Randomized Evaluations: Applications & Externalities

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September 29, 2009

Global Poverty and Impact Evaluation

Practical Applications

- **Noncompliance**
- Externalities

Kling, Liebman and Katz (2007)

- Do neighborhoods affect their residents? (That is, is living in a good neighborhood good for you?)

Do neighborhoods affect their residents?

- Positively

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  - Social connections, role models, security, community resources

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  - Discrimination, competition with advantaged peers
- Not at all

Do neighborhoods affect their residents?

- Positively
  - Social connections, role models, security, community resources
- Negatively
  - Discrimination, competition with advantaged peers
- Not at all
  - Only family influences, genetic factors, individual human capital investments or broader non-neighborhood environment matter

Do neighborhoods affect their residents?

- What is Y?

Do neighborhoods affect their residents?

- What is Y?
  - Adults
    - Self sufficiency
    - Physical & mental health
  - Youth
    - Education (reading/math test scores)
    - Physical & mental health
    - Risky behavior

Neighborhood Effects

- Natural Experiment

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  - Hurricane Katrina

- Can we randomly assign people to live in different neighborhoods?

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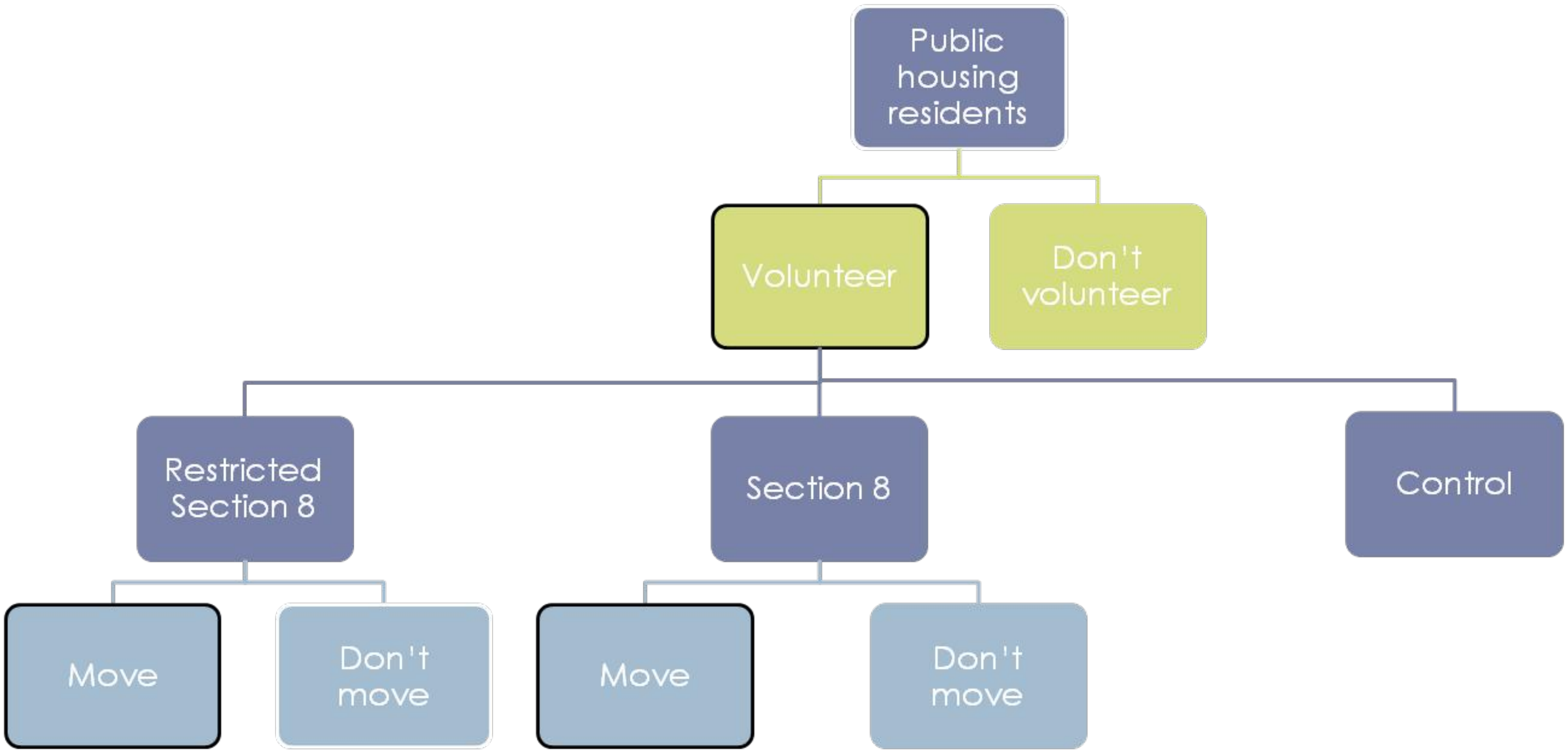
- Can we randomly assign people to live in different neighborhoods?

  - Sort of…

Moving to Opportunity
Kling, Liebman and Katz (2007)

- Solicit volunteers to participate
- Randomly assign each volunteer an option
  - Control
  - Section 8
  - Section 8 with restriction (low poverty neighborhood)
- Volunteers decide whether to move
  - Compliers: use voucher
  - Non-compliers: don't move

Moving to Opportunity



Non-random Participation

- Why is this OK?
  - Volunteers presumably care about their neighborhood environment, so should be the target when thinking about uptake for the use of housing vouchers

BUT

  - Results might not generalize to other populations with different characteristics

Treatment and Compliance

- With perfect compliance:
  - $Pr(X=1 | Z=1)=1$
  - $Pr(X=1 | Z=0)=0$
- With imperfect compliance:
  - $1>Pr(X=1 | Z=1)>Pr(X=1 | Z=0)>0$

Where X - actual treatment
Z - assigned treatment

Some Econometrics

- Intention-to-treat (ITT) Effects
  - Differences between treatment and control group means

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  - Differences between treatment and control group means

$$ITT = E(Y|Z = 1) - E(Y|Z = 0)$$

Y - outcome
Z - assigned treatment

Some Econometrics

- Intention-to-treat (ITT) Effects
  - Writing this relationship in mathematical notation

$$Y = Z\pi_1 + W\beta_1 + \varepsilon_1$$

Individual wellbeing (*Y*) depends on whether or not the individual is assigned to treatment (*Z*), baseline characteristics (*W*), and whether or not the individual got lucky (*ε*)

π_1 - effect of being assigned to treatment group

= (effect of actually moving) x (compliance rate)

Some Econometrics

- Effect of Treatment on the Treated (TOT)

$$\frac{\text{Differences between treatment and control group means}}{\text{Differences in compliance for treatment and control groups}}$$

Some Econometrics

- Effect of Treatment on the Treated (TOT)
  - <u>Differences between treatment and control group means</u>
    Differences in compliance for treatment and control groups

  - TOT = “Wald Estimator” = $\dfrac{E(Y|Z = 1) – E(Y|Z = 0)}{E(X|Z = 1) – E(X|Z = 0)}$

    Y - outcome

    Z - assigned treatment

    X - actual treatment (i.e. compliance)

Some More Econometrics

- Estimate TOT using instrumental variables
  - Use offer of a MTO voucher as an instrument for MTO voucher use

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(1) $X = \mathbf{Z}\rho_d + \mathbf{W}\beta_d + \varepsilon_d$

1. Predict whether people use voucher (X), given their assigned treatment (Z) and observable characteristics (W)

Some More Econometrics

- Estimate TOT using instrumental variables
  - Use offer of a MTO voucher as an instrument for MTO voucher use. In mathematical notation:

(1) $X = \mathbf{Z}\rho_d + \mathbf{W}\beta_d + \varepsilon_d$

(2) $Y = X\gamma_2 + \mathbf{W}\beta_2 + \varepsilon_2$

1. Predict whether people use voucher (X), given their assigned treatment (Z) and observable characteristics (W)
2. Estimate how much individual wellbeing (Y) depends on predicted compliance (X) and observable characteristics (W)

Some Econometrics

- Effect of Treatment on the Treated (TOT)
  - Writing the reduced-form relationship in mathematical notation

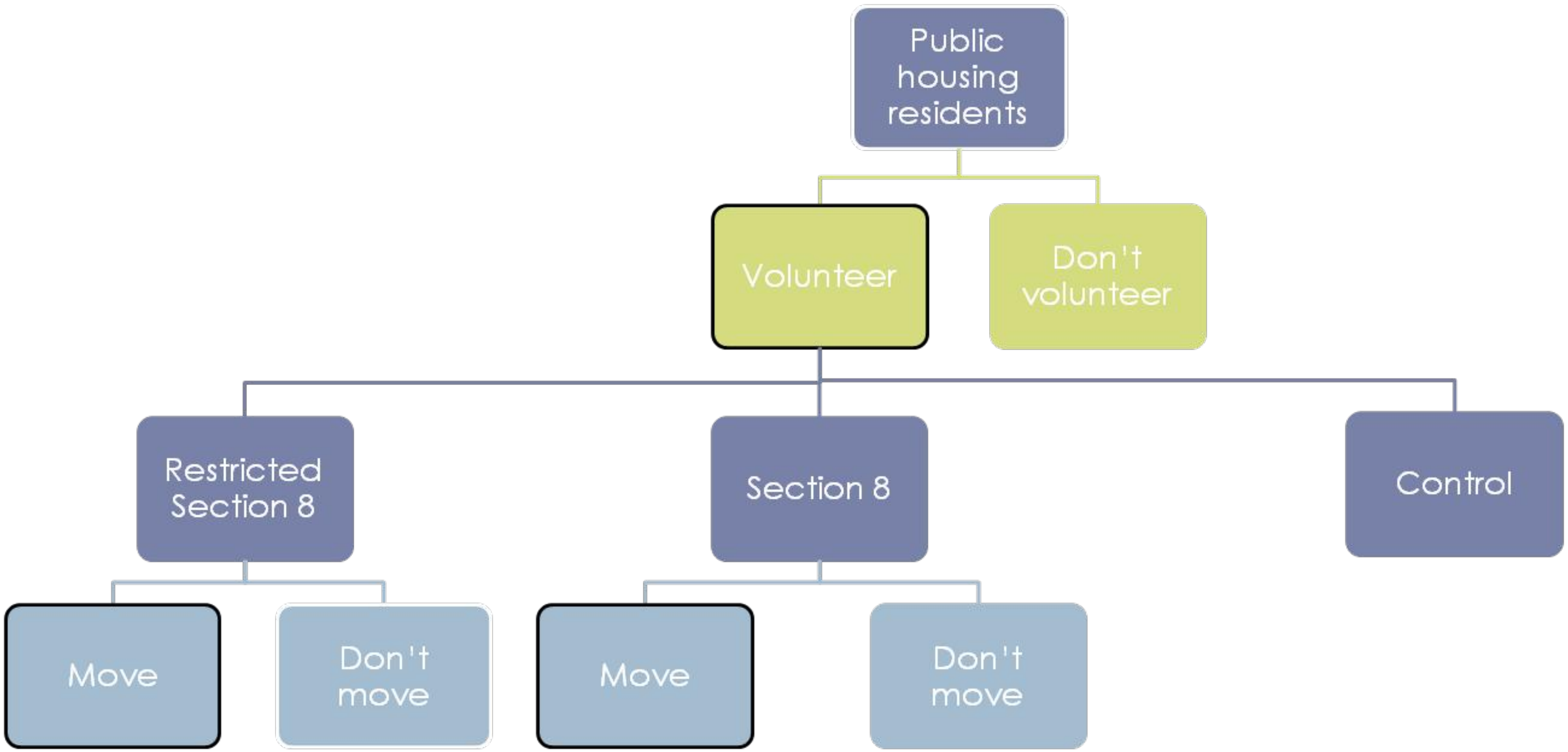
$$Y = X\gamma_2 + W\beta_2 + \varepsilon_2$$

Individual wellbeing (*Y*) depends on whether or not the individual complies with treatment (*X*), baseline characteristics (*W*), and whether or not the individual got lucky (*ε*)

Note: γ_2- effect of *actually* moving (i.e. compliance)

$$= \frac{\text{effect of being assigned to treatment group}}{\text{compliance rate}}$$

Moving to Opportunity



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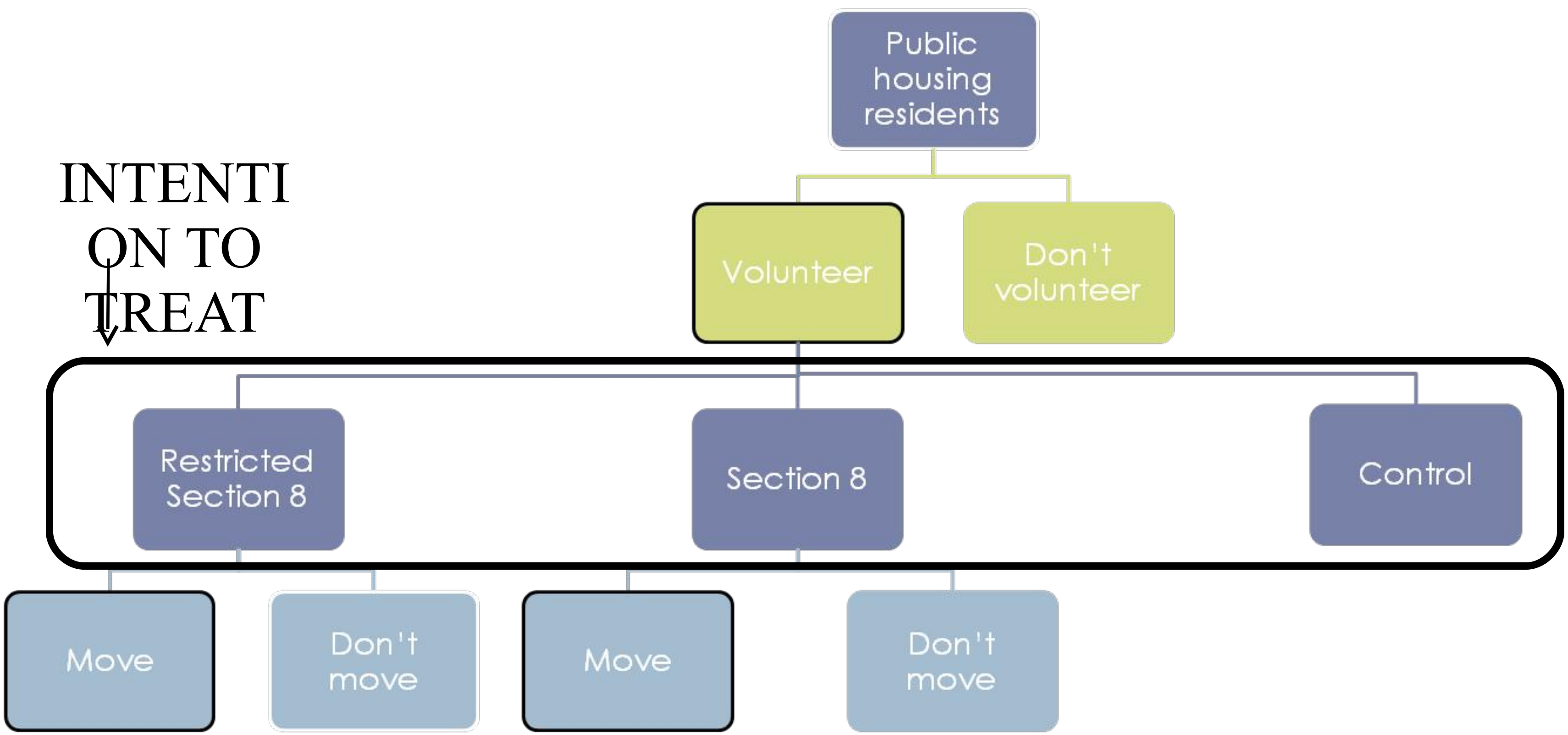

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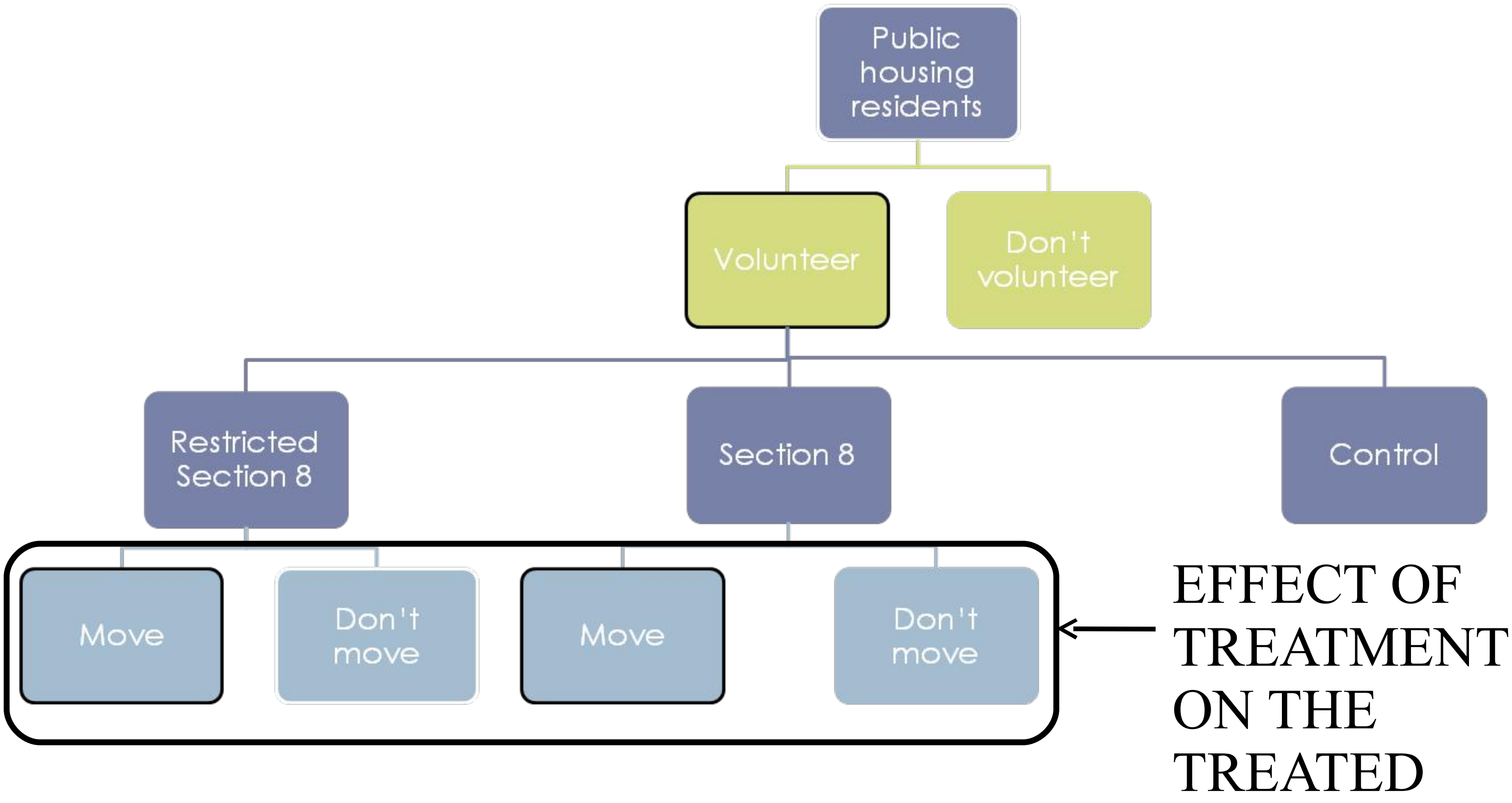

Results

- Positive effects
  - Teenage girls
  - Adult mental health
- Negative effects
  - Teenage boys
- No effects
  - Adult economic self-sufficiency & physical health
  - Younger children
- Increasing effects for lower poverty rates

Limitations

- Can’t fully separate relocation effect from neighborhood effect
- Can’t observe spillovers into receiving neighborhoods

Some Thoughts

- We can still estimate impacts in cases where we don’t have full compliance

- Policies sometimes target people who are different from the general population (i.e. those more likely to take up a program)

BUT

- We have to be careful about generalizing these results for other populations (**external validity**)

Other examples (if necessary)

- Quarter of Birth (Angrist, QJE Nov. '91)
- Vietnam Lottery (Angrist, AER '90)

Final Thoughts

- Randomized evaluation can have many applications beyond merely looking at reduced-form relationships between X and Y

Practical Applications

- Noncompliance
- **Externalities**

Externalities

- Two parties engage in a transaction and harm/benefit a third party uninvolved in the original transaction.
  - Positive: Vaccines, Honeybees. Too little of X.
  - Negative: Pollution. Too much of X.

Worms

- Worms: Identifying Impacts on Education and Health in the Presence of Treatment Externalities. Edward Miguel, Michael Kremer

- 1 in 4 worldwide
- Bad in USA until Rockefeller 1910-1920
- Hook/Round/Whipworm plus Schisto

Worms

- Treatment is easy and cheap.
  - Treat everyone if prevalent (>50%,>30%)
  - $0.49/person/year in Tanzania
- What if we randomized by individual?
  - 75 schools with 400 kids each
  - 15,000 treatment; 15,000 control
  - Expect 200 treated in each school

Worms

- How do you get worms?

Worms

- How do you get worms?
  - Feces for hook/round/whip
  - Water for Schisto
- So your schoolmates' treatment status affects you.

Worms

- Are control kids attending same school with treated kids a pure control group?
- How would this affect your estimate?

Worms

- Are control kids attending same school with treated kids a pure control group?
- (No.)

- How would this affect your estimate?

(Bias it downwards. Yc has increased, so Yt-Yc is lower.)

Worms

- Regardless, this is what people used to do.
- Dickson, British Medical Journal (2000)

Thirty randomised controlled trials in more than 15 000 children were identified. Effects on mean weight were unremarkable, and heterogeneity was evident in the results. There were some positive effects on mean weight change in the trials reporting this outcome: after a single dose (any anthelmintic) the pooled estimates were 0.24 kg (95% confidence interval 0.15 kg to 0.32 kg; fixed effects model assumed) and 0.38 kg (0.01 kg to 0.77 kg; random effects model assumed). Results from trials of multiple doses showed mean weight change in up to one year of follow up of 0.10 kg (0.04 kg to 0.17 kg; fixed effects) or 0.15 kg (0.00 to 0.30; random effects). At more than one year of follow up, mean weight change was 0.12 kg (-0.02 kg to 0.26 kg; fixed effects) and 0.43 (-0.61 to 1.47; random effects). Results from studies of cognitive performance were inconclusive.

Conclusions: There is some limited evidence that routine treatment of children in areas where helminths are common has effects on weight gain, but this is not consistent between trials. There is insufficient evidence as to whether this intervention improves cognitive performance.

Our interpretation of these findings is that the evidence of benefit for mass treatment of children related to positive effects on growth and cognitive performance is not convincing. In the light of these data, we would be unwilling to recommend that countries or regions invest in programmes that routinely treat children with anthelmintic drugs to improve their growth or cognitive performance.

Worms, Randomized by School

- Ted Miguel (Berkeley) and Michael Kremer (Harvard) evaluated the Primary School Deworming Project, run by a Dutch NGO called ICS-Africa
- 75 schools, almost all rural schools in district
- 30,000 pupils
- Stratify by zone and involvement in other programs, arrange alphabetically, count off by threes.
- Group 1: Treated starting in 1998
- Group 2: Treated starting in 1999
- Group 3: Treated starting in 2001.

Worms, Randomized by School

- Group 1: Treated starting in 1998
- Group 2: Treated starting in 1999
- Group 3: Treated starting in 2001.

- Can phasing in cause problems?
- Is it likely to in this case?

TABLE I

1998 AVERAGE PUPIL AND SCHOOL CHARACTERISTICS, PRE-TREATMENT[a]

	Group 1 (25 schools)	Group 2 (25 schools)	Group 3 (25 schools)	Group 1 – Group 3	Group 2 – Group 3
Panel A: Pre-school to Grade 8					
Male	0.53	0.51	0.52	0.01	−0.01
				(0.02)	(0.02)
Proportion girls <13 years, and all boys	0.89	0.89	0.88	0.00	0.01
				(0.01)	(0.01)
Grade progression (= Grade − (Age − 6))	−2.1	−1.9	−2.1	−0.0	0.1
				(0.1)	(0.1)
Year of birth	1986.2	1986.5	1985.8	0.4**	0.8***
				(0.2)	(0.2)
Panel B: Grades 3 to 8					
Attendance recorded in school registers (during the four weeks prior to the pupil survey)	0.973	0.963	0.969	0.003	−0.006
				(0.004)	(0.004)
Access to latrine at home	0.82	0.81	0.82	0.00	−0.01
				(0.03)	(0.03)
Have livestock (cows, goats, pigs, sheep) at home	0.66	0.67	0.66	−0.00	0.01
				(0.03)	(0.03)
Weight-for-age Z-score (low scores denote undernutrition)	−1.39	−1.40	−1.44	0.05	0.04
				(0.05)	(0.05)
Blood in stool (self-reported)	0.26	0.22	0.19	0.07**	0.03
				(0.03)	(0.03)
Sick often (self-reported)	0.10	0.10	0.08	0.02**	0.02**
				(0.01)	(0.01)
Malaria/fever in past week (self-reported)	0.37	0.38	0.40	−0.03	−0.02
				(0.03)	(0.03)
Clean (observed by field workers)	0.60	0.66	0.67	−0.07**	−0.01
				(0.03)	(0.03)

Averages are the same, so randomizati on worked.

Worms, Randomized by School

- Are we calculating ITT or TOT here?
- Is that what we're interested in?

Results

TABLE V

JANUARY TO MARCH 1999, HEALTH AND HEALTH BEHAVIOR DIFFERENCES BETWEEN GROUP 1 (1998 TREATMENT) AND GROUP 2 (1998 COMPARISON) SCHOOLS[a]

	Group 1	Group 2	Group 1 – Group 2
Panel A: Helminth Infection Rates			
Any moderate-heavy infection, January–March 1998	0.38	–	–
Any moderate-heavy infection, 1999	0.27	0.52	−0.25***
			(0.06)
Hookworm moderate-heavy infection, 1999	0.06	0.22	−0.16***
			(0.03)
Roundworm moderate-heavy infection, 1999	0.09	0.24	−0.15***
			(0.04)
Schistosomiasis moderate-heavy infection, 1999	0.08	0.18	−0.10*
			(0.06)
Whipworm moderate-heavy infection, 1999	0.13	0.17	−0.04
			(0.05)
Panel B: Other Nutritional and Health Outcomes			
Sick in past week (self-reported), 1999	0.41	0.45	−0.04**
			(0.02)
Sick often (self-reported), 1999	0.12	0.15	−0.03**
			(0.01)
Height-for-age Z-score, 1999 (low scores denote undernutrition)	−1.13	−1.22	0.09*
			(0.05)

25% less "any moderate infection"

- 9% higher height-for-age z-score

That's nice and all, but...

- What's still wrong?

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- What's still wrong?
- Nearly ¼ of kids attend a school that is not the closest school to their home.
- You can get more/fewer worms by having your classmates treated (within-school externality).
- You can get more/fewer worms by living near a treated school even though your school is control (across-school externality.)

That's nice and all, but...

- KEY: Externalities are mostly a problem you reduce in size, not eliminate.

- Across-School: Easy. Add a term for distance from treated school.
  - (Actually, number of pupils within a given distance from your school and the number of pupils attending a treated school within that distance.)

That's nice and all, but...

- Within-School: Less awesome method.

“Group 1 pupils who did not receive treatment in 1998 are compared to Group 2 pupils who did not receive treatment in 1999, the year that Group 2 schools were incorporated into treatment, to at least partially deal with potential bias due to selection into medical treatment. For the health outcomes, we compare these two groups as of January to February 1999, when Group 1 schools had already been treated (in 1998) but Group 2 schools had not.”

That's nice and all, but...

- Not as cool as randomization because we've got different time periods, and the parental consent rule changed.

- Group 1 not treated=34% chance of infection
- Group 2 not treated=55% chance
  - 21% difference
- Group 1 treated=24% chance of infection
- Group 2 treated=51% chance
  - 27% difference
- 21/27 implies ¾ of effect thanks to within school externalities. That's big.

Cost-Benefit

- Was all this worthwhile?

  Health:

- 649 DALY averted, $5 per DALY assuming $0.49 per student per year (Tanzania).
- Measles/Dip/Pert/Tet cost $12 to $17 per DALY
- Externalities 76% of the gain. 99% of gain from Schisto.
- Without Schisto, $280 per DALY. Not worth it.

Cost-Benefit

- Was all this worthwhile?

  Education:

- 7% more school attendance, 25% less absenteeism
- $0.49 per student per year/0.14 years more schooling
- $3.50 for a year of school.
- Providing uniforms costs $99 for a year of school.

Cost-Benefit

- Was all this worthwhile?

  Returns to Education:

- Wages=$570, 7% return for year of schooling.
- Increase net present value of wages by $30 for only $0.49
- More attendance requires more teachers ($1942 salary).

  $1942*0.14/30 students per class=$9.06 of extra teacher. Full cost still only $9.55.

Conclusion

- Deworming is great.
- “When local treatment externalities are expected, field experiments can be purposefully designed to estimate externalities by randomizing treatment at various levels.”