

ECON 7910: RESEARCH SEM IN ECON (MICRO)

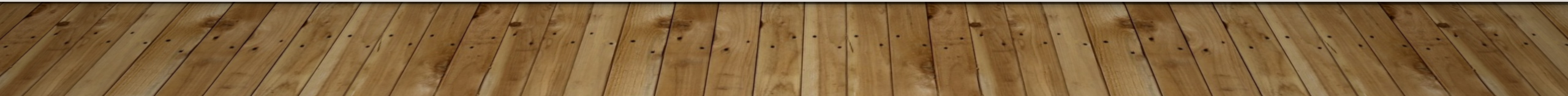
WORMS: IDENTIFYING IMPACTS ON EDUCATION AND HEALTH IN THE PRESENCE OF TREATMENT EXTERNALITIES

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OVERVIEW

- **Research questions**
- **Paper contributions**
- **Background: worms and intervention**
- **Data issues**
- **Econometric strategy**
- **Main empirical results**
- **Discussion and further results**
- **Conclusions**

RESEARCH QUESTIONS ADDRESSED

- **Main concern: impact evaluation of social programs**
 - **Effect of externalities on estimated effect ?**
- **Individual-level treatment randomization: underestimation of health program benefits**
 - **1) Externality benefits to the comparison group (reduced disease transmission)**
 - **2) Underestimation of benefits for the treatment group**
- **May lead to misleading policy recommendations**

CONTRIBUTIONS OF THIS PAPER

- **New methodological approach: school-level randomization for identifying treatment externalities (deworming treatment)**
 - allows identification of cross-school externalities
 - ... and within-school externalities can be measured by non-experimental econometric methods
- **Empirical study: simple differences between outcomes for treatment and comparison groups severely understate program's impacts**

BACKGROUND: INTESTINAL HELMINTH INFECTIONS

- **High prevalence of geohelminth and schistosomiasis infections in poor countries**
 - Differing modes of transmission
- **Infection effects according to worm burden**
 - Light: may be asymptomatic
 - Heavy: related to iron-deficiency anemia, malnutrition, abdominal pain, listlessness, liver enlargement
- **Treatment: low-cost single dose oral therapy**
 - But rapid reinfection: treatment at constant intervals
- **Treatment externalities on disease transmission**
 - School-aged children most likely to spread worm infections

BACKGROUND: PRIMARY SCHOOL DEWORMING PROJECT (PSDP)

- **Poor, densely-settled farming region in Western Kenya**
- **Highest helminth infection rates in Busia district**
- **75 project primary schools (>30,000 pupils aged 6- 18)**
- **Jan/98: schools equally and randomly divided into three groups**
 - **Group 1: treatment in 1998 & 1999**
 - **Group 2: treatment in 1999**
 - **Group 3: treatment in 2001**
- **Intervention: mass deworming treatment (WHO recommendations); public health lectures on worm prevention**

ESTIMATION STRATEGY (I): CROSS-SCHOOL EXTERNALITIES

$$(1) \quad Y_{ijt} = a + \beta_1 \cdot T_{1it} + \beta_2 \cdot T_{2it} + X'_{ijt} \delta + \sum_d (\gamma_d \cdot N_{dit}^T) + \sum_d (\phi_d \cdot N_{dit}) \\ + u_i + e_{ijt}.$$

Y_{ijt} = outcome of individual j , in school i , in year t (1,2)

T_{1it}, T_{2it} = indicator variables, school assignment to first or second year of treatment

X_{ijt} = school and pupil characteristics

N_{dit} = total no. pupils in primary schools at distance d from school i in year t

N_{dit}^T = no. above pupils in schools randomly assigned to treatment

$(u_i + e_{ijt})$ = individual disturbance term independent across schools, but correlated for observations within the same school

Thus:

$\beta_1 + \sum_d (\gamma_d \check{N}_{dit}^T)$ is the average effect of 1st year of deworming on overall infection prevalence in treatment schools

ESTIMATION STRATEGY (II): WITHIN-SCHOOL EXTERNALITIES

- Randomization allows...
 - overall treatment effect estimation, even in the presence of within-school externalities
 - estimation of cross-school externalities
- ...but it is **NOT** possible to experimentally decompose the effect for treatment schools
 - nonexperimental approach

ESTIMATION STRATEGY (II): WITHIN-SCHOOL EXTERNALITIES

$$(3) \quad Y_{ijt} = a + \beta_1 \cdot T_{1it} + b_1 \cdot D_{1ij} + b_2 \cdot (T_{1it} * D_{1ij}) + X'_{ijt} \delta \\ + \sum_d (\gamma_d \cdot N_{dit}^T) + \sum_d (\phi_d \cdot N_{dit}) + u_i + e_{ijt}.$$

β_1 = **within-school** externality effect on the untreated

D_{1ij} = indicator variable, equals 1 if individual j in school i received treatment when offered, zero otherwise

b_2 = direct effect of treatment on treated

Thus:

$(\beta_1 + b_2)$ is the overall effect of deworming on treatment schools

$\beta_1 + \sum_d (\gamma_d \check{N}_{dit}^T)$ is the total externality effect for the untreated in treatment schools

Data Description

- ❑ International Christelijk Steunfonds Africa (ICS).
- ❑ Mostly similar nutritional, demographic, and socioeconomic characteristics.
- ❑ Overall, in 1998, 78% of girls <13 years old and all boys in treatment schools, and 19% of girls over 13 years old

Table 1: 1998 Average Pupil and School Characteristics, Pre-Treatment

	Group 1 (25 schools)	Group 2 (25 schools)	Group 3 (25 schools)	Group 1- Group 3	Group2- Group3
Panel A: Pre-school to Grade 8					
Male	0.5329	0.5096	0.5221	.0108 (.0184)	-.012 (.0183)
Proportion girls<13 years, and all boys	0.8858	0.8919	0.8842	.0016 (.0066)	.0077 (.0066)
Grade progression (=grade-(age-6))	-1.9725	-1.822	-1.969	-.0027 (.0952)	.1475 (.0945)
Year of birth	1986.19	1986.54	1985.78	.4060 (.1648)	.7554 (.1648)

Data Description

- ❑ No statistically significant differences among groups 1, 2, and 3 concerning their enrolment, school sanitation facilities, distance to Lake Victoria..
- ❑ However, pupils in group 1 appeared to be worse off than pupils in group 2 and 3. Undermines program effectiveness
- ❑ Valid counterfactual
- ❑ When comparing school characteristic per group without weight and with weight, the difference in p-values are statistically not significant .

Table 1: 1998 Average Pupil and School Characteristics without weight, Pre-Treatment

	Group 1 (25 schools)	Group 2 (25 schools)	Group 3 (25 schools)	Group 1- Group 3	Group2- Group3	P-values, Group 1- Group 3	P-value, Group2- Group3
Panel A: Pre-school to Grade 8							
Male	0.5312	0.5108	0.5193	0.0118 (0.1817)	-0.012 (0.0183)	0.515	0.639
Proportion girls<13 years, and all boys	0.8872	0.8977	0.8826	0.0046 (0.0079)	0.0151 (0.0079)	0.558	0.66
Grade progression (=grade-(age-6))	-1.998	-1.884	-1.884	-0.0242 (0.0975)	0.096 (0.0975)	0.805	0.356
Year of birth	1986.23	1986.56	1985.75	0.478 (0.1739)	0.8041 (0.1739)	0.008	0.00

TABLE 2: 1998 AVERAGE PUPIL AND SCHOOL CHARACTERISTICS WITH WEIGHT, PRE-TREATMENT

- When we run the t-tests for both
- weighted and without weight cases,
- the P-values for Group1 average -Group3
- average and Group2 average -Group3
- average are also slightly different,
- however the differences are statistically
- indistinguishable under 95% confidence level.

Table 2: 1998 Average Pupil and School Characteristics with weight, Pre-Treatment

	Group 1 (25 schools)	Group 2 (25 schools)	Group 3 (25 schools)	Group 1- Group 3	Group2- Group3	P-values, Group 1- Group 3	P-value, Group2- Group3
Panel A: Pre-school to Grade 8							
Male	0.5329	0.5096	0.5221	0.0108 (0.0184)	-0.012 (0.0183)	0.559	0.498
Proportion girls<13 years, and all boys	0.8858	0.8919	0.8842	0.0016 (0.0066)	0.0077 (0.0066)	0.803	0.246
Grade progression (=grade-(age-6))	-1.9725	-1.822	-1.969	-0.0027 (0.0952)	0.1475 (0.0945)	0.977	0.123
Year of birth	1986.19	1986.54	1985.78	0.406 (0.1648)	0.7554 (0.1648)	0.016	0.00

Data Description

Group 1

- ❑ Group 1 had significantly reported higher symptom of schistosomiasis infection.
- ❑ Often sick, not as clean as pupils in group 2 and 3
- ❑ Lower scores

Table 3: January 1998 Helminth Infections, Pre-Treatment, Group 1 Schools

	Prevalence of infection	Prevalence of moderate-heavy infection	Average infection intensity, in eggs per gram (s.e.)
Hookworm	0.7729	0.1541	425.69 (1055.28)
Roundworm	0.4239	0.1573	2336.52 (5155.71)
Schistosomiasis, all schools	.02175	0.0712	90.54 (412.96)
Whipworm	0.5517	0.0982	161.31 (469.65)
At least one infection	0.9155	0.3658	-
Born since 1985	0.9306	0.3990	-
Born before 1985	0.9077	0.3382	-
Female	0.9051	0.3433	-
Male	0.9268	0.3824	-
At least two infections	0.6484	0.1034	-
At least three infections	0.3405	0.0116	-

Compliance

- ❑ In 1998:
- ❑ ~~Albendazole Round 1 - 74,29%~~
- ❑ Praziquante 69,76%
- ❑ Albendazole Round 2 - 59,27%

- ❑ In 1999:
- ❑ Albendazole Round 1, Group1 - 45,58%
- ❑ Albendazole Round 1, Group2 - 37,57%
- ❑ Albendazole Round 1, Group3 - 0,66%
- ❑ Praziquante, Group 1 - 48,53%
- ❑ Praziquante, Group 2 - 38,79%
- ❑ Albendazole Round 2, Group1 - 53,13%
- ❑ Albendazole Round 2, Group2 - 51,49%
- ❑ Albendazole Round 2, Group3 - 1,26%

Proportion of male pupils receiving treatment	Group 1	Group 2	Group 3
	<i>Treatment</i>	<i>Comparison</i>	<i>Comparison</i>
Any medical treatment in 1998	0,83	0	0
Round 1 Albendazole	0,74	0	0
Praziquantel	0,70	0	0
Round 2 Albendazole	0,59	0	0
	Treatment	<i>Treatment</i>	<i>Comparison</i>
Any medical treatment in 1999	0,60	0,57	0,01
Round 1 Albendazole	0,46	0,38	0
Praziquantel	0,49	0,39	0
Round 1 Albendazole	0,53	0,51	0,01

Main Results

- ❑ January 1998 Helminth Infections, Pre-Treatment, Group 1 Schools, Male Pupils
- ❑ Prevalence of Helminth Infections

Table 4: January 1998 Helminth Infections, Pre-Treatment, Group 1 Schools, Male Pupils

	Prevalence of infection	Prevalence of moderate-heavy infection	Average infection intensity, in eggs per gram (s.e.)
Hookworm	0.7952	0.1721	469.93 (1122.21)
Roundworm	0.4213	0.1513	2224.35 (4943.90)
Schistosomiasis, all schools	0.2462	0.0850	108.36 (444.27)
Whipworm	0.5588	0.0999	143.71 (364.44)
At least one infection	0.9268	0.3827	-
Born since 1985	0.9308	0.4148	-
Born before 1985	0.9276	0.3636	-
At least two infections	0.6676	0.1127	-
At least three infections	0.3481	0.0128	-

Compare Male pupils in Group 1 and Group 2 schools from January to March 1999

- ❑ The prevalence of moderate-to-heavy hookworm, roundworm, schistosomiasis, and whipworm infections were all lower in Group 1 schools than in Group 2 schools, for male pupils.
- ❑ These average differences btw eligible boys in Group 1 and 2 are likely to further understate true deworming treatment effects.
- ❑ Group 1 had higher hemoglobin concentrations than Group 2, the difference is not statistically different than zero.
- ❑ There are no significant differences across treatment and comparison school pupils in early 1999 in three worm prevention behaviors

	Male 1	Male 2	Male1-Male2	Std.Err
Hookworm moderate-heavy infection(hw)	0.16	0.86	-0.70	0.12
Roundworm moderate-heavy infection(al)	1.23	3.88	-2.65	0.81
Schistosomiasis moderate-heavy infection(sm)	0.15	0.26	-0.11	0.12
Whipworm moderate-heavy infection(tt)	0.25	0.34	-0.09	0.14
Sick Often,1999	1.96	1.96	0.00	0.04
Height-for-age Z-score	-1.32	-1.40	0.08	0.05
Weight-for-age-Z-score	-1.45	-1.50	0.06	0.06
Hemoglobin (Hb),1999	125.65	122.66	2.99	1.55
Proportion anemia (Hb < 100 g/L),1999	0.01	0.04	-0.03	0.01
Clean(observed by field worker),1999	1.58	1.51	0.07	0.04
Wears shoes(observed by field worker),1999	2.74	2.76	-0.01	0.05
Days contact with fresh water in past week	0.38	0.40	-0.03	0.03

Compare pupils in Group 1 and Group 2 schools from January to March 1999

- ❑ Similar results in helminth infections as well as hemoglobin concentrations and proportion anemia between whole sample and eligible male pupils
- ❑ Similar results in health education
- ❑ Whole group: Group 1 reported better health outcomes (fewer being sick, better height-for-age)
- ❑ Subgroup: same case between Group1 and Group2 in reported being sick, better height-for-age and weight-for-age

	Group 1	Group 2	Group1-Group2	Std.Err.
Any moderate-heavy infection	0.27	0.52	-0.26	0.06
Hookworm moderate-heavy infection(hw)	0.06	0.22	-0.16	0.02
Roundworm moderate-heavy infection(al)	0.09	0.24	-0.15	0.04
Schistosomiasis moderate-heavy infection(sm)	0.08	0.18	-0.1	0.06
Whipworm moderate-heavy infection(tt)	0.12	0.17	-0.05	0.05
Sick Often,1999	1.96	1.99	-0.02	0.03
Height-for-age Z-score	-1.13	-1.11	-0.02	0.05
Weight-for-age-Z-score	-1.25	-1.22	-0.02	0.05
Hemoglobin (Hb),1999	124.81	123.04	1.77	1.24
Proportion anemia (Hb < 100 g/L),1999	0.02	0.04	-0.02	0.01
Clean(observed by field worker),1999	1.47	1.42	0.05	0.03
Wears shoes(observed by field worker),1999	2.66	2.59	0.07	0.02
Days contact with fresh water in past week	0.39	0.42	0.07	0.02

	Male 1	Male 2	Male1-Male2	Std.Err
Any moderate-heavy infection	0.25	0.54	-0.29	0.06
Hookworm moderate-heavy infection(hw)	0.05	0.26	-0.21	0.03
Roundworm moderate-heavy infection(al)	0.08	0.22	-0.14	0.04
Schistosomiasis moderate-heavy infection(sm)	0.09	0.18	-0.09	0.06
Whipworm moderate-heavy infection(tt)	0.12	0.17	-0.05	0.06
Sick Often,1999	1.96	1.96	0.00	0.04
Height-for-age Z-score	-1.32	-1.40	0.08	0.05
Weight-for-age-Z-score	-1.45	-1.50	0.06	0.06
Hemoglobin (Hb),1999	125.65	122.66	2.99	1.55
Proportion anemia (Hb < 100 g/L),1999	0.01	0.04	-0.03	0.01
Clean(observed by field worker),1999	1.58	1.51	0.07	0.04
Wears shoes(observed by field worker),1999	2.74	2.76	-0.01	0.05
Days contact with fresh water in past week	0.38	0.40	-0.03	0.03

Deworming Treatment Effects on Health and Nutrition

- ❑ In 1999, the proportion of pupils with moderate to heavy infection is 25.3% lower in Group 1 than Group 2 schools in early 1999, for eligible male pupils, is 27.9% lower
- ❑ Similar results between whole sample and subsample
- ❑ This deworming program has greater effect on geohelminth infection than schistosomiasis infection.

	Group 1	Std.Err
Any moderate-heavy helminth infection	-0.2735	0.06
Moderate-heavy schistosomiasis infection	-0.0965	0.06
Moderate-heavy geohelminth infection	-0.2610	0.05

	Male 1	Std.Err
Any moderate-heavy helminth infection	-0.2794	0.06
Moderate-heavy schistosomiasis infection	-0.0978	0.07
Moderate-heavy geohelminth infection	-0.2673	0.05

School participation impact

- ❑ The difference in school participation in the first year after treatment is almost 9 percentage points , and this is significantly different from zero at 99 percent confidence level

	<i>Group 1</i>	<i>Group 2</i>	<i>Group 3</i>		
<i>First year post-treatment (May 1998 to March1999)</i>	<i>1st Year Treatment</i>	<i>Comparison</i>	<i>Comparison</i>	<i>Group1 - (Groups2&3)</i>	<i>Group2 - Group3</i>
<i>Males</i>	0,844	0,736	0,78	0,088*** (0.031)	-0.044 (0.037)
<i>Second year post-treatment (March to November1999)</i>	<i>2st Year Treatment</i>	<i>1st Year Treatment</i>	<i>Comparison</i>	<i>Group1 - Group3</i>	<i>Group2 - Group3</i>
<i>Males</i>	0.698	0,695	0.655	0.043 (0.028)	0.04 (0.029)

School participation on individual level

- ❑ ~~We can conclude that deworming effect for the first year of treatment is higher than second year of treatment, as well as statistically significant~~

<i>Dependant variable: Average individual School participation</i>	
<i>Whole sample</i>	
Treatment school	0.048*** (0.0166)
First year as treatment School	0.057*** (0.0166)
Second year as treatment School	0.024 (0.026)
<i>Males</i>	
Treatment school	0.046** (0.018)
First year as treatment School	0.053*** (0.018)
Second year as treatment School	0.025 (0.026)

CONCLUSIONS

- **Methodological**
 - Individual-level randomization doubly underestimates the effects of deworming programs
 - Instead, **group-level** randomization allows identification of cross-group externalities
- **In the presence of substantial spillovers, public subsidies may be optimal**
 - Provision at higher (district, provincial) levels
- **Systematic underestimation of the impact of health on income conditional on educational attainment**
 - some of the overall health effect works through the education channel

**THANKS FOR YOUR
ATTENTION!**

