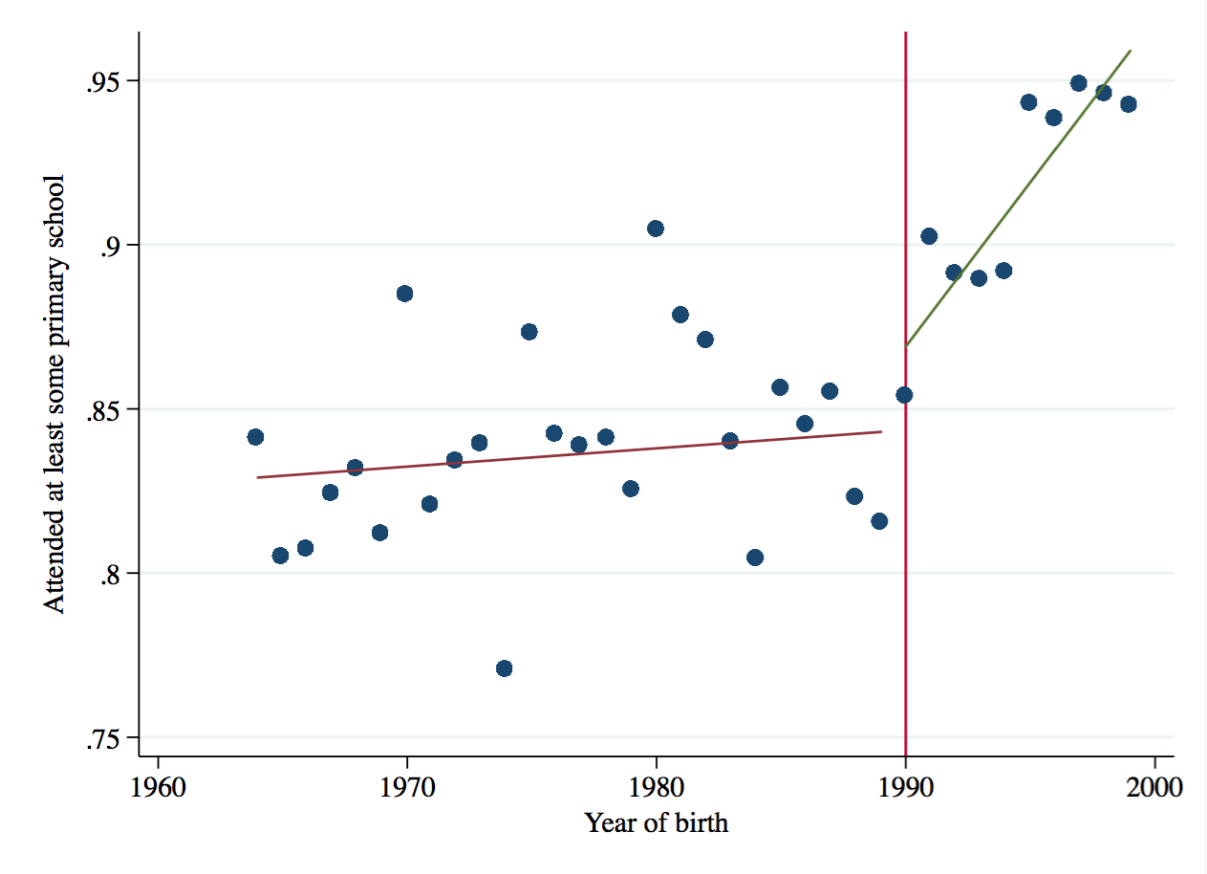


Figure 3: Mean literacy rate by year of birth

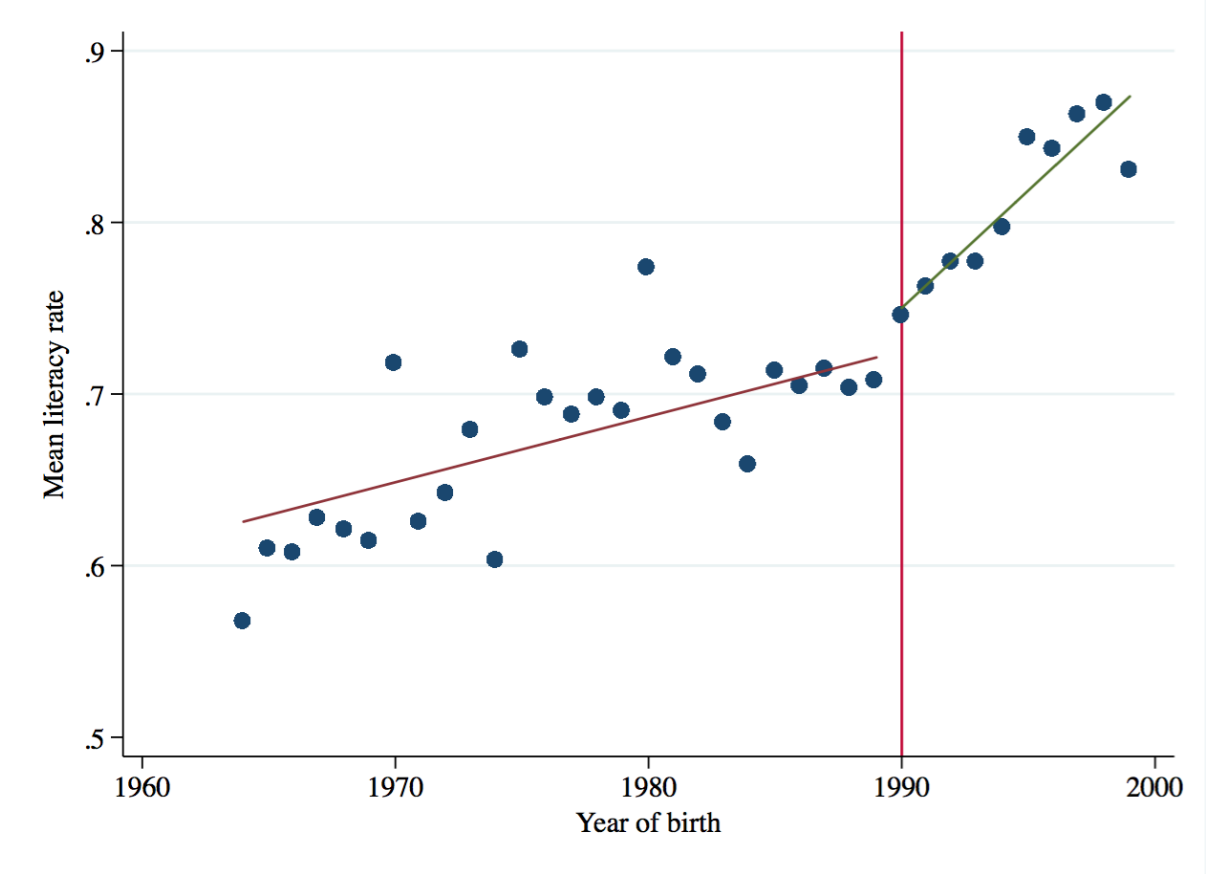
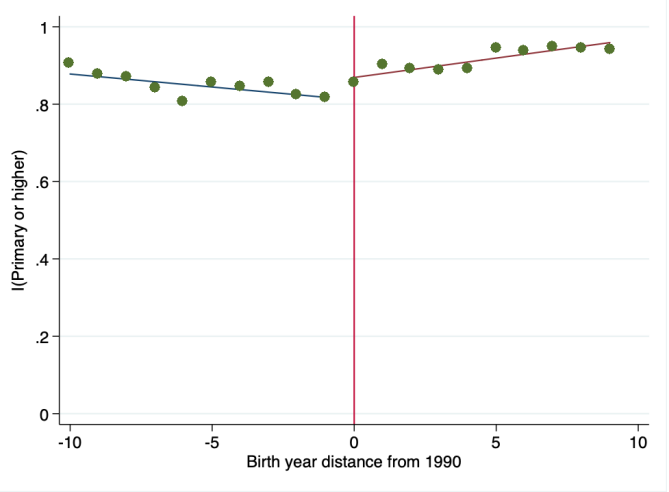
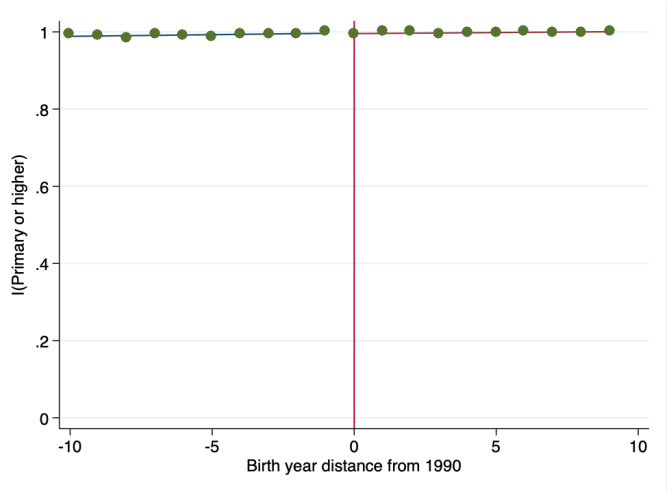


Figure 4: FPE effect on educational attainment

(a) Completed at least some primary school - full sample



(b) Completed at least some primary school - Kikuya



(c) Completed at least some primary school - Somali

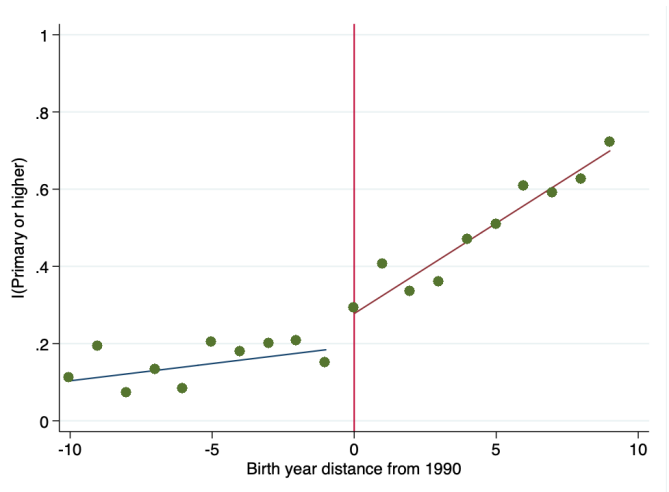
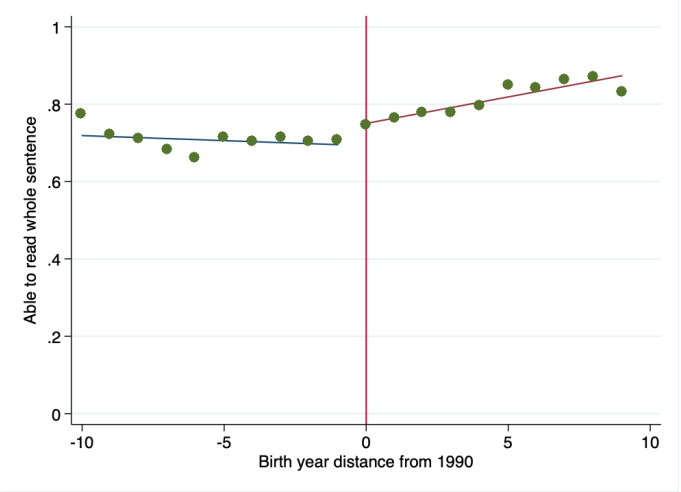
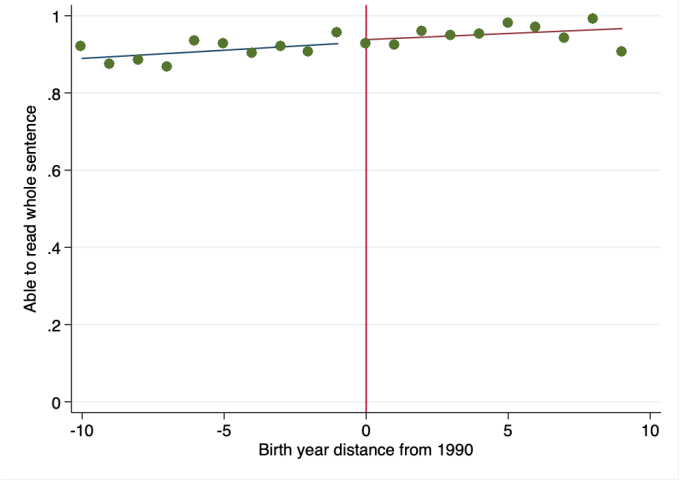


Figure 5: FPE effect on literacy

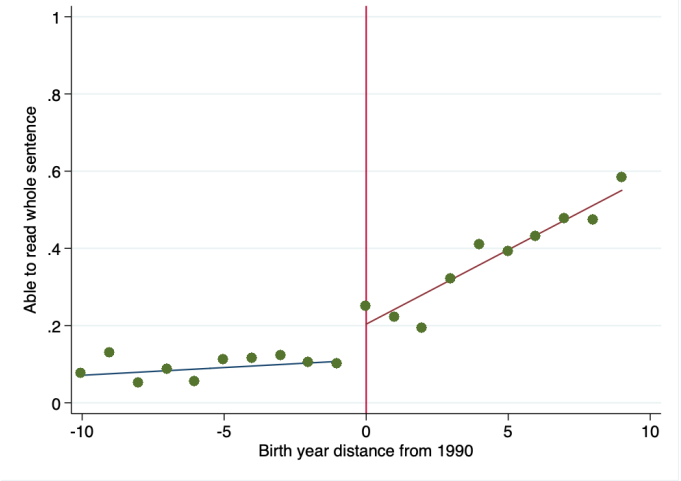
(a) Able to read a full sentence - full sample



(b) Able to read a full sentence - Kikuya



(c) Able to read a full sentence - Somali



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