Cycling to School: Increasing Secondary School Enrollment for Girls in India

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Motivation

- *"I think the bicycle has done more to emancipate women than anything else in the world."*- Susan B. Anthony (19th century leader of US women's suffrage movement)
- *"Investment in girls' education may well be the highest-return investment available in the developing world."*- Lawrence H. Summers (former Chief Economist of the World Bank)

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- Increasing school attainment of girls is one of the Millennium Development Goals
- Bridging the gender gap in education is an important policy question
- Improving female education directly contributes to "Inclusive Growth":
  - Growth - by increasing human capital of labor force
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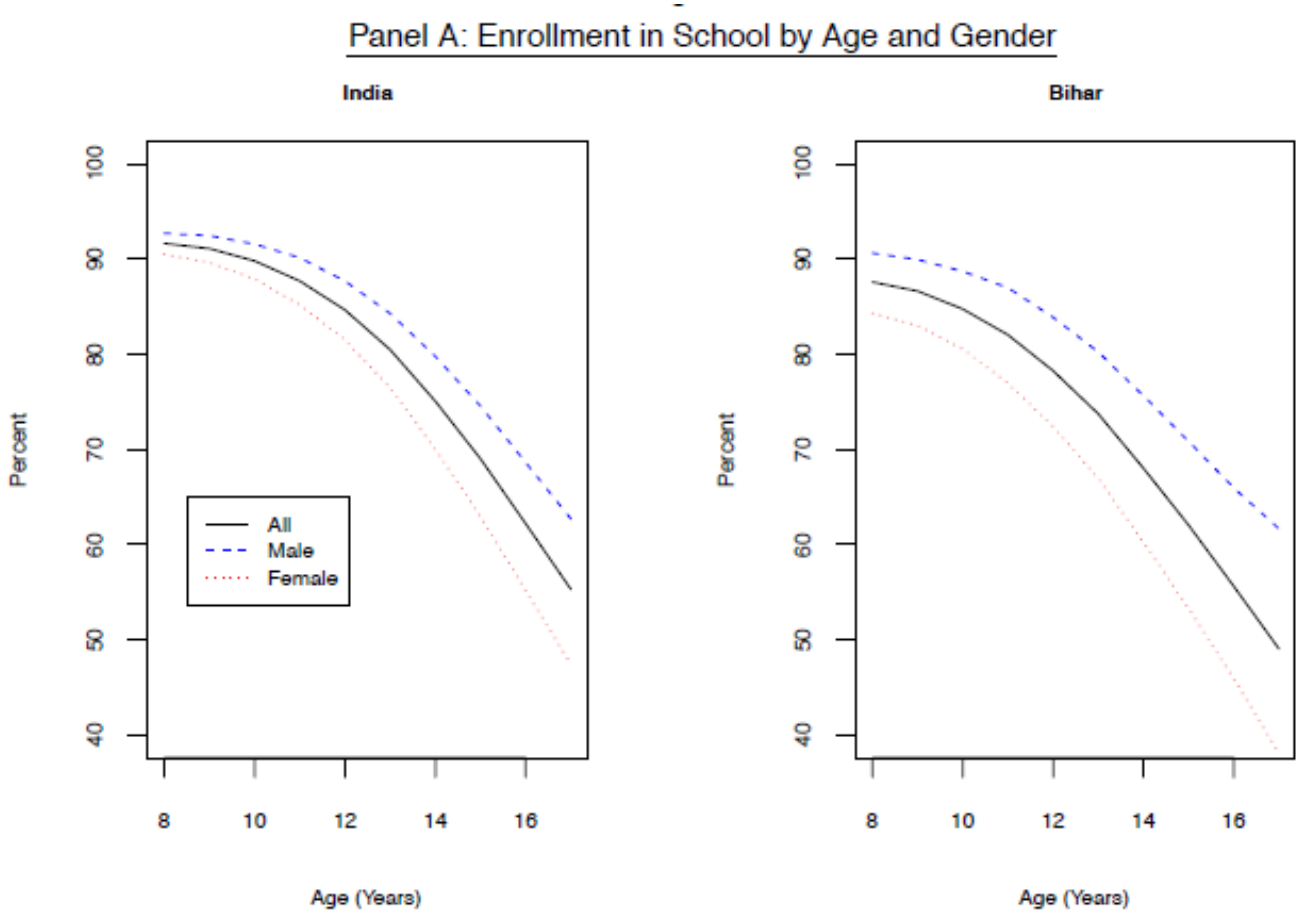
Status of Education in India

- Larger gender gaps in India (and especially in Bihar) in school attendance (grows with age)
- Primary schools now exist within 1 km of most villages
- But distance is still an important barrier to secondary school attendance (again, more so for girls)
- Bihar was among the lowest mean levels of education (IHDS 2005)

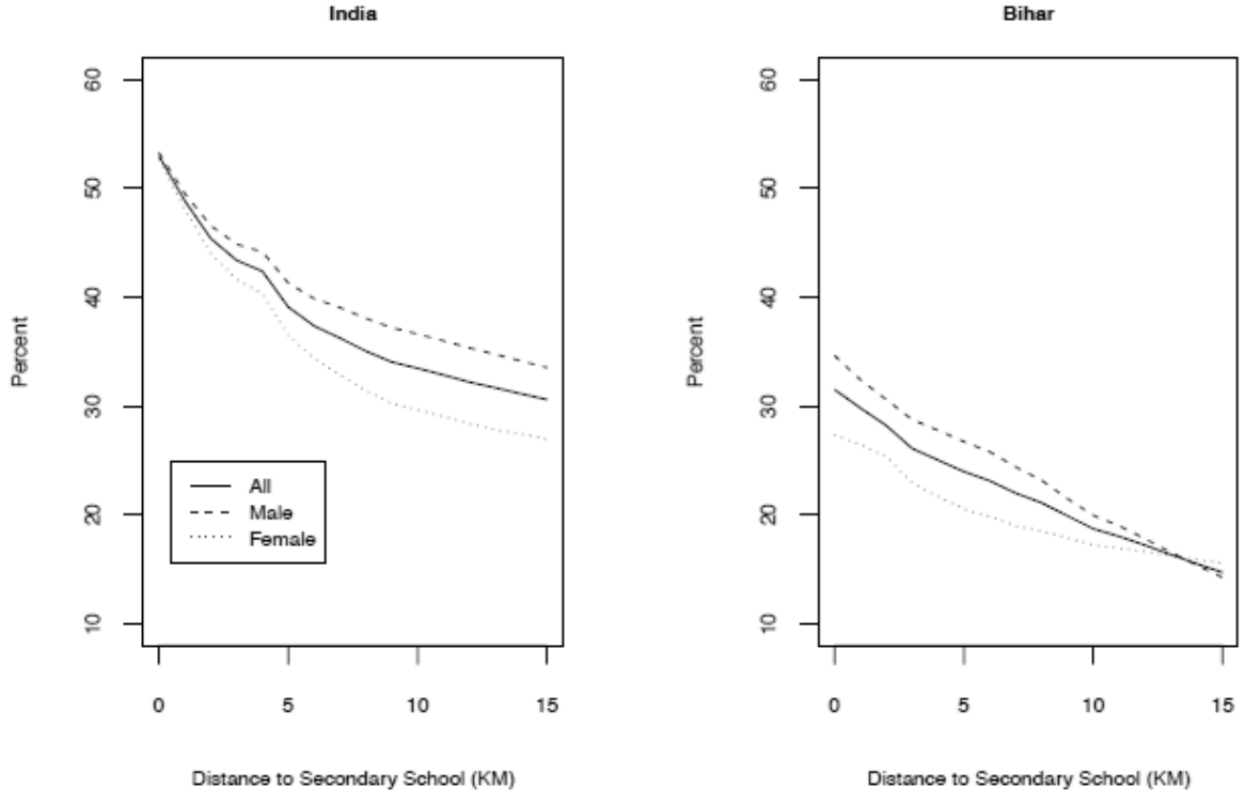
School Enrollment by Age & Gender



Source: Author's calculations using the 2008 District Level Health Survey (DLHS).

Enrollment of 14-15 year olds in Secondary School by Distance & Gender

Panel B: Enrollment in Secondary School of 14 and 15 Year Olds by Distance and Gender



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Summary

- Gender gap in educational attainment is more pronounced in Bihar relative to the all India figures
- The drop off in girls' enrollment is particularly pronounced at age 14, which is the time of transition to secondary schooling
- The probability of 14 and 15 year olds being enrolled in school steadily declines as the distance to the nearest secondary school increases both in the all India data as well as in Bihar

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School Access vs. Scale in India

- The default approach to school access is in terms of school construction
- Ongoing national campaign to expand access to secondary schooling via school construction and expansion (RSMA)
  - Expensive
  - Takes time to build new schools
- There exists trade-off between access and scale
  - Secondary School
    - Access vs. Scale: Trade-off between access and scale in India
    - Access vs. Scale: Trade-off between access and scale in Kenya
- Not obvious if improving school access should always take the form of school construction
  - Need to think of cost-effective scalable policy to improve access to secondary education

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Policy Intervention

- In 2006, the Govt. of Bihar initiated a program to provide cycles to all girls studying in grade 9
  - Personal initiative of the Chief Minister
  - Program was called the *"Cycle Program"*
  - An allocation of Rs. 2000/student was made (now Rs. 2500)
  - High-profile program, politically very visible (and also copied)
- No direct provision of cycles–cash provided to eligible students through the schools, and receipts for purchase of cycles were collected (not a typical CCT that goes to HH budget)

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- Unique hybrid of demand and supply-sided intervention
  - Enrollment conditionality resembles a traditional CCT
  - But cycles improve school access by reducing the distance cost of attendance (also allows economies of scale in school quality)
- This was effectively a CKT program and was one of India's first scaled up CT program for girls' secondary education

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Policy in Action

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Research Questions

- What is the impact of exposure to cycle program on secondary school enrollment for girls?
- Disentangle the *mechanisms* through which policy affects outcomes (conditionality vs. cycle)?
- What are the impacts on learning outcomes?

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Preview of Main Results

- Cycle program increased the *age-appropriate* secondary school enrollment of girls by 5.2 percentage points
- Most of the treatment effect appears to be coming from villages where the nearest secondary school is more than 3 km away
  - The triple difference non-parametric plot as a function of distance to the nearest secondary school has an inverted-U shape
- The program had a modest positive impact on percentage of girls' appearing for grade 10 exam
- The program had no impact on percentage of girls' passing grade 10 exam

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Contributions and Policy Implication

- Rigorously evaluates the effectiveness of one of India's first scaled up CCT/CKT program for girls' secondary education
- Answers the question of whether 'distance cost' reduces gender gap in enrollment and attainment
- Relevant not just for India but other developing countries
- This paper also makes a methodological contribution to the program evaluation literature by demonstrating the feasibility of credible impact evaluations even in contexts of universal program roll out

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Brief Related Literature

- School Access:
  - Impact of school construction programs have found positive effects on enrollment (Duflo 2001, Burde and Linden 2012, Kazianga et al. 2012)
  - Access to roads increases enrollment (Mukherjee 2011)
  - Trade-off between access and scale (Muralidharan et al. 2013, Jacob, Kochar, and Reddy 2008, De Haan, Leuven, and Osterbeek 2011)
- Conditional Transfers:
  - CCT programs have found a positive impact on girls' education enrollment and attainment (Fiszbein and Schady 2009)
- Methodological:
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Outline of Today's Talk

- Data & Outcome Measures
- Identification and Empirical Framework
- Main Findings
- Robustness Checks
- Discussion

Data Sources

- District-Level Health Survey (DLHS) Data 2008
  - Survey conducted $\approx$1.5 years after Cycle program launched
  - Representative sample of approximately 1,000 HH/district (total sample of close to 50,000 HH across Bihar/Jharkhand)
  - Family roster with education histories
  - Village data includes distance to nearest secondary school
- We also collect official data on student learning outcomes using appearance/passing on 10th grade board exam
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Outcome Measures

- Enrollment outcome
  - Dummy variable if a student is enrolled in or completed grade 9
- Learning outcomes: grade 10 performance
  - Log of number of students appearing for grade 10 exam (aggregate at school level)
  - Log of number of students who passed grade 10 exam (aggregate at school level)

Empirical Challenges

- Identification:
  - Main challenge for the empirical analysis is that the program was implemented state-wide and so it is difficult to find a control group
  - The program was launched across the full state of Bihar at a time of high growth, improving law and order, and plausibly increasing rates of return to education
    - Address this by employing triple difference
- Risk of over-reporting of girls' enrollment in administrative data in response to the Cycle program:
  - Use large household data to mitigate this risk

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Difference in Difference

- We treat 14-15 year olds as 'treated' cohorts (exposed to the program) and 16-17 year olds as 'control' cohorts (not exposed to the program) – [as in Duflo 2001]
- 14-15 vs.16-17 year old girls (first difference)
- Compare with corresponding difference for boys (second difference)
  - Boys are exposed to similar changes in Bihar but are *NOT* eligible for the cycle program (for e.g. increasing household incomes and increased public investment in education)

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Estimating Equation

$$
\begin{aligned}
y_{ihv} &= \beta_0 + \beta_1 \textit{Female dummy}_{ihv} * \textit{Treat}_{ihv} + \\
&\quad \beta_2 \textit{Female dummy}_{ihv} + \beta_3 \textit{Treat}_{ihv} + \gamma X + e_{ihv} \quad (1)
\end{aligned}
$$

where
y_{ihv} is the outcome variable of interest corresponding to child i, in household h and village v
X = control variables (social groups, religion, household level characteristics, and village level characteristics)

Descriptive Statistics

	Full Sample	Bihar	Jharkhand
PANEL A: *Dependent variable*			
Enrolled in or completed grade 9 (Among 14-17 year olds)	0.378	0.309	0.337
	(0.485)	(0.462)	(0.473)
PANEL B: *Key independent variables*			
Treatment group = Child age 14 & 15 (Among 14-17 year olds)	0.545	0.543	0.586
	(0.498)	(0.498)	(0.493)
Female dummy	0.476	0.485	0.473
	(0.499)	(0.500)	(0.499)
PANEL C: *Demographic controls*			
Social group: Scheduled caste	0.191	0.190	0.136
	(0.393)	(0.393)	(0.343)
Social group: Scheduled tribes	0.075	0.022	0.361
	(0.263)	(0.145)	(0.480)
Social group: Other backward caste	0.547	0.588	0.423
	(0.498)	(0.492)	(0.494)
Social group: Hindu	0.814	0.846	0.646
	(0.389)	(0.361)	(0.478)
Social group: Muslim	0.142	0.151	0.118
	(0.349)	(0.358)	(0.323)

Difference in Difference Estimate for the Exposure of Cycle Program on Girl's Enrollment

	Dependent variable=Enrolled in or completed grade 9			
	(1)	(2)	(3)	(4)
Treat × Female dummy	**0.123*** **	**0.114*** **	**0.0908*** **	**0.0904*** **
	(0.0149)	**(0.0144)**	**(0.0135)**	**(0.0134)**
Treat	-0.192***	-0.184***	-0.167***	-0.166***
	(0.0108)	(0.0106)	(0.00992)	(0.00992)
Female dummy	-0.186***	-0.178***	-0.168***	-0.167***
	(0.0117)	(0.0112)	(0.0103)	(0.0103)
Constant	0.475***	0.823***	0.487***	0.502***
	(0.00980)	(0.0831)	(0.0622)	(0.0673)
Demographic controls	NO	YES	YES	YES
HH level and literacy controls	NO	NO	YES	YES
Village level controls	NO	NO	NO	YES
Observations	18,453	18,453	18,353	18,331
R-squared	0.038	0.106	0.225	0.227

Parallel Trend Assumption for Difference in Difference

- Treating the double-difference estimate as causal requires that there were parallel trends in boys and girls enrollment prior to the program

Do Parallel Trends Hold?

- We reject the parallel trend assumption
- Half of the increase in enrollment would have happened anyway!

Dependent variable=Log(Enrollment)	Grade 9 School Level (1)
Female Dummy × Year	**0.0518***** **(0.00476)**
Female Dummy	-0.870*** (0.0631)
Pre Year	0.0852*** (0.00539)
Constant	4.235*** (0.0492)
Observations	20,266
R-squared	0.167

Parallel Trend Assumption for Triple Difference

- We compare the double difference estimate in the state of Bihar (the treated state), with the same estimate for the state of Jharkhand (the control state), which is a neighboring state which *was a part of the state of Bihar till recently*, and only separated administratively in 2001

Do Parallel Trends Hold?

- Fail to reject the parallel trend assumption

Dependent variable=Log(Enrollment)	Grade 9 School Level (1)
Female Dummy × Year × Bihar dummy	**-0.0100**
	(0.0120)
Female Dummy × Year	0.0618***
	(0.0111)
Female Dummy × Bihar dummy	0.175
	(0.110)
Bihar dummy × Year	0.0290**
	(0.0129)
Female dummy	-1.045***
	(0.0900)
Time trend	0.0562***
	(0.0117)
Bihar dummy	-0.123
	(0.118)
Constant	4.358***
	(0.108)
Observations	22,279
R-squared	0.171

Triple Difference

- Compare double difference across Bihar & Jharkhand (triple difference)
- The triple difference is our preferred estimate of program impact
- Estimating equation:

$$
\begin{aligned}
y_{ihv} \quad = \quad & \beta_0 + \beta_1 Treat_{ihv} * Female\ dummy_{ihv} * Bihar + \\
& \beta_2 Treat_{ihv} * Female\ dummy_{ihv} + \beta_3 Treat_{ihv} * Bihar + \\
& \beta_4 Female\ dummy_{ihv} * Bihar + \\
& \beta_5 Treat_{ihv} + \beta_6 Female\ dummy_{ihv} + \\
& \beta_7 Bihar + \gamma X + e_{ihv} \qquad (2)
\end{aligned}
$$

Triple Difference Estimate for the Exposure of Cycle Program on Girl's Enrollment

	Dependent variable=Enrolled in or completed grade 9			
	(1)	(2)	(3)	(4)
Treat × Female dummy × Bihar dummy	**0.103*** **	**0.0912*** **	**0.0525** **	**0.0523** **
	(0.0302)	**(0.0294)**	**(0.0252)**	**(0.0253)**
Treat × Female dummy	0.0195	0.0235	0.0380*	0.0381*
	(0.0263)	(0.0256)	(0.0214)	(0.0215)
Treat × Bihar dummy	-0.0437**	-0.0418**	-0.0290*	-0.0281*
	(0.0179)	(0.0177)	(0.0160)	(0.0161)
Female dummy × Bihar dummy	-0.0942***	-0.0905***	-0.0686***	-0.0673***
	(0.0233)	(0.0226)	(0.0200)	(0.0201)
Treat	-0.148***	-0.143***	-0.138***	-0.138***
	(0.0143)	(0.0142)	(0.0127)	(0.0127)
Female dummy	-0.0915***	-0.0880***	-0.0986***	-0.0994***
	(0.0202)	(0.0196)	(0.0172)	(0.0172)
Bihar dummy	0.0115	-0.0437***	-0.0247*	-0.0378**
	(0.0163)	(0.0165)	(0.0146)	(0.0148)
Demographic controls	NO	YES	YES	YES
HH level and literacy controls	NO	NO	YES	YES
Village level controls	NO	NO	NO	YES
Constant	0.464***	0.771***	0.503***	0.463***
	(0.0130)	(0.0240)	(0.0240)	(0.0393)
Observations	30,295	30,295	30,147	30,112
R-squared	0.035	0.088	0.208	0.210

Summary of Results

- Exposure to the Cycle program increased the age-appropriate secondary school enrollment of girls by 5.2 percentage points (or 40% increase on a base of 13%)
- Exposure to the Cycle program also reduced the gender gap in age-appropriate secondary school enrollment by 40%
- The age-appropriate secondary school enrollment rate for boys was 26 percent

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Mechanisms

- Even if we find an effect, there may be multiple mechanisms
  - Conditionality, cycle, third factors (other programs, returns)
- If the channel of impact is that the cycle reduces the 'distance cost' of attending school, then we should see a larger impact in villages where the nearest secondary school is further away (data lets us test this)
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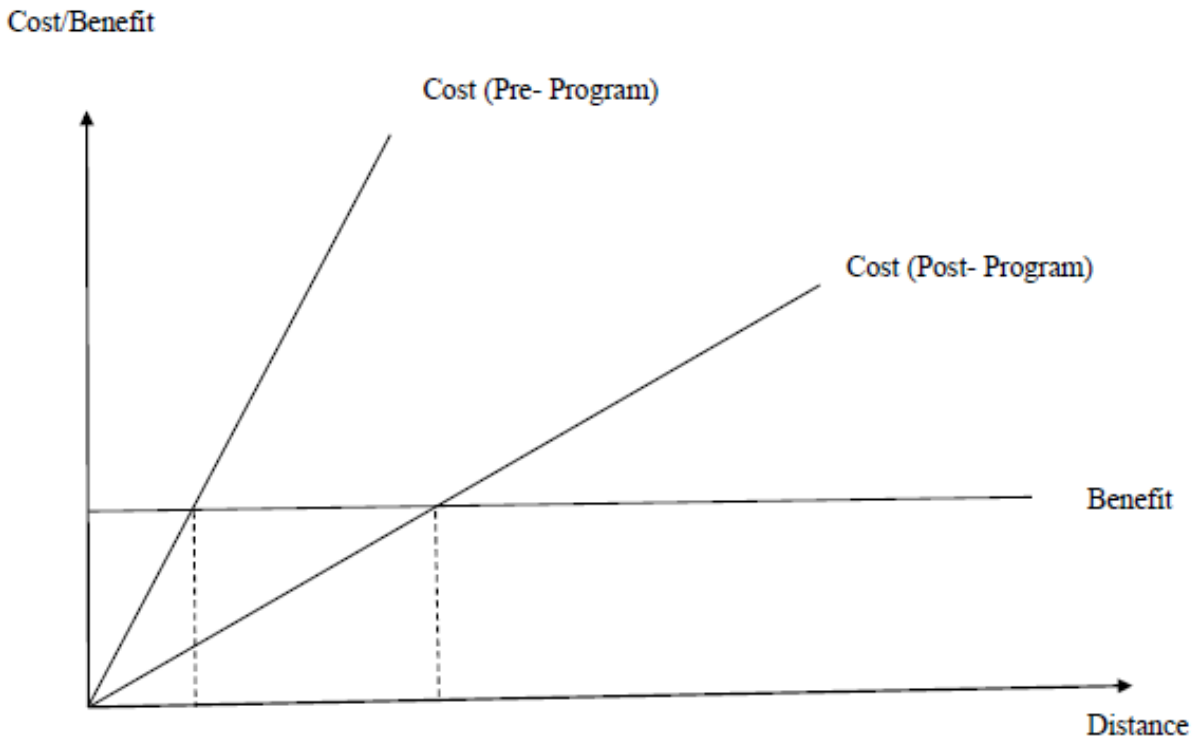
Sketch of Mechanism of Impact



Prediction

- Returns to secondary school does not vary by distance but cost does
- This suggests maximum impact at the ‘intermediate’ range of distance to school
  - Predicts an inverted U-shaped from a model where the cycle reduces costs of schooling proportional to the distance to school (but where the absolute cost of attendance is still too high to attend at very large distances)
  - Consistent with the evidence

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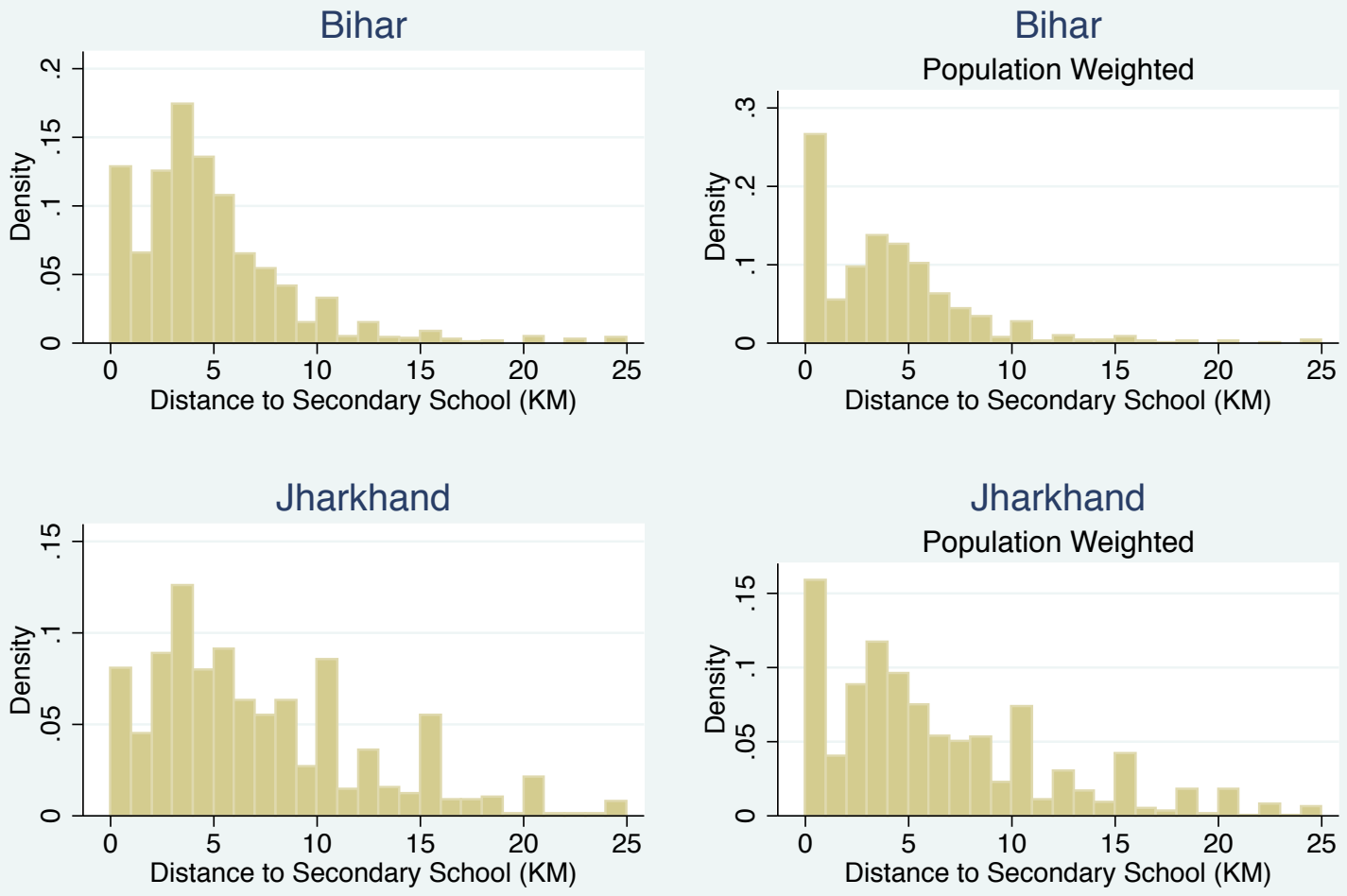
Distribution of Villages by Distance to Nearest Secondary School

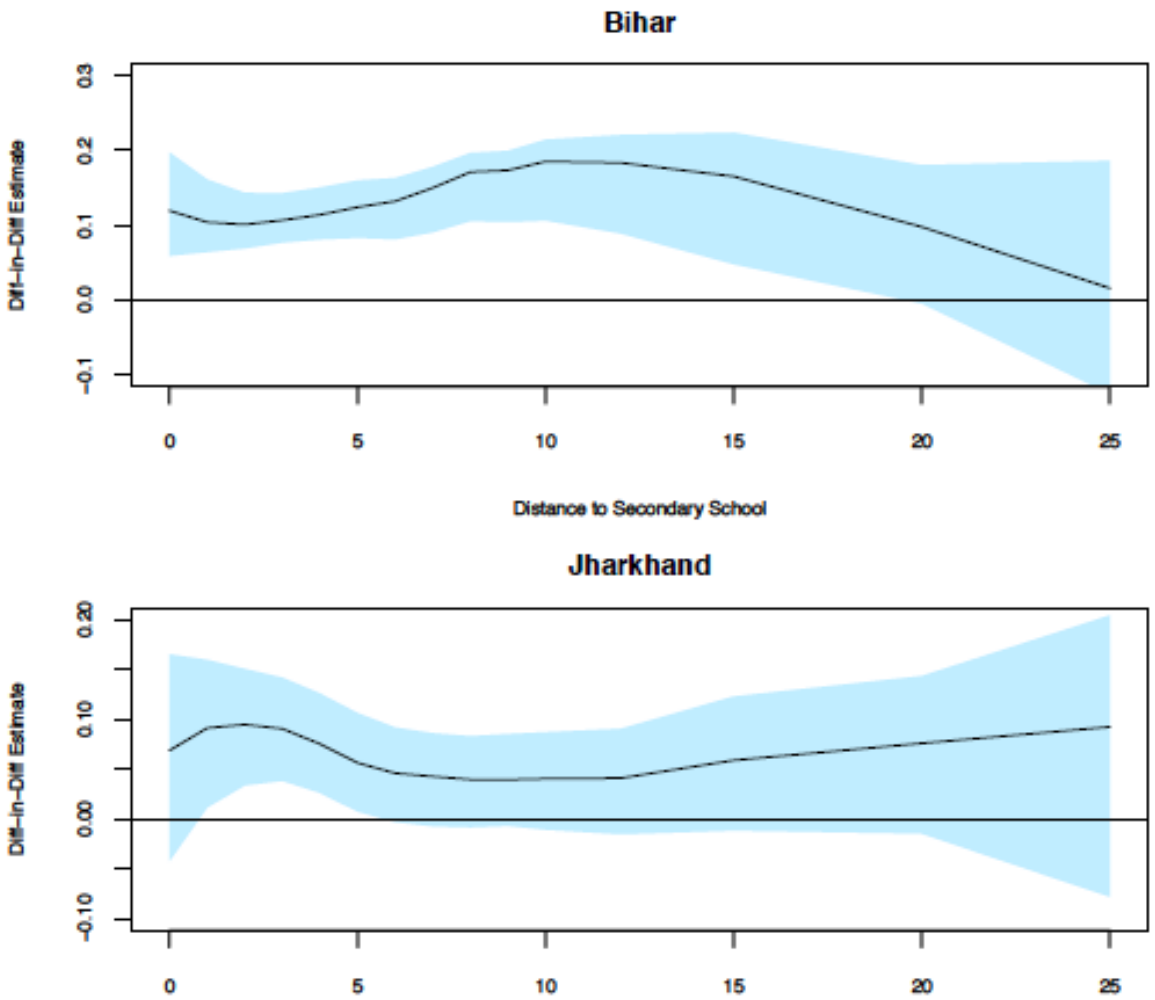
Figure 2: Distribution of Villages by Distance to Nearest Secondary School



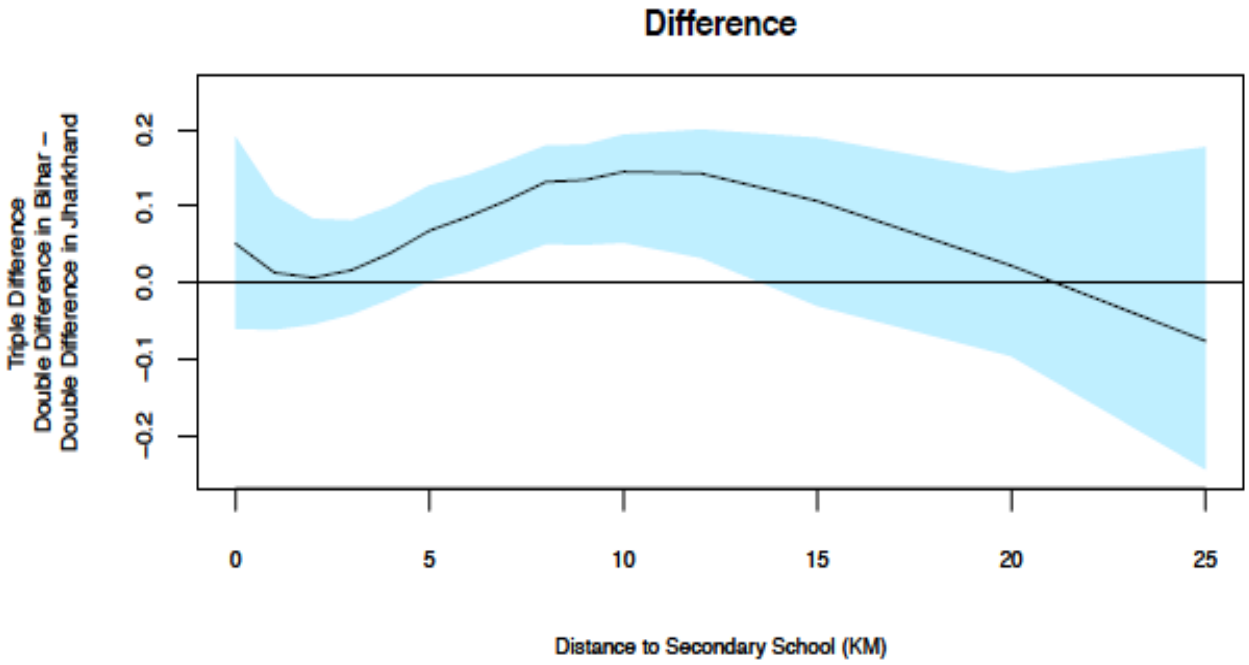
Quadruple Difference: The Impact of Distance to Secondary School on Girl's Enrollment

	Dependent variable=Enrolled in or completed grade 9			
	(1)	(2)	(3)	(4)
Treat × Female dummy × Bihar dummy × Long distance	**0.0940**	**0.0875**	**0.0898***	**0.0882***
	(0.0578)	**(0.0560)**	**(0.0503)**	**(0.0502)**
Treat × Female dummy × Long distance	-0.0788	-0.0803*	-0.0745*	-0.0733*
	(0.0496)	(0.0480)	(0.0427)	(0.0426)
Treat × Female dummy × Bihar dummy	0.0426	0.0338	-0.00504	-0.00420
	(0.0410)	(0.0394)	(0.0376)	(0.0376)
Female dummy × Bihar dummy × Long distance	-0.0826*	-0.0746*	-0.0698*	-0.0695*
	(0.0450)	(0.0433)	(0.0393)	(0.0391)
Treat × Bihar dummy × Long distance	-0.0285	-0.0254	-0.00856	-0.00790
	(0.0363)	(0.0356)	(0.0328)	(0.0328)
Demographic controls	NO	YES	YES	YES
HH level and literacy controls	NO	NO	YES	YES
Village level controls	NO	NO	NO	YES
Constant	0.513***	0.816***	0.530***	0.487***
	(0.0228)	(0.0279)	(0.0271)	(0.0410)
Observations	30295	30295	30147	30112
R-squared	0.039	0.091	0.209	0.210

Non-Parametric DD by Distance



Non-Parametric DDD by Distance



What did we Learn?

- Important to have state level controls as parallel trend is rejected
- Considerable catching up at all distances in Bihar
- Positive DD estimates in Jharkhand at all distances $\Rightarrow$ girls' age-appropriate secondary school enrollment catching up
  - If there is generic catching up $\Rightarrow$ more likely to happen more when secondary schools close by
  - DD estimate insignificant at most distance above 5 km
- Not much going on the conditionality side
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- Almost all the program impacts are found in villages that are over 3 km away from a secondary school (with the point estimate of treatment effects in villages that are closer being close to zero)
  - The main mechanism of program impact is not the conditionality, but rather the reduction of the distance cost of attending school
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- Further concern:
  - Improvements in *roads* & *law and order* in Bihar would also have a greater impact on girls' school participation than boys
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- Address this concern by conducting a placebo test:
  - Estimate triple-difference impact of exposure to the cycle program on the probability of girls' age appropriate enrollment in (or completion of) the eighth grade
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Triple Difference Estimate for the Exposure of Cycle Program on Girl's Enrollment in 8th Grade

	Dependent variable=Enrolled in or completed grade 8			
	(1)	(2)	(3)	(4)
Treat × Female dummy × Bihar dummy	**0.0111**	**-0.00226**	**0.00235**	**0.00189**
	(0.0237)	**(0.0229)**	**(0.0214)**	**(0.0215)**
Treat × Female dummy	0.0259	0.0384**	0.0462***	0.0457***
	(0.0184)	(0.0178)	(0.0169)	(0.0170)
Treat × Bihar dummy	-0.00940	-0.00699	-0.00968	-0.00957
	(0.0184)	(0.0180)	(0.0164)	(0.0164)
Female dummy × Bihar dummy	-0.0380**	-0.0350**	-0.0365**	-0.0352**
	(0.0184)	(0.0176)	(0.0168)	(0.0168)
Treat	-0.151***	-0.155***	-0.154***	-0.154***
	(0.0152)	(0.0149)	(0.0133)	(0.0134)
Female dummy	-0.0956***	-0.0950***	-0.101***	-0.101***
	(0.0148)	(0.0141)	(0.0137)	(0.0137)
Bihar dummy	-0.0438***	-0.105***	-0.0779***	-0.0891***
	(0.0163)	(0.0165)	(0.0146)	(0.0148)
Demographic controls	NO	YES	YES	YES
HH level and literacy controls	NO	NO	YES	YES
Village level controls	NO	NO	NO	YES
Constant	0.522***	0.818***	0.549***	0.532***
	(0.0130)	(0.0240)	(0.0240)	(0.0393)
Observations	33,179	33,179	33,012	32,972
R-squared	0.038	0.089	0.202	0.203

Robustness-II

- Border Districts:
  - Restrict the sample for our main triple-difference estimates to just the border districts in Bihar and Jharkhand
    - Point estimates are practically indistinguishable from those in the full sample
- Triple difference analysis requires very large samples to have adequate power
  - Duflo (2001) used Indonesia intercensal survey dataset
  - Replicating this using Indonesian Family Life Survey (IFLS-3) yields positive point estimates on the impact of school construction on education attainment, but these are insignificant because of the considerably smaller sample size

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Triple Difference Estimate for the Exposure of Cycle Program on Girl's Enrollment (Border Districts Only)

	Dependent variable=Enrolled in or completed grade 9			
	(1)	(2)	(3)	(4)
Treat × Female dummy × Bihar dummy	**0.0985****	**0.0946****	**0.0592***	**0.0563**
	(0.0407)	**(0.0385)**	**(0.0357)**	**(0.0356)**
Treat × Female dummy	0.0400	0.0412*	0.0485**	0.0484**
	(0.0267)	(0.0242)	(0.0230)	(0.0232)
Treat × Bihar dummy	-0.0683**	-0.0740**	-0.0726***	-0.0698***
	(0.0295)	(0.0288)	(0.0268)	(0.0267)
Female dummy × Bihar dummy	-0.0876***	-0.0945***	-0.0618**	-0.0591**
	(0.0338)	(0.0320)	(0.0295)	(0.0295)
Treat	-0.154***	-0.146***	-0.138***	-0.139***
	(0.0177)	(0.0167)	(0.0158)	(0.0158)
Female dummy	-0.115***	-0.108***	-0.117***	-0.118***
	(0.0233)	(0.0218)	(0.0213)	(0.0214)
Bihar dummy	0.0195	-0.0152	-0.000376	-0.0116
	(0.0288)	(0.0277)	(0.0237)	(0.0234)
Demographic controls	NO	YES	YES	YES
HH level and literacy controls	NO	NO	YES	YES
Village level controls	NO	NO	NO	YES
Constant	0.449***	0.612***	0.387***	0.292***
	(0.0185)	(0.0411)	(0.0408)	(0.0588)
Observations	9939	9939	9899	9886
R-squared	0.040	0.093	0.219	0.222

Robustness-III

- Cluster the standard errors at the district level:
  - The coefficients on the triple interaction terms continue to be significant in all four specifications
- Spillovers:
  - If boys reduce schooling (undertake more chores) because their sisters go to school $\Rightarrow$ estimates bias upwards
  - Alternatively, if girls reduce schooling because their brothers go to school $\Rightarrow$ estimates bias downwards
  - Table 9 shows that the triple interaction terms are not significant for girls
  - Table 10 shows that the triple interaction terms are significant for boys

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    - We plot single difference for boys and girls for Bihar by distance
    - No noticeable pattern for boys
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What are the Impacts on Learning Outcomes?

- We found positive impact of the exposure to the Cycle program on girls enrollment in secondary school
- The next logical step is to look at the impact of the cycle program on learning outcomes
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Estimates of Exposure of the Cycle Program on Performance in Grade 10 Exam (School Level)

Dependent Variable	Log(Appeared)	Log(Passed)
	(1)	(2)
PANEL B: *DDD Estimates*		
Female Dummy × Bihar × Post	**0.0946****	**0.00103**
	(0.0399)	**(0.0449)**
Observations	45564	45215
R-squared	0.162	0.144

Summary of Results

- We find that exposure to the cycle program increased the number of girls appearing for the SSC exam by 9.5% (significant at the 5% level)
- No increase in the number of girls who passed the SSC exam
- Results consistent with other evaluations of conditional transfer programs in developing countries (especially Latin America) that find significant impacts on enrollment but typically find no impacts on learning outcomes

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  - The program provided an incentive for enrollment but not for achievement
  - The girls induced to stay in school are likely to have been drawn from the lower end of the eighth grade test score distribution $\Rightarrow$ less likely to pass the strict standards of the externally-graded SSC exam
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Cost Effectiveness

- Compare our estimates to CCT program in Pakistan (Chaudhury and Parajuli 2010)
  - Girls's stipend program ($3/month per recipient) increased female enrollment in grade 6–8 (between 2003–2005) by 9 percent (4 percentage points on a base of 43%)
  - Cycle program ($2/month per recipient) increased female enrollment by 40 percent (5 percentage points on a base of 13%)
  - Female dropout much bigger challenge at secondary level vs. middle level

- Cycle program had both a higher absolute impact and higher impact relative to base enrollment rates compared to the Stipend program
- Cycle program more cost-effective than comparable CCT
  - Likely to be more cost-effective for girls who live further away from a secondary school

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- Compare our estimates to CCT program in Pakistan (Chaudhury and Parajuli 2010)
  - Girls's stipend program ($3/month per recipient) increased female enrollment in grade 6–8 (between 2003–2005) by 9 percent (4 percentage points on a base of 43%)
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Cash vs. Kind Transfers as a Tool for Social Policy

- Under what circumstances may in-kind transfer do better than equivalent cash transfer?
  - Cycle for an adolescent girl was unlikely to be infra-marginal to pre-program household spending ⇒ difficult to substitute away (Das et al. 2013)
  - Bicycle directly reduced the marginal cost of schooling on a daily basis relative to general cash transfer (augments household budget)
  - Why might a household not use cash transfer to buy a bicycle on their own if this was a binding constraint?
    - Household still face credit constraint ⇒ difficult to transform small monthly transfers into an expensive capital good (need to pay upfront)
    - In-kind provision changes the default of what the money is spent on, and removes the transfer from sphere of intra-household bargaining
- Coordinated provision:
  - Positive spillovers, group externalities (greater safety when girls cycle together, change in social norms)

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Historical Perspective

- Role played by bicycles in enhancing the mobility, freedom, and independence of women in the 19th century
- Cycle program can also empower girls' beyond school attendance by increasing their mobility and independence
  - This suggests an additional reason for why an in-kind transfer like the bicycle may in this context be more effective at improving female education outcomes
- Households in strongly patriarchal settings like rural Bihar may be more inclined to direct the girl's share towards consumption (or saving for marriage) than to make investments for girls (such as a bicycle)
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Summary of Results

- Impact of exposure to the Cycle program suggest that it increased girls age-appropriate enrollment in secondary schools by 5 percentage points
  - On a base of 13%, this is a 40% increase in enrollment
- Exposure to the Cycle program had a greater impact for girls who lived further away from a secondary school
  - A key mechanism for program impact was the reduction in the 'distance cost' of school attendance for girls due to the cycle
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Policy Implications and Future Research

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