# Rainfall Shocks and Child Health: Evidence from Rural Vietnam

By Mikko Myrskylä*

and

Thuan Quang Thai*

September 2010

## Abstract

Early life rainfall shocks causally influence health. The mechanisms behind the link are unknown but could be related to income shocks, changes in the opportunity cost of parental time, and disease exposure. We study the rainfall shock-child health mechanism by using Vietnamese data and analyze how the effect depends on regional and individual characteristics. Preliminary results suggest that the effects of rainfall shocks on child health are large but context-dependent so that a positive shock has a positive effect on child health in the rain-fed rice based region. In other regions, the effects are negative. Further, the negative effects are largest among low-income families. Since rainfall may affect the behavior and income of households, in future work we investigate if there is causal link between rainfall shock and value of parental time or parental behavior. The results will help understand the rainfall-child health link and help plan efficient policy interventions.

* Contact information: Max Planck Institute for Demographic Research, Konrad-Zuse-Strasse 1, 18057 Rostock, Germany; emails: myrskyla@demogr.mpg.de and thai@demogr.mpg.de

## INTRODUCTION

Shocks in early life conditions have been found to play an important role in determining the long term health and socioeconomic outcomes. The majority of the evidence comes from historical populations. For example, van den Berg et al. (2006) document a positive effect of being born during an economic boom on later life expectancy using historical data from the Netherlands, and Banerjee et al. (2010) find that negative income shock induced by an exogenous crop loss causes the adult height to decline considerably in 19$^{th}$ century France.

Similar efforts have been made to link shocks during early life periods to later life outcomes in the context of contemporary developing countries. A number of studies make use of rainfall shock as a source of identification of the intended effect. Maccini and Yang (2009) established the significant and positive causal effect of birth year rainfall shock on adult health and wealth of Indonesian female population. The authors argue that an important pathway in which rainfall shock affect woman's health is via negative income shock faced by rural families. In another study with Indian survey data, Sonia Bhalotra (2010) includes both rainfall and income shocks as determinants of child mortality. In this study, the impact of rainfall shock on child health, net of income shocks, is negative (increasing mortality), suggesting that there are additional channels than just income through which rainfall may influence child health. Two potentially important channels (in addition to income shocks) have been identified in the literature: disease exposure, which may increase during periods of extensive rainfall, and changes in the opportunity cost of time of the parents, as increased rainfall may change the incentive to work instead of caring for the offspring.

Thus even though it has been well established that rainfall shocks may have an important causal effect on child outcomes, the mechanisms behind the causal effect are largely unknown. In particular, there are no studies which would have directly measured the changing

opportunity cost of parental time, or would have directly observed parental behavior during rainfall shocks – instead, the studies often simply attribute the negative effects of rainfall shocks on hypothesized change in parental opportunity cost and behavior. The desirable policy intervention, however, requires us to establish a good understanding about the mechanisms in which shock in rainfall might exert its influence on health. Since lifetime health stock is crucially determined by the health condition in utero and during the first years of life, it is important to understand the nature of the causal effect of rainfall shocks on health during these periods. Currently, the empirical evidence about the underpinnings of this link remains scant and thus limits the ability to design effective interventions. The goal of this paper is to make a contribution in this substantive area by shedding light on the mechanisms behind the rainfall shocks-child health association.

We build on and extend the work by Thai and Falaris (2010) who found that birth year rainfall shock significantly affects long term child health in the form of standardized height for age. These authors present this result in their first stage analysis of the effect of standardized height for age on the subsequent schooling outcome. Birth year rainfall shock is therefore used as an instrument for endogenous child health. Their estimates are based on an OLS regression model with fixed effects of region interactive with birth cohort using a sample of 4775 children age 6 to 20 from the 1998 Vietnam Living Standard Survey. The effect of birth year rainfall shock is not uniform but differential by region. In particular, an above average rainfall shock is favorable to child health in the rain-fed rice based region while a similar shock is associated with worsening health outcome in regions with different socio-economic characteristics.

In this paper we extend this result by exploring some possible intermediate pathways of rainfall effect in Vietnam. Recent research in developing countries documents that the

opportunity cost of parental time might play an important role in the initial formation of child health. For example, Miller and Urdinola (2010) found that parents in Colombia cut back time-related health input when the cost of time is high and vice versa, and Sonia Bhalotra (2010) discovers that higher income induces Indian mothers to have their birth delivered at private facility, to increase number of antenatal care as well as having their children treated for diarrhea and respiratory infection.

Our data which comes from Vietnam allows us to analyze how the rainfall health effect depends on the regional and individual family characteristics. Preliminary results suggest that in Rural Vietnam the effect of rainfall shocks on child health are large but context-dependent so that a positive shock is favorable to child health in the rain-fed rice based region while a similar shock has a negative health effect in other regions. Since rainfall is likely to affect the income of rural households, we further investigate if there is causal link between rainfall shock and the value of parental time. The results will help understand the rainfall-child health link and help plan efficient policy interventions.

## DATA AND METHODS

We combine two data sets: the Vietnam Living Standard Survey (VLSS) and the Vietnam Demographic Health Survey (VNDHS). Both data sets are designed to be nationally representative. The VLSS provides us with the information on anthropometric measures as well as appropriate controls for community, household and individual child characteristics. The VNDHS focused exclusively on the subject of maternal and child care such as health seeking behaviors of mothers during their pregnancy and the postnatal caring period. It also provides detailed information on the practices of breast feeding by mothers. We pool data from the 1997 and 2002 DHS surveys to obtain a sample of children with ages up to 24 months. We use the precipitation data from the Gridded Monthly Time Series (Version 2.01)

as in Thai and Falaris (2010). These sources of data are merged by birth year and by geographic information on birth location to construct those rainfall shock variables.

We first use the 1998 VLSS to estimate the impact of rainfall shocks on child health, measured by standardized height for age score, at ages 6-20. In particular, we estimate the following reduced form equation:

$$h_{ijkt} = \beta Z_{ijkt} + \gamma X_{jkt} + \delta S_{ijkt} + v_{ijkt} \quad (1)$$

where $h_{ijkt}$ is standardized height for age score of an individual child i born in year t, who lives in community j, region k; $Z_{ijkt}$ is a vector of observed individual child characteristics such as age, gender, and ethnicity, family characteristics including parents' education, number of siblings, and family socioeconomic status; $X_{jkt}$ is a vector of community characteristics; $S_{ijkt}$ measures rainfall shocks with separate coefficients by region; and $v_{ijkt}$ is the error term representing unobserved variables and heterogeneities such as parental preferences for child health, child specific attributes, as well as measurement error.

As shown below, the 1998 VLSS data demonstrates that the impact of rainfall shocks on child health in Vietnam are large and context dependent. To further shed light on the mechanisms, we turn into Vietnam DHS which allows us to directly observe parental behavior during rainfall shocks. We start with the following basic empirical models (for simplicity, for the time being we ignore the notation of index):

$$HS = h(\alpha_1 + \beta_0 Rainshock0 + \beta_1 Rainshock1 + \beta_2 Rainshock2 + \gamma_{c1} C + \gamma_{m1} M) \quad (2)$$

$$BF = g(\alpha_2 + \delta_0 Rainshock0 + \delta_1 Rainshock1 + \delta_2 Rainshock2 + \gamma_{c2} C + \gamma_{m2} M) \quad (3)$$

In these equations, HS (health seeking) denotes the behavior of parents to seek the essential health care provision for their infants such as vaccination, treatment of diarrhea and

respiratory infection etc. as well as for antenatal care. BF (Breast Feeding) is the duration or frequency of breast feeding that an infant receives from the mother up to the age of 24 months old. Rainshock0, Rainshock1 and Rainshock2 denote rainfall shock during year in utero and up to the first 24 months of life. C and M are vectors of child (gender, ethnicity, month of birth) and mother characteristics (age at birth, education, birth order, number of children etc.).

We deal with the unobserved heterogeneities that may be both region and time varying by using two main strategies as follows. First, we include in the basic model a fixed effect term with birth region interacted with birth cohort denoted by $f_{yr}$. This term captures the socio-economic changes among regions and between years that may be correlated with the two outcomes in consideration. Second, we interact the rainfall shock variables with the regional dummies denoted by the variables **Rainshock0,1,2*RegDum**. Our models to estimate thus become:

$$HS = h(\alpha_1 + \boldsymbol{\beta}\textbf{Rainshock0,1,2*RegDum} + \gamma_{c1}C + \gamma_{m1}M + f_{yr}) \quad (4)$$

$$BF = g(\alpha_2 + \boldsymbol{\delta}\textbf{Rainshock0,1,2*RegDum} + \gamma_{c2}C + \gamma_{m2}M + f_{yr}) \quad (5)$$

If rainfall shocks truly affect opportunity cost of parental time, the vectors of parameters of interest $\boldsymbol{\beta}$ and $\boldsymbol{\delta}$ in these equations should be statistically significant. Furthermore, this expected result indicates the role of regional differences in terms of direction or magnitude that a shock in rainfall is supposed to operate on the health outcome.

## PRELIMINARY RESULTS

TABLE 1 ABOUT HERE

Summary statistics for the 1998 VLSS sample are presented in Table 1. The sample that is used for the estimation of equation (1) includes 4775 children with ages from 6 to 20 years.

The proportions for boy and Kinh majority ethnicity are 52% and 88% respectively. On average, the standardized height-for-age for Vietnamese children is about 1.7 standard deviation below the median of the reference height-for-age distribution. In the sample 38% of children are categorized as stunted compared to the height-for-age distribution of the reference population (United States).

TABLE 2 ABOUT HERE

We investigate the effect of rainfall on child health in Table 2. In the first two columns, we include a fixed effect of birth region interactive with birth year in the OLS regression of height-for-age score on rainfall shocks and other controls. We estimate the effects of rainfall separately for five different regions. The estimates show that a rainfall shock significantly affects child health in all regions except the Northern Mountain, South Central and Highlands regions. Furthermore, rainfall shocks have positive effects on child health in the Red River Delta and the Northern Central regions but negative effects in others.

In the context of Vietnam it is important to take into consideration the regional variation in the composition of agricultural production in order to understand the effect of rainfall shock on child health. In the Red River Delta and North Central regions the most important crop is rice. It is likely that in these rice-based regions a positive shock is associated with a better rice harvest and possibly better children's nutrition while exposure of the household to drought could be adverse to child health. However, this is not the case for the Mekong delta which is the largest rice production area of the country. A positive rainfall shock in this region has an adverse effect on child health. Due to the difference in ecological characteristics, it is likely that positive shocks in rainfall causes undesirable floods in the Mekong delta. This could adversely affect health either via a negative income shock or via the deterioration of the health environment. The estimates also indicate that child health is negatively related to a

shock in birth year rainfall in the Southern Central, Central Highlands and Southeast regions. Farmers in these regions specialize in long term industrial crops such as coffee, rubber and perennial fruit trees whose productivity may be less sensitive to rainfall variations than is the production of rice. Those cash crop growers are better able to insure against income risks relative to small farmers in rice growing regions. Therefore, a negative shock in rainfall is not likely to affect child health through the income channel. On the other hand, it could be that higher rainfall is associated with other adverse health conditions such as increasing incidence of diseases or contaminated drinking water and that those factors negatively affect child health.

In the next two columns of Table 2, we explore whether or not a shock in rainfall varies with the Socioeconomic Status (SES) of the household. We use household income as a proxy for SES, and rank the households by income quintiles. In the regressions, we use dummy variables defined for these quintiles interacted with the rainfall shocks to capture the modifying effect of SES in the rainfall shock-child health association. Our regression also includes community fixed effect. The estimates show that the effect of a shock in rainfall is largest in the poorest households, and declines with the income of the household so that in households that are in the top two quintiles of income distribution are not affected by these shocks.

**FUTURE STEPS**

The above results motivate a further investigation of rainfall effect on health. Our preliminary results showed that the impact of a rainfall shock in child health depends strongly on the regional characteristics and on the individual family characteristics. These findings give some leeway in hypothesizing about the mechanism that could produce the effect, but a direct measurement of the impact of rainfall shock on income and parenting behavior – two

potentially important mechanisms – still needs to be done. We will continue to explore plausible mechanisms behind the rainfall shock-child health link as outlined earlier. We place our focus on one of the most important channels, the opportunity cost of parental time during the period of rainfall shock, indicated by their level of effort to invest in child health. For empirical analysis, we primarily use the VNDHS to estimate those parameters of interest regarding these mechanisms.

**References**

Banerjee, A., E. Duflo, G. Postel-Vinay, and T. Watts. Forthcoming. Long-run Health Impacts of Income Shocks: Wine and Phylloxera in 19th Century France. *Review of Economics and Statistics.*

Grant Miller, B. Piedad Urdinola, (2010)**.** Cyclicality, Mortality, and the Value of Time: The Case of Coffee Price Fluctuations and Child Survival in Colombia. *The Journal of Political Economy*, Vol. 118 (1), pp. 113-155.

Maccini, Sharon, and Dean Yang. (2009). Under the Weather: Health, Schooling, and Economic Consequences of Early-life Rainfall. *The American Economic Review*, 99(3), pp. 1006-1026.

National Committee for Population and Family Planning - The Population and Family Health Project (1999). *Vietnam - Demographic and Health Survey 1997.*

National Committee for Population, Family and Children - Population and Family Health Project, Hanoi—September 2003: *Vietnam Demographic and Health Survey 2002.*

Sonia Bhalotra (2010). Fatal fluctuations? Cyclicality in infant mortality in India. *Journal of Development Economics 9,* pp.7-19.

The World Bank. (2001). *Vietnam Living Standards Survey (VLSS), 1997-98 Basic Information,* Poverty and Human Resources Division, Washington, DC: The World Bank.

Thuan Q. Thai, and Evangelos M. Falaris. (2010). The Effect of Child Health on Schooling: Evidence from Rural Vietnam. *University of Delaware, Department of Economics Working Papers*, No.10-04.

Van der Berg, G., Lindeboom, M., Portrait, F., (2006). Economic Conditions Early in Life and Individual Mortality. *The American Economic Review*, Vol. 96 (1), pp. 290-302.

**Table 1: Summary statistics, communities, families and children ages 6 – 20 in rural Vietnam, VLSS 1998. N = 4,775**

| Variable | Mean | Std. Dev. | Min | Max |
|---|---|---|---|---|
| Height-for-age (z-score) | -1.71 | -0.97 | -4.98 | 3.26 |
| Gender (1 if male) | 0.52 | 0.50 | 0.00 | 1.00 |
| Age | 12.05 | 3.65 | 6.00 | 20.00 |
| Ethnicity (1 if Kinh) | 0.88 | 0.33 | 0.00 | 1.00 |
| Stunted | 0.38 | 0.48 | 0.00 | 1.00 |
| Father's schooling | 7.55 | 2.97 | 1.00 | 19.00 |
| Mother's schooling | 6.50 | 3.00 | 1.00 | 15.00 |
| Number of siblings | 3.24 | 1.37 | 1.00 | 9.00 |
| Log of per capita expenditure | 7.04 | 0.36 | 5.64 | 9.59 |
| Northern mountain | 0.19 | 0.39 | 0.00 | 1.00 |
| Red river delta | 0.19 | 0.39 | 0.00 | 1.00 |
| North Central | 0.16 | 0.37 | 0.00 | 1.00 |
| Southern Central | 0.10 | 0.30 | 0.00 | 1.00 |
| Central Highlands | 0.08 | 0.27 | 0.00 | 1.00 |
| Southeast | 0.10 | 0.30 | 0.00 | 1.00 |
| Mekong delta | 0.18 | 0.38 | 0.00 | 1.00 |
| Birth year rainfall shock (% from mean) | -0.24 | -0.33 | 1.90 | 0.35 |

**Table 2 - Estimates of the rainfall shock effect on child health**
Dependent Variable: Height-for-age z-score

| Variables | Without SES[a] | | With SES | |
|---|---|---|---|---|
| | b | t[b] | b | t[b] |
| Gender (1 if male) | -0.172*** | -6.04 | -0.160*** | -5.85 |
| Ethnicity (1 if Kinh) | -0.049 | -0.65 | -0.013 | -0.16 |
| Father's schooling | 0.014* | 2.21 | 0.011 | 1.63 |
| Mother's schooling | -0.003 | -0.37 | -0.006 | -0.85 |
| Number of siblings | -0.045** | -2.75 | -0.033* | -2.11 |
| Shock in northern mountain | -0.041 | -0.26 | | |
| Shock in Red River & North Central | 0.574** | 3.07 | | |
| Shock in South Central,Higlands | -0.332 | -1.49 | | |
| Shock in Southeast | -1.168*** | -7.64 | | |
| Shock in Mekong Delta | -0.417** | -2.7 | | |
| Age | | | -0.073*** | -13.92 |
| Rainshock with 1st income quintile | | | 0.212+ | 1.86 |
| Rainshock with 2nd income quintile | | | 0.126+ | 1.73 |
| Rainshock with 3rd income quintile | | | 0.148+ | 1.72 |
| Rainshock with 4th income quintile | | | 0.043 | 0.5 |
| Rainshock with 5th income quintile | | | -0.115 | -1.1 |
| F | 11.94 | | 28.06 | |
| p-value | 0 | | 0 | |
| N | 4775 | | 4775 | |

+ p<0.10, * p<0.05, ** p<0.01, *** p<0.001

[a] An overall intercept and fixed effects for region and birth year are also included.
[b]The estimates of the standard errors take account of the clustering of observations by commune.