The Effect of an Early-Childhood and Fertility Intervention on Firm and Farm Productivity

Tania Barham (CU-Boulder), Randall Kuhn (UCLA),
Brett A. McCully (UCLA), Patrick Turner (Notre Dame)

Overview. Early childhood vaccination and family planning programs are among the most important and widely adopted policies in the developing world over the second half of the twentieth century, yet their long-term effects have been little studied. In particular, these programs' effects on long-run productivity growth through the channel of human capital have rarely been examined.

In this project, we explore long-run effects of a mother and early childhood intervention on productivity in agriculture and enterprises. We focus on a novel channel for health and human capital to affect productivity—technology adoption and firm complexity—and find substantial and positive effects. Finally, the long-term nature of our data allows us to observe program effects decades after implementation, which are substantial and positive, while medium-term effects in agriculture are negligible. While most program evaluations in developing countries only look at short- or medium-run outcomes, doing so in our context would understate the effect of the program we study.

We use uniquely rich data in a subdistrict in Bangladesh to assess the long-run effects of a quasi-experimentally designed maternal and child health and family planning program (MCH-FP). Our data allow us to observe a rich vector of pre-period characteristics as well as medium- and long-run impacts of the program on a variety of relevant enterprise and agricultural outcomes with a large sample size.

Doubt remains about the sign and magnitude of the effect of population health on economic growth. Some argue (e.g., Weil 2007, Bleakley 2010) that health improvements lead to higher income as a result of improved human capital. In contrast, Acemoglu and Johnson (2007) suggest that the productivity-enhancing effects of better health are washed out by increased fertility, a force absent in Weil's 2007 analysis. In our context, we look at the effect of a program which first reduces fertility through policy interventions and then, in a later phase of the intervention, also improves child health. In this setting, the Malthusian channel of increased population competition canceling out the economic benefits of improved health is effectively shut off, and in our results we find an economically significant impact of reduced fertility and improved child health on later-life productivity outcomes. The pairing of a fertility and health program thus provides a unique context to assess the effect of health on productivity and economic growth.

Much of the previous literature has focused on contemporaneous effects of health on agricultural productivity (e.g., Pitt and Rosenzweig 1986 and Fink and Masiye 2015). More generally, Foster and Rosenzweig (1996) find that education raises farm productivity and technology adoption. In addition, Bleakley and Lange (2009) look at the long-run impact of child health improvements on fertility. In contrast, we look at long-term productivity outcomes of a program jointly affecting fertility and child health.

In addition, new management technique and production technology adoption is often slow in the developing world despite the significant financial benefits to farmers and entrepreneurs (Atkin et al., 2017; World Bank, 2007). We hypothesize that an important determinant of new technology and management technique adoption is the human capital of the entrepreneur or farmer, shaped significantly by one's childhood environment (Heckman, 2006), and a channel thus far understudied in the literature.

Intervention. In 1977 the MCH-FP program was introduced to half the Matlab subdistrict of Bangladesh by the International Center for the Diarrhoeal Disease Research, Bangladesh (icddr,b), with the remaining half serving as the control. The MCH-FP rollout balanced pre-program covariates between treatment and control regions and provides the quasi-experimental variation that we leverage to identify causal effects in this paper (Phillips et al., 1982) (see Table 1 for a balance test at the household level). Prior research on the MCH-FP has extensively documented the similarity in mortality and fertility rates and household and individual characteristics prior to the intervention (Koenig et al., 1990; Menken and Phillips, 1990;

Joshi and Schultz, 2013). Barham (2012) shows that cognition, height, and education were similar after the intervention for individuals too old to be directly affected by the MCH-FP. Barham et al. (2019) also show that pre-program labor market outcomes were balanced as well as just before the child health interventions were rolled out in 1982.

Recent research on the long-run effects of the MCH-FP has found positive impacts. Barham et al. (2019) find that the program led to increased entrepreneurship and occupational upgrading 35 years later for the most affected children. Barham et al. (2021) find that the program resulted in sustained improvements in height.

Program interventions were phased in, with the family planning program and tetanus toxoid vaccines for pregnant women distributed in the first few years (1977 to 1982), a measles vaccine for children starting in 1982, and other vaccines for tetanus, pertussis, polio, and tuberculosis for children distributed starting in 1985. After 1988, the program expanded to the control area. This staggered rollout of program components led to differential treatment of children depending on their year of birth.

The MCH-FP program availability depended on one's location of residence during the program period. Since households may have selectively changed location in response to the program and so their location during the program is potentially endogenous (Barham and Kuhn, 2014), we use Demographic Surveillance System (DSS) and census data to generate an intent-to-treat indicator for each individual based on the pre-program village of residence in 1974. We link individuals to their pre-program household in the following way: (i) link respondent to the 1974 census through the household head of their first residence in the DSS area, (ii) if their household head was absent for the 1974 census, we identify that person's first household head in the DSS area and link that new person to the 1974 census, (iii) we assign remaining unlinked respondents a treatment status using the location of their household head in the DSS area after the 1974 census, but before the start of the MCH-FP in 1977.

Data. We leverage several unusually detailed datasets collected in the Matlab study area. Moreover, we link each of these datasets at the individual or household level, using unique individual and household identifiers provided in the data.

To measure firm and farm outcomes, we use both the 1996 (MHSS1) and 2012 (MHSS2) waves of the Matlab Health and Socioeconomic Survey panel. These data contain a rich set of household agricultural variables, including inputs (e.g., acres, spending on inputs, use of high-yield seeds) and output (quantity harvested, revenue, profits) for 11 types of crops. We also observe a rich set of outcomes for household enterprises. In addition, we use the 1974 and 1982 censuses to obtain baseline characteristics.

To assign treatment status to individuals and households, we use Demographic Surveillance System (DSS) data. These data track every life event—births, deaths, marriages, separations, and migrations—for every inhabitant of Matlab, as well as where each person lives within Matlab, since 1974. The DSS data allow us to observe the family tree of individuals living in Matlab and trace back whether an individual's antecedents lived in the treatment or control area. We use this traceback of antecedent treatment status back in 1974 to assign intent-to-treat status, as we detail below. We exploit the fact that each individual has a unique ID, allowing us to link across DSS, census, and MHSS1 and MHSS2 datasets.

Due to the long-term nature of our outcomes 35 years after the conclusion of the MCH-FP experimental period, it was crucial to minimize attrition. To accomplish this, the tracking protocol for the data collection followed internal migrants throughout Bangladesh, interviewed international migrants when they returned for holidays or over the phone. This comprehensive tracking was a key feature of the design of this study and had substantial success. Thirty-five years after the start of the MCH-FP, we interviewed over 90 percent of men born during the experimental program—the group with the highest migration rates. Response rates for females and other age groups are even higher. Relative to other studies covering similar populations and longitudinal studies that cover shorter time periods, these rates of attrition are remarkably low.

Preliminary Results. We estimate the effect of the MCH-FP on enterprise outcomes using variation between treatment and control villages and the timing of the rollout of program components to different villages. We find that the program led to substantially higher profits for firms owned and operated by individuals treated with the early life health interventions. We also find suggestive evidence that individuals treated with the health interventions in childhood (those born 1982-88) found more enterprises, are more likely to keep a dedicated bank account for their business, and employ more workers.[1]

We find that the positive effect of the MCH-FP on enterprise profits is driven by treated individual's human capital, both physical and cognitive. In particular, we find that one's height and MMSE score positively impact firm profits.

We next turn to the effects of the MCH-FP on agricultural productivity and technology adoption. We find that the program had a negligible effect on the propensity to farm and profits-per-acre in the medium-term (columns 1 and 2 of Table 2). In the long-term (i.e., by 2012), we find that the program moderately increased the propensity to farm, had a substantially positive effect on profits per acre on the order of a 29% rise relative to the mean, and a positive effect (43% increase relative to the mean) on the chance of adopting a new, more productive technology—high-yield seeds (columns 3, 4, and 5 of Table 2). The small and statistically insignificant effects in the short-run contrast with the economically large and precisely estimated effects in the long-run. A key contribution of our study is demonstrating the need to look at long-run outcomes of early childhood interventions.

We look at how sibling competition shapes agricultural outcomes. Specifically, since the MCH-FP induced families to have fewer children, this may have led to greater investment per child for treated families. This higher investment raised the child's human capital, making them more capable of adopting new technologies and being more productive at work. In addition, a key channel for the number of male siblings to shape agricultural profitability is through land inheritance. In Bangladesh, each male son typically receives an equal share of land following the father's death (van Schendel and Rahman, 1997). Therefore, having fewer brothers means that a son will inherit relatively more land.

We find that sibling competition mediates agricultural outcomes but no evidence for enterprise outcomes. We find that as the number of male siblings rises for a household head, profit made from crops per acre declines. Moreover, we find that larger landholdings are associated with greater takeup of high-yield variety seeds and higher crop profits per acre. In contrast, we find no association between Malthusian forces and enterprise outcomes. We hypothesize that this differential effect of the number of male siblings is driven by the nature of land inheritance, since additional brothers are direct competition for a son's agricultural landholdings.

Future Work. We aim to estimate several additional models to better understand the effects of the MCH-FP on firm and farm outcomes, and the mechanisms that drive the effects. For example, because households split between survey rounds, and land is measured at the household level, we will estimate the effect of the MCH-FP on agricultural outcomes at the MHSS1 household level rather than at the MHSS2 household level. In addition, we hope to explore a range of additional potential mediators, such as education, which may drive our results. Finally, we will attempt to further strengthen the inference of our design by testing models that identify exposure to the treatment not merely by household location, but by the age and remaining years of fertility of women living in the household at the time of program placement.

References

Daron Acemoglu and Simon Johnson. Disease and development: the effect of life expectancy on economic growth. *Journal of Political Economy*, 115(6):925–985, 2007.

David Atkin, Azam Chaudhry, Shamyla Chaudry, Amit K. Khandelwal, and Eric Verhoogen. Organizational barriers to technology adoption: Evidence from soccer-ball producers in Pakistan. *Quarterly Journal of Economics*, 132(3):1101–1164, 2017.

Tania Barham. Enhancing cognitive functioning: Medium-term effects of a health and family planning program in Matlab. *American Economic Journal: Applied Economics*, 4(1):245–73, 2012.

Tania Barham and Randall Kuhn. Staying for benefits the effect of a health and family planning program on out-migration patterns in Bangladesh. *Journal of Human Resources*, 49(4):982–1013, 2014.

Tania Barham, Randall Kuhn, and Patrick Turner. No place like home: Long-run impacts of early child health and family planning on labor and migration outcomes. Technical report, October 2019.

[1] We also note that the effect of the treatment on the reference group–those born before 1970–is negative. This negative effect can rationalize our findings of positive effects of the program on the more intensively treated with the findings in Barham et al., 2019 that consumption did not rise due to the MCH-FP. In particular, there appears to be some crowding out of enterprises by younger entrepreneurs who received the health intervention at an early age.

Tania Barham, Gisella Kagy, Brachel Champion, and Jena Hamadani. Early childhood health and family planning: Long-term and intergenerational effects on human capital. Technical report, 2021.

Hoyt Bleakley. Malaria eradication in the Americas: A retrospective analysis of childhood exposure. *American Economic Journal: Applied Economics*, 2(2):1–45, 2010.

Hoyt Bleakley and Fabian Lange. Chronic disease burden and the interaction of education, fertility, and growth. *The Review of Economics and Statistics*, 91(1):52–65, 2009.

Günther Fink and Felix Masiye. Health and agricultural productivity: Evidence from Zambia. *Journal of health economics*, 42:151–164, 2015.

Andrew Foster and Sveta Milusheva. Household recombination, retrospective evaluation, and educational mobility over 40 years. 2017.

Andrew D. Foster and Mark R. Rosenzweig. Technical change and human-capital returns and investments: evidence from the green revolution. *The American Economic Review*, pages 931–953, 1996.

James J. Heckman. Skill formation and the economics of investing in disadvantaged children. *Science*, 312 (5782):1900–1902, 2006.

Shareen Joshi and T. Paul Schultz. Family planning and women's and children's health: Long-term consequences of an outreach program in Matlab, Bangladesh. *Demography*, 50(1):149–180, 2013.

Michael A. Koenig, Mehrab Ali Khan, Bogdan Wojtyniak, John D. Clemens, Jyotsnamoy Chakraborty, Vincent Fauveau, James F. Phillips, Jalaluddin Akbar, and Uday S. Barua. Impact of measles vaccination on childhood mortality in rural Bangladesh. *Bulletin of the World Health Organization*, 68(4):441, 1990.

Jane Menken and James F. Phillips. Population change in a rural area of Bangladesh, 1967-87. *The Annals of the American Academy of Political and Social Science*, 510(1):87–101, 1990.

James F. Phillips, Wayne S. Stinson, Shushum Bhatia, Makhlisur Rahman, and Jyotsnamoy Chakraborty. The demographic impact of the family planning–health services project in Matlab, Bangladesh. *Studies in Family Planning*, pages 131–140, 1982.

Mark Pitt and Mark R. Rosenzweig. Agricultural prices, food consumption, and the health and productivity of Indonesian farmers. *Agricultural household models: Extensions, applications and policy*, pages 153–82, 1986.

Willen van Schendel and Mahbubar Rahman. Gender and the inheritance of land: Living law in Bangladesh. *The Village in Asia Revisited*, pages 237–276, 1997.

David N. Weil. Accounting for the effect of health on economic growth. *Quarterly Journal of Economics*, 122(3):1265–1306, 2007.

World Bank. *World development report 2008: Agriculture for development*. The World Bank, 2007.

Table 1: Balance at 1974 Baseline

Baseline (1974 Census) Variable	Comparison Area Mean	Comparison Area SD	Treatment Area Mean	Treatment Area SD	Difference in Means Mean	Difference in Means p-value
Land (1982)	11.258	(13.279)	10.807	(18.175)	-0.452	(0.685)
Bari size	8.302	(5.229)	9.628	(6.386)	1.326**	(0.020)
Family size	6.923	(2.867)	6.854	(2.935)	-0.069	(0.743)
Wall tin or tin mix (=1)	0.292	(0.441)	0.301	(0.450)	0.009	(0.770)
Tin roof (=1)	0.814	(0.379)	0.812	(0.384)	-0.002	(0.949)
Number of boats	0.666	(0.586)	0.648	(0.643)	-0.017	(0.769)
Owns a lamp (=1)	0.583	(0.482)	0.621	(0.479)	0.038	(0.371)
Owns a watch (=1)	0.124	(0.320)	0.146	(0.347)	0.022	(0.373)
Owns a radio (=1)	0.067	(0.242)	0.072	(0.254)	0.005	(0.759)
Number of rooms	0.209	(0.097)	0.216	(0.096)	0.007	(0.255)
Number of cows	1.398	(1.748)	1.395	(1.630)	-0.003	(0.982)
Latrine (=1)	0.871	(0.327)	0.781	(0.408)	-0.090**	(0.011)
Drinking water, tubewell (=1)	0.141	(0.339)	0.317	(0.459)	0.176***	(0.000)
Drinking water, tank (=1)	0.351	(0.467)	0.388	(0.480)	0.037	(0.519)
HH head years of education	1.945	(2.869)	2.261	(2.906)	0.316	(0.102)
HH head works in agriculture (=1)	0.586	(0.481)	0.613	(0.480)	0.028	(0.494)
HH head works in fishing (=1)	0.063	(0.237)	0.067	(0.248)	0.004	(0.860)
HH head age	46.587	(13.181)	47.106	(14.034)	0.519	(0.580)
HH head spouse's years of education	0.540	(1.256)	0.687	(1.462)	0.146	(0.105)
HH head spouse's age	36.229	(9.976)	36.738	(10.914)	0.509	(0.486)
Observations	1,302		1,208		2,510	

Notes: Sample includes households observed both in MHSS1 and MHSS2 survey waves. Characteristics refer to baseline in reference to household head (or closest person to head with nonmissing data) at time of MHSS2. We cluster standard deviations at the 1974 village level. We use sampling household weights from Foster and Milusheva (2017).

Table 2: Effects of MCHFP: Agriculture

	MHSS1 (1996)		MHSS2 (2012-2014)		
	(1) =1 if household farms	(2) Agr profit per acre	(3) =1 if household farms	(4) Agr profit per acre	(5) =1 if uses high-yield seed
Treat	0.0471	-14.99	0.0547*	83.49**	0.0901**
	(0.0442)	(13.14)	(0.0316)	(36.63)	(0.0350)
Observations	1836	1836	2510	2510	2510
Adjusted R^2	0.054	0.038	0.086	0.037	0.027
Baseline controls	Y	Y	Y	Y	Y
% chg. rel. to mean	7.2	-15.7	8.5	29.4	43.4

Notes: This table shows our estimates of $Y_{hv} = \omega_0 + \omega_1 Treat_v + \zeta BaselineControls_h + \varepsilon_{hv}$ for MHSS1 (columns 1 and 2) and MHSS2 (columns 3-5). Standard errors clustered at the baseline village level. Weights from Foster and Milusheva (2017). *, **, and *** denote statistical significance at the 10%, 5%, and 1% levels, respectively.

Table 3: Long-run Effects of MCHFP: Enterprises (Men)

	(1) Num. business owned	(2) Have business loans	(3) Keep dedicated bank acct. for business	(4) Keep detailed accts. for business
Treat	-0.0175	0.0409*	-0.0227**	-0.0236
	(0.0520)	(0.0223)	(0.00978)	(0.0251)
Treat × Born 1970-1977	-0.101	-0.0915**	0.0384*	0.0322
	(0.0827)	(0.0367)	(0.0206)	(0.0336)
Treat × Born 1977-1982	0.137*	-0.0407	0.0141	0.00606
	(0.0763)	(0.0355)	(0.0195)	(0.0446)
Treat × Born 1982-1988	0.120*	-0.0202	0.0348**	0.0444
	(0.0651)	(0.0249)	(0.0173)	(0.0347)
Observations	2911	2911	2911	2911
Mean if born 1970-77	0.69	0.16	0.03	0.17
Mean if born 1977-82	0.44	0.10	0.04	0.16
Mean if born 1982-88	0.33	0.04	0.03	0.10
	(1) Num. workers employed	(2) Tot. profits (taka)	(3) Revenue	(4) Revenue per worker
Treat	-0.480*	-19760.3**	3733.3	61.84
	(0.282)	(9413.3)	(6559.8)	(1741.2)
Treat × Born 1970-1977	0.119	43978.3	1109.9	1719.5
	(0.333)	(36819.1)	(10111.8)	(4305.4)
Treat × Born 1977-1982	0.417	37654.1	-32512.6**	-10106.4**
	(0.317)	(38433.8)	(13850.5)	(4567.1)
Treat × Born 1982-1988	0.598**	102089.7**	4014.9	21.96
	(0.283)	(50779.2)	(12200.3)	(3705.2)
Observations	2911	2911	2911	2911
Mean if born 1970-77	1.2	69036.1	17456.3	10466.0
Mean if born 1977-82	0.8	56948.6	37200.9	15115.8
Mean if born 1982-88	0.5	33017.1	14608.2	6846.5

Notes: The table presents estimates of $Y_{iv} = \beta_0 + \beta_1 T_v + \beta_2 Born_i^{70-77} + \beta_3 Born_i^{77-82} + \beta_4 Born_i^{82-88} + \beta_5(T_v \times Born_i^{70-77}) + \beta_6(T_v \times Born_i^{77-82}) + \beta_7(T_v \times Born_i^{82-88}) + \alpha_{y(i)} + \gamma X_i + \epsilon_{iv}$ at the individual-level, where T_v is a treatment indicator at the 1974 village level, X_i is a vector of baseline controls, and $\alpha_{y(i)}$ are year of birth fixed effects. Means by age group are for the comparison group. Standard errors are clustered by pre-program village. *, **, and *** denote statistical significance at the 10%, 5%, and 1% levels, respectively.