

# **The Lasting Effects of Early Childhood Interventions: The National Vaccination Commando Program in Burkina Faso.**

Richard Daramola, Md Shahadath Hossain, Harounan Kazianga, and Karim Nchare

ASSA 2023

January 7, 2023

# Introduction

- ▶ Early childhood socioeconomic circumstances are critical for lifetime economic outcomes (Currie and Vogl, 2013; Almond et al., 2018; Case et al., 2005; Flores et al., 2020; Heckman et al., 2013; Gertler et al., 2014).
- ▶ Programs targeting children have the potential to enhance the human capital accumulation and economic outcomes.
- ▶ There is scarce evidence on the long-run impact of large public programs targeting child health.
  - ▶ A few notable studies are Nandi et al. (2020) and Atwood (2021)

# Introduction

- ▶ Vaccination as an early childhood intervention
- ▶ Rising vaccine hesitancy in developed nations and continued under-investment in vaccines in developing nations
- ▶ Long term effects of vaccines is still not well understood.

# Background

- ▶ Half of all deaths of children (1-4 years) in Burkina Faso were directly attributed to measles (Bellamy, 1998).
- ▶ Failure of the Expanded Program on Immunization (EPI) in the early 80s due to organizational, logistic and infrastructure constraints.

# Background

- ▶ Half of all deaths of children (1-4 years) in Burkina Faso were directly attributed to measles (Bellamy, 1998).
- ▶ Failure of the Expanded Program on Immunization (EPI) in the early 80s due to organizational, logistic and infrastructure constraints.
  - ▶ Only 25,000 of the half a million children under age two were vaccinated in 1981.
  - ▶ On 4 August 1984, a revolutionary government led by [Thomas Sankara](#) took power in Burkina Faso.

# Background

- ▶ Half of all deaths of children (1-4 years) in Burkina Faso were directly attributed to measles (Bellamy, 1998).
- ▶ Failure of the Expanded Program on Immunization (EPI) in the early 80s due to organizational, logistic and infrastructure constraints.
  - ▶ Only 25,000 of the half a million children under age two were vaccinated in 1981.
  - ▶ On 4 August 1984, a revolutionary government led by [Thomas Sankara](#) took power in Burkina Faso.
- ▶ The new government placed a high priority on nationwide immunization with the aim to overcome the shortcomings of EPI. They launched the [Vaccination Commando Program](#).

## Background: Vaccination Commando Program (Demand)

- ▶ All available means of information were used to publicize the campaign (Bassole, 1986)
- ▶ A guide manual for health workers, schoolteachers and parents was published.
- ▶ Round table discussions took place on radio and television.
- ▶ Poems and songs were written for theatre shows.
- ▶ Posters were designed and displayed in towns and villages, more than 100k fliers were distributed.

# Background: Vaccination Commando Program(Supply)

- ▶ The Ministry of health provided a refresher course for the health workers
- ▶ Temporarily assigned workers to ensure adequate staffing
- ▶ New vaccination cards were issued.
- ▶ Government established multisectoral vaccination committees in every province to mobilize community support and participation.
- ▶ Military were deployed to facilitate transportation logistics.

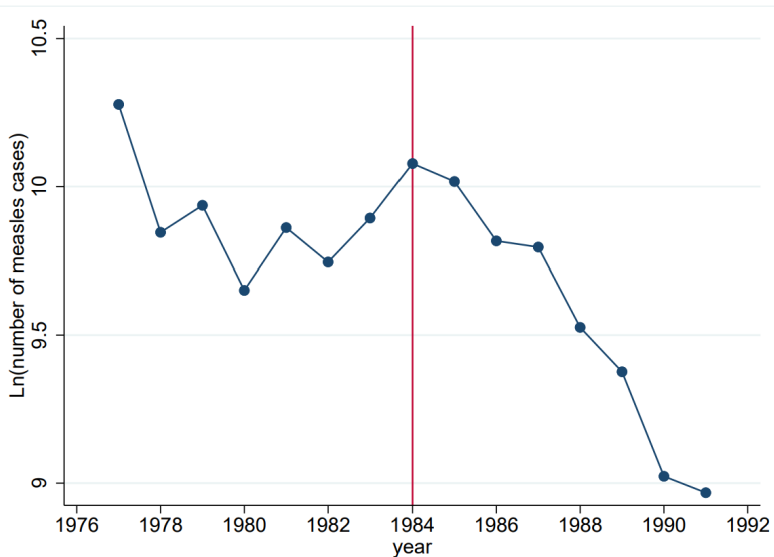


# Background: Vaccination Commando Program

- ▶ VCP campaign in November 25-December 10, 1984
- ▶ Vaccinated over 1 million children against measles, yellow fever, and meningitis
- ▶ The VC campaign covered 68-75% of the previous unimmunized children
- ▶ An increase in the national vaccination coverage from the previous 17% to 77%.

# Measles Prevalence

Figure (1) Measles prevalence over time



# Research Question

**What is the effect of national child immunization on child mortality, education, and labor market outcomes in Burkina Faso?**

- ▶ Short-term outcomes: Health
  - ▶ Does childhood measles vaccination reduce child mortality rate?
    - ▶ Medium-term outcome: Human capital
    - ▶ Does childhood measles vaccination improve educational attainment?

# Research Question

## **What is the effect of national child immunization on child mortality, education, and labor market outcomes in Burkina Faso?**

- ▶ Short-term outcomes: Health
  - ▶ Does childhood measles vaccination reduce child mortality rate?
    - ▶ Medium-term outcome: Human capital
    - ▶ Does childhood measles vaccination improve educational attainment?
- ▶ Long-term outcomes: labor market outcomes at adulthood
  - ▶ Does childhood measles vaccination increase labor force participation?
  - ▶ Does childhood measles vaccination improve earnings?

# Key Findings

- ▶ Vaccination leads to a significant decline in mortality
- ▶ Vaccination leads to a substantial rise in the likelihood of primary school enrollment and completion.

# Key Findings

- ▶ Vaccination leads to a significant decline in mortality
- ▶ Vaccination leads to a substantial rise in the likelihood of primary school enrollment and completion.
- ▶ Vaccination increases the likelihood of employment in both the informal and the formal labor sectors.
- ▶ Vaccination significantly increases agricultural yields.
  - ▶ The effect on agricultural productivity works almost exclusively through the effectiveness of labor instead of the quantity of labor

# Contribution

- ▶ We evaluate the impact of nationwide vaccination program
  - ▶ We complement to the existing studies that are limited in scale (i.e., regional coverage).
- ▶ Early childhood interventions (such as vaccine) have a strong and positive effect in the long-run
  - ▶ Even in environments where the labor market is less than perfect
  - ▶ One of the first to look at the impact of early childhood vaccination on agricultural productivity in a low-income context.

# Data Sources

## **Micro analysis: Difference-in-Differences**

- ▶ Report from the Ministry of Health (number of children vaccinated for measles, yellow fever, and meningitis in each province)
- ▶ Demographic and Health Survey (DHS) 1993
- ▶ Censuses data: 1985, 1996, and 2006 rounds from IPUMS, and the full census from 1985.
- ▶ Permanent agricultural survey 2010, 2011, and 2012 rounds

## **Aggregate level analysis: Synthetic control type(Counterfactual estimators)**

- ▶ World Bank's world development indicators for 27 Sub-saharan African countries



## Data: Vaccination Rate

- ▶ Vaccination Commando Program (VCP) was implemented in Nov-Dec of 1984
- ▶ Children between 9 months and six years were eligible for measles vaccination
- ▶ Number of eligible children in each province from 1985 population census
- ▶ Number of vaccinated children in each province from Ministry of Health's archive
- ▶ Vaccination rate (in a province) =  $\frac{\text{Number of children vaccinated}}{\text{Number of eligible children}}$

## Two Way Fixed Effect

$$Y_{ijk} = \alpha_0 + \beta_1 (I_k * VCP_j) + X_{ijk} + \eta_k + \gamma_j + \varepsilon_{ijk} \quad (1)$$

- ▶ where  $Y_{ijk}$  is the outcome of interest of individual  $i$  in cohort  $j$  in province  $k$
- ▶  $I_k$  is the treatment intensity (the percentage of children vaccinated in December 1984) in province  $k$
- ▶  $VCP_j$  is a dummy variable indicating whether the individual belongs to a cohort exposed to the vaccination commando program.
- ▶  $\eta_k$  and  $\gamma_j$  represent province and cohort fixed effects, respectively.

# Estimations

## **Short-term impact**

- ▶ Health outcomes (infant and child mortality)

## **Medium-term impact**

- ▶ Education outcome (primary school completion)

## **Long-term impact**

- ▶ Labor force participation
- ▶ Agricultural productivity

# Results: Infant Mortality

Table 1: Vaccination effects on infant mortality

	(1)	(2)	(3)	(4)
Cohort of birth 1978-83=1 × vaccination rate measles	-0.069** (0.030)	-0.065** (0.031)		
Cohort of birth 1978-83=1 × High vaccination rate measles=1			-0.043* (0.023)	-0.043* (0.023)
Constant	0.298*** (0.029)	0.317*** (0.029)	0.298*** (0.029)	0.316*** (0.029)
Observations	4836	4783	4836	4783
Fixed Effects	Province	Province	Province	Province
Fixed Effects	YOB	YOB	YOB	YOB
Other controls	None	Yes	None	Yes
Data Source	DHS	DHS	DHS	DHS

Robust standard errors clustered at the province level.

Dependent variable is the infant (age less than 2) mortality rate

Controls include ethnicity and gender

Estimations using the 1993 Demographic and Health Survey (DHS) of Burkina Faso

- ▶ Continuous vaccination intensity: About 6.5 percentage point decline in infant mortality
- ▶ High vaccination intensity (=1 if yes): about 4.3 percentage point decline in infant mortality

# Placebo Result: Infant Mortality

Table 2: Placebo effects on infant mortality

	(1)	(2)	(3)	(4)
Cohort of birth 1972-77=1 × vaccination rate measles	0.135 (0.089)	0.133 (0.087)		
Cohort of birth 1972-77=1 × High vaccination rate measles=1			0.032 (0.041)	0.031 (0.041)
Constant	0.363*** (0.045)	0.352*** (0.053)	0.362*** (0.047)	0.350*** (0.054)
Observations	2657	2623	2657	2623
Fixed Effects	Province	Province	Province	Province
Fixed Effects	YOB	YOB	YOB	YOB
Other controls	None	Yes	None	Yes
Data Source	DHS	DHS	DHS	DHS

Robust standard errors clustered at the province level.

Dependent variable is the infant (age less than 2) mortality rate

Controls include ethnicity and gender

Estimations using the 1993 Demographic and Health Survey (DHS) of Burkina Faso

- ▶ The estimated effects are statistically insignificant

# Results: Child Mortality

Table 3: Vaccination effects on child mortality

	(1)	(2)	(3)	(4)
Cohort of birth 1978-83=1 × vaccination rate measles	-0.069** (0.031)	-0.063*		
Cohort of birth 1978-83=1 × High vaccination rate measles=1			-0.048* (0.024)	-0.047* (0.023)
Constant	0.343*** (0.029)	0.371*** (0.034)	0.343*** (0.029)	0.370*** (0.033)
Observations	4836	4783	4836	4783
Fixed Effects	Province	Province	Province	Province
Fixed Effects	YOB	YOB	YOB	YOB
Other controls	None	Yes	None	Yes
Data Source	DHS	DHS	DHS	DHS

Robust standard errors clustered at the province level.

Dependent variable is the child (age less than 5) mortality rate

Controls include ethnicity and gender

Estimations using the 1993 Demographic and Health Survey (DHS) of Burkina Faso

- ▶ VCP has significantly reduced under-five child mortality

# Placebo Result: Child Mortality

Table 4: Placebo effects on child mortality

	(1)	(2)	(3)	(4)
Cohort of birth 1972-77=1 × vaccination rate measles	0.152 (0.094)	0.149 (0.091)		
Cohort of birth 1972-77=1 × High vaccination rate measles=1			0.046 (0.045)	0.044 (0.045)
Constant	0.404*** (0.052)	0.404*** (0.061)	0.402*** (0.054)	0.402*** (0.064)
Observations	2657	2623	2657	2623
Fixed Effects	Province	Province	Province	Province
Fixed Effects	YOB	YOB	YOB	YOB
Other controls	None	Yes	None	Yes
Data Source	DHS	DHS	DHS	DHS

Robust standard errors clustered at the province level.

Dependent variable is the child (age less than 5) mortality rate

Controls include ethnicity and gender

Estimations using the 1993 Demographic and Health Survey (DHS) of Burkina Faso

- ▶ The estimated effects are statistically insignificant

# Results: Primary School Completion

Table 5: Vaccination effects on primary school completion

	(1)	(2)	(3)	(4)
Cohort of birth 1978-83=1 × vaccination rate measles	0.051** (0.020)	0.049** (0.022)		
Cohort of birth 1978-83=1 × High vaccination rate measles=1			0.023** (0.009)	0.021** (0.009)
Constant	0.127*** (0.006)	0.261*** (0.010)	0.128*** (0.006)	0.261*** (0.009)
Observations	403951	389389	403951	389389
Fixed Effects	Province	Province	Province	Province
Fixed Effects	Year	Year	Year	Year
Fixed Effects	YOB	YOB	YOB	YOB
Other controls	None	Yes	None	Yes
Data Source	Census	Census	Census	Census

Robust standard errors clustered at the province level.

Dependent variable is the primary school completion rate

Controls include religion and gender

Estimations using the 1985, 1996, and 2006 General Population and Housing Censuses of Burkina Faso

- ▶ VCP increased primary school completion rate by 4.9 percentage point



# Placebo Result: Primary School Completion

Table 6: Placebo effects on primary school completion

	(1)	(2)	(3)	(4)
Cohort of birth 1972-77=1 × vaccination rate measles	0.023 (0.016)	0.044* (0.023)		
Cohort of birth 1972-77=1 × High vaccination rate measles=1			-0.001 (0.008)	0.002 (0.012)
Constant	0.094*** (0.004)	0.180*** (0.007)	0.094*** (0.004)	0.180*** (0.007)
Observations	400761	311436	400761	311436
Fixed Effects	Province	Province	Province	Province
Fixed Effects	Year	Year	Year	Year
Fixed Effects	YOB	YOB	YOB	YOB
Other controls	None	Yes	None	Yes
Data Source	Census	Census	Census	Census

Robust standard errors clustered at the province level.

Dependent variable is the primary school completion rate

Controls include religion and gender

Estimations using the 1985, 1996, and 2006 General Population and Housing Censuses of Burkina Faso

- ▶ The estimated effect are statistically insignificant

# Results: Labor Supply

Table 7: Vaccination effects on labor supply

	(1)	(2)	(3)	(4)
Cohort of birth 1978-83=1 × vaccination rate measles	0.056** (0.025)	0.057** (0.027)		
Cohort of birth 1978-83=1 × High vaccination rate measles=1			0.016 (0.013)	0.016 (0.014)
Constant	0.590*** (0.007)	0.637*** (0.018)	0.590*** (0.008)	0.637*** (0.018)
Observations	411947	411947	411947	411947
Fixed Effects	Province	Province	Province	Province
Fixed Effects	Year	Year	Year	Year
Fixed Effects	YOB	YOB	YOB	YOB
Other controls	None	Yes	None	Yes
Data Source	Census	Census	Census	Census

Robust standard errors clustered at the province level.

Dependent variable is an indicator of labor supply decision that equals 1 if working or studying, and zero otherwise

Controls include individual characteristics: age, gender, and religion

Estimations using the 1996 and 2006 General Population and Housing Censuses of Burkina Faso

► Positive but insignificant effect

# Placebo Result: Labor Supply

Table 8: Placebo effects on labor supply

	(1)	(2)	(3)	(4)
Cohort of birth 1972-77=1 × vaccination rate measles	-0.023 (0.017)	-0.043 (0.026)		
Cohort of birth 1972-77=1 × High vaccination rate measles=1			-0.003 (0.009)	-0.000 (0.013)
Constant	0.495*** (0.010)	0.771*** (0.026)	0.495*** (0.009)	0.771*** (0.026)
Observations	422451	334507	422451	334507
Fixed Effects	Province	Province	Province	Province
Fixed Effects	Year	Year	Year	Year
Fixed Effects	YOB	YOB	YOB	YOB
Other controls	None	Yes	None	Yes
Data Source	Census	Census	Census	Census

Robust standard errors clustered at the province level.

Dependent variable is an indicator of labor supply decision that equals 1 if working or studying, and zero otherwise

Controls include individual characteristics: age, gender, and religion

Estimations using the 1985, 1996, and 2006 General Population and Housing Censuses of Burkina Faso

- ▶ The estimated effect is close to zero and statistically insignificant

# Results: Agricultural Productivity

Table 9: Vaccination effects on agricultural productivity

	(1)	(2)	(3)	(4)
Birth cohort 1978-83=1 × vaccination rate measles	0.290*** (0.097)	0.266*** (0.078)		
Birth cohort 1978-83=1 × High vaccination rate measles=1			0.114* (0.065)	0.129** (0.059)
Constant	11.549*** (0.028)	5.664* (3.109)	11.612*** (0.012)	12.867*** (0.070)
Observations	17561	17470	17561	17470
Fixed Effects	Household	Household	Household	Household
Fixed Effects	Year	Year	Year	Year
Fixed Effects	Crop	Crop	Crop	Crop
Fixed Effects	YOB	YOB	YOB	YOB
Other controls	None	Yes	None	Yes
Data Source	PAS	PAS	PAS	PAS

Robust standard errors clustered at the province level.

Dependent variable is the natural log of harvest value per hectare

Plot owner characteristics: education, gender, age; plot characteristics: toposequence, distance to village

Estimations using the 2010-2012 panel of the Permanent Agricultural Survey of the Ministry of Agriculture of Burkina Faso

- ▶ VCP has significantly increased agricultural productivity
- ▶ High vaccination intensity leads to a 13 percent higher harvest value per hectare

# Placebo Results: Agricultural Productivity

Table 10: Placebo effects on agricultural productivity

	(1)	(2)	(3)	(4)
Birth cohort 1972-77=1 × vaccination rate measles	-0.079 (0.126)	-0.071 (0.133)		
Birth cohort 1972-77=1 × High vaccination rate measles=1			-0.004 (0.084)	0.031 (0.090)
Constant	11.623*** (0.037)	11.098*** (3.457)	11.601*** (0.017)	12.771*** (0.079)
Observations	19046	18952	19046	18952
Fixed Effects	Household	Household	Household	Household
Fixed Effects	Year	Year	Year	Year
Fixed Effects	Crop	Crop	Crop	Crop
Fixed Effects	YOB	YOB	YOB	YOB
Other controls	None	Yes	None	Yes
Data Source	PAS	PAS	PAS	PAS

Robust standard errors clustered at the province level.

Dependent variable is the natural log of harvest value per hectare

Plot owner characteristics: education, gender, age; plot characteristics: toposequence, distance to village

Estimations using the 2010-2012 panel of the Permanent Agricultural Survey of the Ministry of Agriculture of Burkina Faso

► The estimated effects are statistically insignificant

# Sources of Agricultural Productivity

- ▶ No significant increase in labor hours work
- ▶ No significant increase in fertilizer use
- ▶ No significant increase in the use of improved seed
- ▶ No significant increase in the quality of land use
- ▶ **Indicates that agricultural productivity came almost exclusively through the effectiveness of labor instead of increase in inputs.**

# Robustness Check

## Placebo treatment cohort

- ▶ Cohort of birth 1972-77

# Robustness Check

## Placebo treatment cohort

- ▶ Cohort of birth 1972-77

## Internal migration

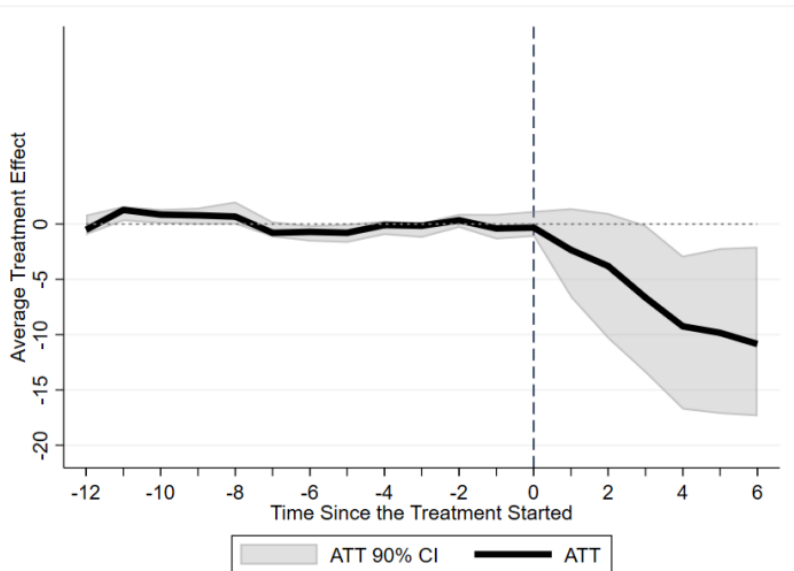
- ▶ We employ the model-based imputation approach (Liu et al., 2021).
  - ▶ Takes observations under the treatment condition as missing and uses model-based estimation to impute counterfactuals of treated observations.

$$Y_{it} = \delta_{it}D_{it} + L_{it} + x_{it}\beta + \epsilon_{it} \quad (2)$$

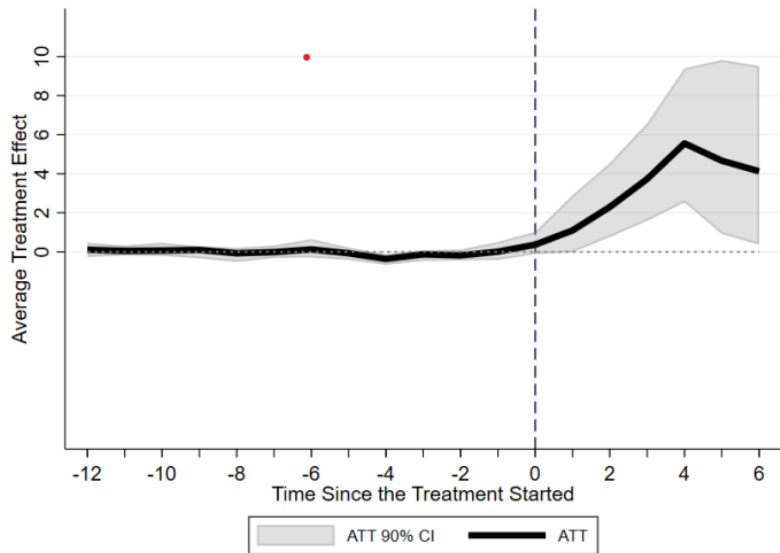
- ▶  $Y_{it} \in (N * T)$  matrix of untreated.
- ▶  $L$  is the lower rank matrix of unobserved cofounders.
- ▶  $x_{it} \in (N * T * k)$  array of covariates,
- ▶  $\epsilon_{it}$  represent a  $(N * T)$  matrix of idiosyncratic errors.
- ▶ We obtain  $\hat{Y}_{it}(0)$  for the treated and compute the treatment effect on the treated as  $Y_{it} - \hat{Y}_{it}(0)$ .



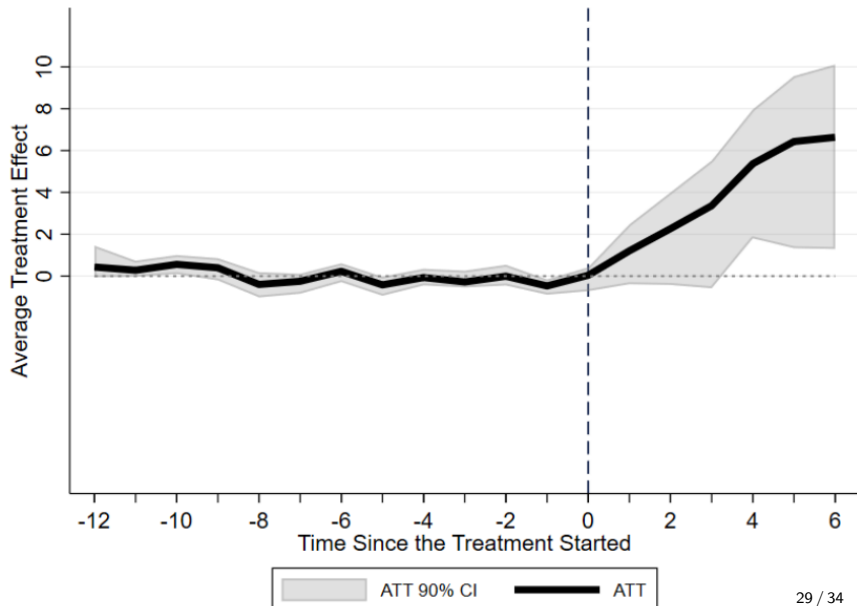
# Mortality rate under five



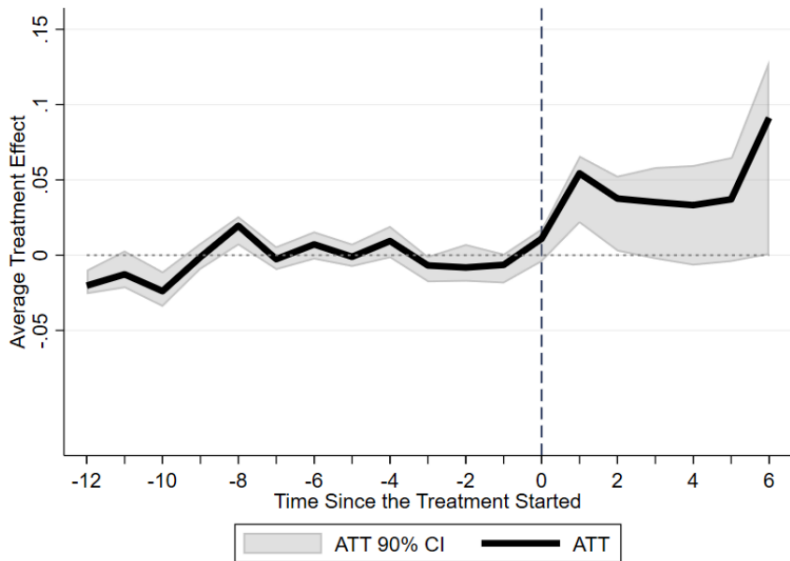
# Primary school enrollment net overall



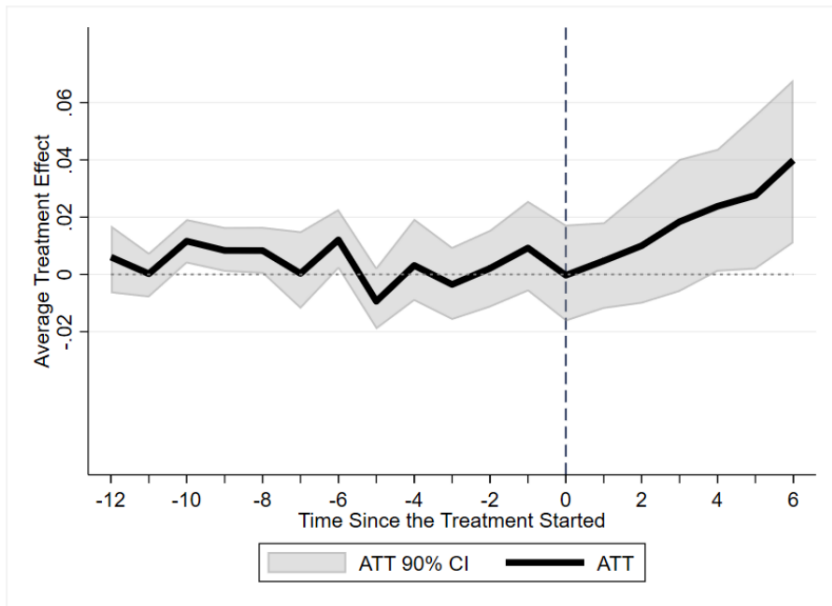
# Primary school completion rate



# Employment rate



# Formal Employment



# Conclusion

- ▶ VCP has improved short-term and long-term health, educational, and economic outcomes.
  - ▶ Increase in earnings through agricultural productivity in a low-income context.
- ▶ We extend the existing literature on the long-term effects of immunization.

THANK YOU

- Almond, Douglas, Janet Currie, and Valentina Duque**, “Childhood circumstances and adult outcomes: Act II,” *Journal of Economic Literature*, 2018, 56 (4), 1360–1446.
- Atwood, Alicia**, “The Long-Term Effects of Measles Vaccination on Earnings and Employment,” *American Economic Journal: Economic Policy*, 2021, *Forthcoming*.
- Case, Anne, Angela Fertig, and Christina Paxson**, “The lasting impact of childhood health and circumstance,” *Journal of health economics*, 2005, 24 (2), 365–389.
- Currie, Janet and Tom Vogl**, “Early-life health and adult circumstance in developing countries,” *Annu. Rev. Econ.*, 2013, 5 (1), 1–36.
- Flores, Manuel, Pilar García-Gómez, and Adriaan Kalwij**, “Early life circumstances and labor market outcomes over the life cycle,” *The Journal of Economic Inequality*, 2020, 18 (4), 449–468.
- Gertler, Paul, James Heckman, Rodrigo Pinto, Arianna Zanolini, Christel Vermeersch, Susan Walker, Susan M Chang, and Sally Grantham-McGregor**, “Labor market returns to an early childhood stimulation intervention in