

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

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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 are 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

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- ▶ 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-million children under two years old were vaccinated in 1981.
 - ▶ On 4 August 1984, a revolutionary government led by [Thomas Sankara](#) took power in Burkina Faso.

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 - ▶ Only 25,000 of the half-million children under two years old were vaccinated in 1981.
 - ▶ On 4 August 1984, a revolutionary government led by [Thomas Sankara](#) took power in Burkina Faso.
- ▶ The new government launched the [Vaccination Commando Program](#).

Background: Vaccination Commando Program

Demand Side:

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

Background: Vaccination Commando Program

Supply Side:

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

Background: Vaccination Commando Program

Supply Side:

- ▶ 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

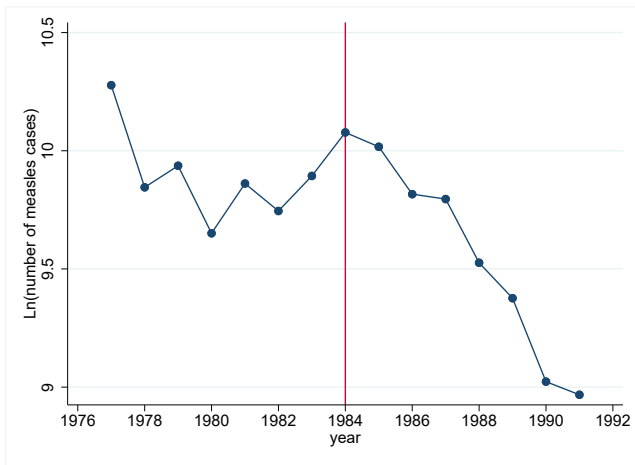


Figure 1: Measles Prevalence Over Time

Research Question

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

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

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- ▶ Short-term outcomes: Health
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 - ▶ Does childhood measles vaccination improve educational attainment?
- ▶ Long-term outcomes: Labor market outcomes in adulthood
 - ▶ Does childhood measles vaccination increase formal employment?
 - ▶ Does childhood measles vaccination improve agricultural earnings?

Data Sources

Micro analysis

- ▶ Report from the Ministry of Health (number of children vaccinated in each province)
- ▶ Demographic and Health Survey (DHS) 1993
- ▶ Census data: 1996 and 2006 rounds from IPUMS, and the full census from 1985.
- ▶ Permanent agricultural survey 2008-2014 rounds

Aggregate level analysis

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

Treatment Variable: 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) = Number of children vaccinated / Number of eligible children**

Method: Two Way Fixed Effects

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

- ▶ Y_{ijk} is the outcome of individual i in cohort j in province k
- ▶ I_k is the treatment intensity in December 1984 in province k
 - ▶ Used two versions of $I \in \{VRM, HVRM\}$.
 - ▶ *Continuous*: VRM is the provincial measles vaccination rate
 - ▶ *Dummy*: $HVRM$ indicates whether a province had a high measles vaccination rate or not
 - ▶ Provinces with a positive residual in the regression of vaccinated children on the number of children eligible for measles vaccination (Duflo, 2001).

Method: Two Way Fixed Effects

$$Y_{ijk} = \alpha_0 + \beta_1 (I_k * \text{Exposure}_j) + X_{ijk}\Pi + \eta_k + \gamma_j + \varepsilon_{ijk}$$

- ▶ Exposure_j is a dummy variable indicating whether the individual belongs to a cohort exposed to the VCP.
 - ▶ Exposed Cohort: Birth year between 1978-83
 - ▶ Unexposed Cohort: Birth year between 1972-77
 - ▶ *Placebo test*: Falsely exposed cohort of birth 1972-77 and unexposed cohort 1966-71
- ▶ η_k and γ_j represent province and cohort fixed effects, respectively.

Child Mortality

Table 1: Vaccination Effect on Child Mortality

	Child Mortality (=1 if Yes)			
	(1)	(2)	(3)	(4)
CB 1978-83=1 × VRM	-0.076* (0.041)	-0.075* (0.041)		
CB 1978-83=1 × HVRM =1			-0.047* (0.023)	-0.047* (0.023)
Constant	0.345*** (0.029)	0.371*** (0.034)	0.345*** (0.029)	0.370*** (0.033)
Observations	4,783	4,783	4,783	4,783
Fixed Effects	Province	Province	Province	Province
Fixed Effects	YOB	YOB	YOB	YOB
Other controls	None	Yes	None	Yes
Data Source	DHS	DHS	DHS	DHS

- ▶ VCP has significantly reduced under-five child mortality
- ▶ A reduction of 16.2% from the pre-treatment mean of 0.29

Results: Educational Attainment

Table 2: Vaccination Effects on Educational Attainment

	School Enrollment (=1 if Yes)				School Completion (=1 if Yes)			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
CB 1978-83=1 × VRM	0.063** (0.029)	0.063* (0.032)			0.052** (0.024)	0.054** (0.026)		
CB 1978-83=1 × HVRM =1			0.022* (0.011)	0.022* (0.012)			0.022** (0.009)	0.021** (0.009)
Constant	0.201*** (0.006)	0.309*** (0.008)	0.201*** (0.006)	0.309*** (0.008)	0.176*** (0.006)	0.223*** (0.009)	0.176*** (0.005)	0.261*** (0.009)
Observations	389,389	389,389	389,389	389,389	389,389	389,389	389,389	389,389
Fixed Effects	Province	Province	Province	Province	Province	Province	Province	Province
Fixed Effects	Year	Year	Year	Year	Year	Year	Year	Year
Fixed Effects	YOB	YOB	YOB	YOB	YOB	YOB	YOB	YOB
Other controls	None	Yes	None	Yes	None	Yes	None	Yes
Data Source	Census	Census	Census	Census	Census	Census	Census	Census

- ▶ 0.02 percentage point higher primary school completion
- ▶ A 13.1% increase from the pre-treatment mean of 0.16

Results: Labor Market Outcomes

Table 3: Vaccination Effects on Labor Market Outcomes

	Formal Employment (=1 if Yes)				Agricultural Yield			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
CB 1978-83=1 × VRM	0.027** (0.011)	0.025** (0.012)			0.089** (0.037)	0.086** (0.037)		
CB 1978-83=1 × HVRM =1			0.011** (0.005)	0.009* (0.004)			0.059** (0.021)	0.057** (0.021)
Constant	0.079*** (0.004)	0.154*** (0.009)	0.097*** (0.004)	0.154*** (0.009)	11.938*** (0.012)	11.973*** (0.079)	11.956*** (0.005)	11.987*** (0.076)
Observations	73,298	73,298	73,298	73,298	20,336	20,336	20,336	20,336
Fixed Effects	Province	Province	Province	Province	Province	Province	Province	Province
Fixed Effects	Year	Year	Year	Year	Year	Year	Year	Year
Fixed Effects	YOB	YOB	YOB	YOB	YOB	YOB	YOB	YOB
Other controls	None	Yes	None	Yes	None	Yes	None	Yes
Data Source	Census	Census	Census	Census	PAS	PAS	PAS	PAS

- ▶ 0.01 percentage point higher formal employment (14.2% increase from pre-treatment)
- ▶ 6% point higher harvest value per hectare

Agricultural Inputs: Continuous Treatment

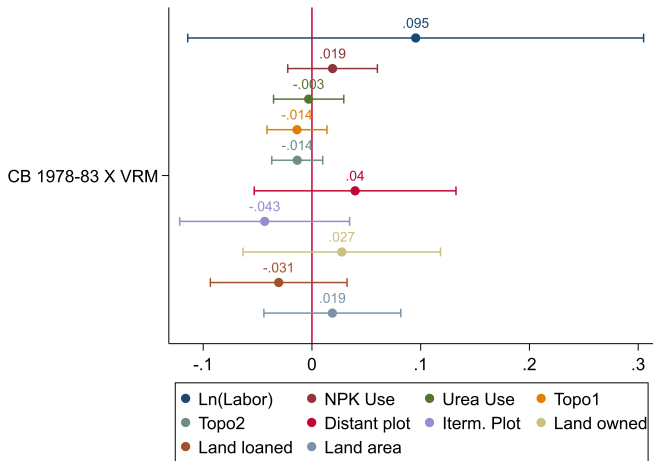


Figure 2: Vaccination Effects on Agricultural Input Use

Agricultural Inputs: Dummy Treatment

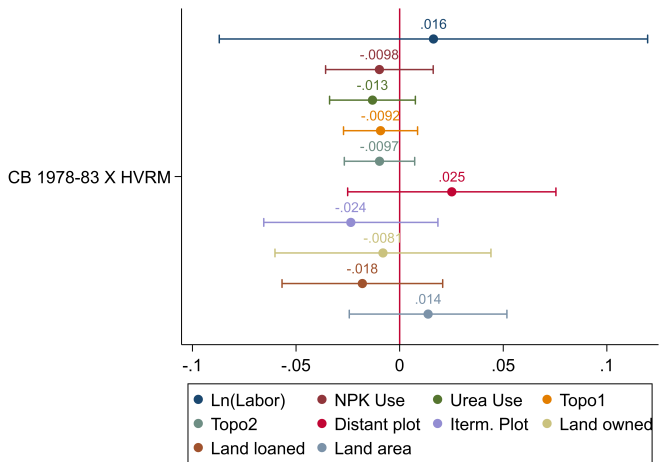


Figure 3: Vaccination Effects on Agricultural Input Use

Robustness Check: Placebo Treatment

- **Placebo treatment cohort** using cohort of birth 1972-77

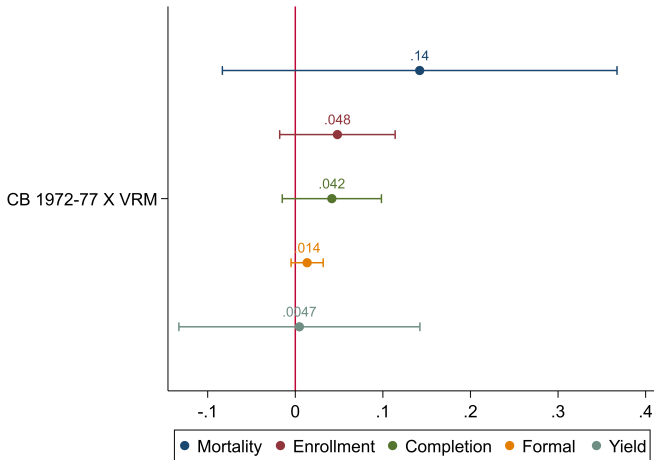


Figure 4: Placebo Effects on Outcomes

Robustness Check: Placebo Treatment

- ▶ **Placebo treatment cohort** using cohort of birth 1972-77

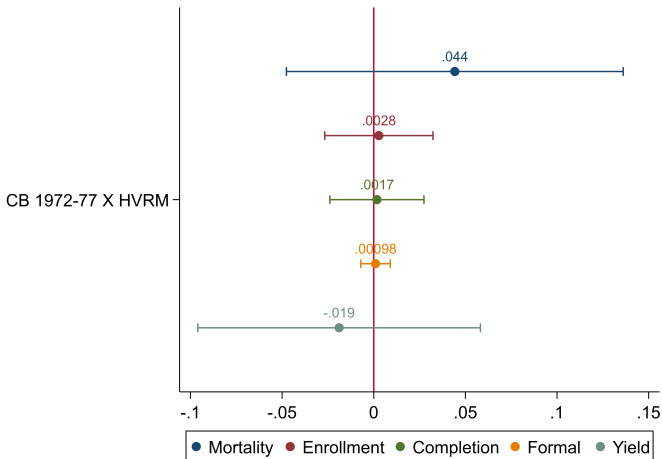
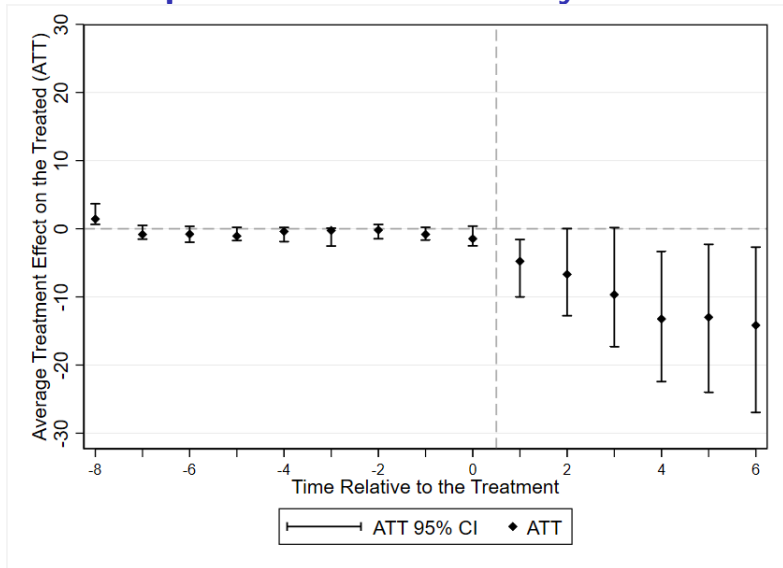


Figure 5: Placebo Effects on Outcomes

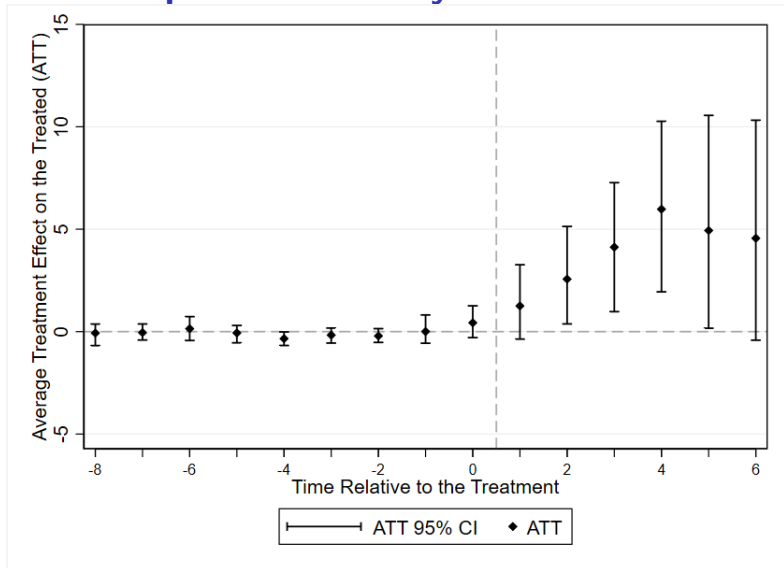
Robustness Check: Sensitivity to Internal Migration

- ▶ Use outcomes aggregated at the national level to account for internal migration
- ▶ Compare pre-and post-VCP Burkina Faso to a synthetic Burkina Faso
- ▶ Used model-based imputation approach following Liu et al. (2024)
- ▶ Liu et al. (2024) provides a simple framework of counterfactual estimation for causal inference with time-series cross-sectional data.

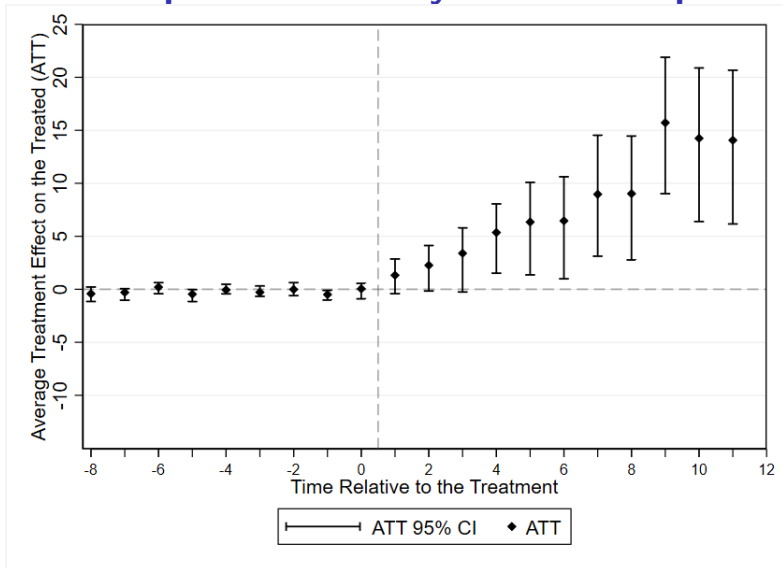
Matrix Completion: Child Mortality



Matrix Completion: Primary School Enrollment



Matrix Completion: Primary School Completion



Robustness Check

- ▶ **Potential misclassification** of provinces ▶ [Misclassification]
- ▶ **Alternative Control Group** following De Chaisemartin and d'Haultfoeuille (2018) ▶ [Alternative Control]
- ▶ **Alternative Estimation Approach: Continuously Distributed Treatment** similar to Callaway et al. (2021) ▶ [Continuous Treatment]

Cost-Benefit Analysis

Estimate the net present value (NPV) of the VCP:

$$NPV = -C + \sum_{t=10}^{59} \Delta \bar{A}_t (1+r)^{-t} + \sum_{t=22}^{59} \Delta \bar{F}_t (1+r)^{-t} \quad (2)$$

- ▶ C is the total cost of the vaccination campaign
- ▶ $\Delta \bar{A}_t$ capture earnings gain in agriculture.
 - ▶ Started nine years after VCP when the vaccinated cohort reached age 15
- ▶ $\Delta \bar{F}_t$ capture earnings gain in formal employment.
 - ▶ Started 21 years after VCP when the vaccinated cohort reached age 28
- ▶ Conservative case uses discount rate, $r = 10\%$

Cost-Benefit Analysis Results

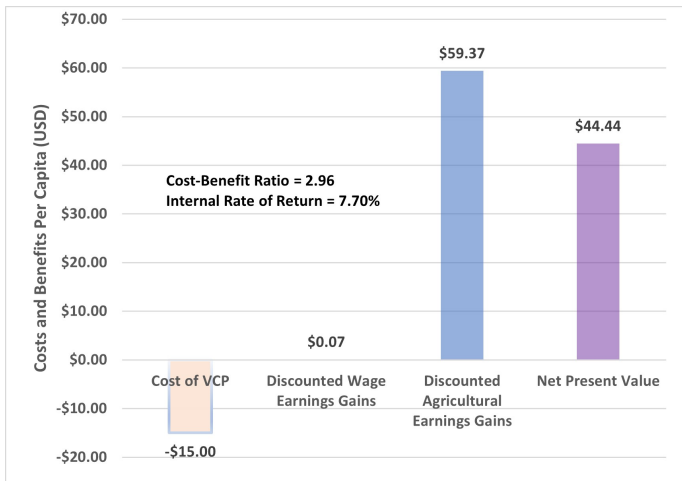


Figure 6: Cost-Benefit Analysis

Contribution

- ▶ Evaluated the impact of a nationwide early childhood health intervention – a vaccination program
 - ▶ Complement existing studies that are limited in scale (i.e., regional coverage).
- ▶ Showed that early childhood interventions have a strong and positive long-term effect
 - ▶ Even in environments where the labor market is less than perfect
 - ▶ In these environments, the bulk of economic returns derived from gains in (small-scale) farm productivity.
 - ▶ The economic returns of childhood interventions in LICs are vastly underestimated if only gains in formal labor markets are accounted for.

Conclusion

- ▶ VCP has improved short-term, mid-term, and long-term 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!

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Check for Potential Misclassification

- ▶ Changing classification of two potential misclassified provinces

Table 4: Robustness: Vaccination Effects with Alternative Province Classification

	Child Mortality	School Enrollment	School Completion	Formal Empl.	Agri. Yield
	(1)	(2)	(3)	(4)	(5)
CB 1978-83=1 × HVRM =1	-0.027 (0.025)	0.023* (0.013)	0.023** (0.010)	0.010* (0.005)	0.060** (0.022)
Constant	0.371*** (0.033)	0.309*** (0.008)	0.261*** (0.007)	0.154*** (0.009)	11.988*** (0.009)
Observations	4,783	389,389	389,389	73,298	20,336
Fixed Effects	Province	Province	Province	Province	Province
Other Controls	Yes	Yes	Yes	Yes	Yes
Data Source	DHS	Census	Census	Census	PAS

Check for Potential Misclassification

- ▶ Dropping the two potential misclassified provinces

Table 5: Robustness: Vaccination Effects Excluding Potential Misclassified Provinces

	Child Mortality	School Enrollment	School Completion	Formal Empl.	Agri. Yield
	(1)	(2)	(3)	(4)	(5)
CB 1978-83=1 × HVRM =1	-0.039* (0.021)	0.024* (0.013)	0.023** (0.010)	0.010* (0.005)	0.063*** (0.022)
Constant	0.378*** (0.035)	0.316*** (0.007)	0.267*** (0.009)	0.157*** (0.009)	12.005*** (0.078)
Observations	4,538	367,738	367,738	69,345	19,386
Fixed Effects	Province	Province	Province	Province	Province
Other Controls	Yes	Yes	Yes	Yes	Yes
Data Source	DHS	Census	Census	Census	PAS

▶ Return

Alternative Control

Table 6: Robustness: Vaccination Effects with Alternative Control Definition

	Child Mortality	School Enrollment	School Completion	Formal Empl.	Agri. Yield
	(1)	(2)	(3)	(4)	(5)
CB 1978-83=1 × HVRM =1	-0.047* (0.023)	0.037*** (0.009)	0.024*** (0.008)	0.008 (0.005)	0.054** (0.021)
Constant	0.370*** (0.033)	0.309*** (0.008)	0.261*** (0.009)	0.154*** (0.009)	11.987*** (0.075)
Observations	4,783	389,389	389,389	69,345	19,386
Fixed Effects	Province	Province	Province	Province	Province
Other Controls	Yes	Yes	Yes	Yes	Yes
Data Source	DHS	Census	Census	Census	PAS

▶ Return

Continuous Treatment

Table 7: Vaccination Effects with Continuous Treatment in High Vaccination Intensity Provinces

	Child Mortality	School Enrollment	School Completion	Formal Empl.	Agri. Yield
	(1)	(2)	(3)	(4)	(5)
CB 1978-83=1 × VRM	-0.068*** (0.029)	0.011* (0.006)	0.013*** (0.005)	0.002 (0.004)	0.048*** (0.014)
Observations	4,783	389,389	389,389	73,298	20,336
Fixed Effects	Province	Province	Province	Province	Province
Fixed Effects	-	Year	Year	Year	Year
Fixed Effects	YOB	YOB	YOB	YOB	YOB
Other controls	Yes	Yes	Yes	Yes	Yes
Data Source	DHS	Census	Census	Census	PAS

▶ Return