Multiple early-life shocks, skill formation and parental responses: the case of Indonesia

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Abstract
This paper analyzes the effects of multiple early-life shocks in Indonesia on children's human capital and parental responses to these shocks. We exploit time and geographical variation of Indonesia's forest fires during the El Nino phenomenon in 1997 and the economic crisis in 1997-98. Children affected by these shocks have worse health and cognitive outcomes relative to children not exposed to these shocks. The persistence of these outcomes is affected by the severity of the initial effects and subsequent parental response. Since parental responses are creates an empirical question with important implications for policies that aim to mitigate early disadvantages.

I. Introduction and theoretical focus

A large body of research in epidemiology and economics has established the persistent role of early life influences on later life human capital accumulation and adult well-being (Barker, 1995; Gluckman and Hanson, 1995; Heckman, 2007; Almond and Currie, 2010; Currie and Vogl, 2012). As a source of variation in child early endowments, this literature has analyzed different types of shocks such as exposure to pandemics, famine, extreme weather, natural disasters, pollution, and violence (For example: Almond, 2006a; Kelly, 2011; Almond et al., 2010; Meng and Qian, 2009: Dercon and Porter, 2010; Akresh et al., 2012; Leon, 2012; Black et al., 2013; and Shah and Steinberg, 2012. See Currie and Vogl, 2012 for a review). However, the evidence from these studies relies on different populations and contexts, time periods and methods (Almond and Currie, 2010). Thus, it is difficult to draw conclusions about the relative magnitudes of the negative consequences of different shocks or about possible interactions between them if children are exposed to multiple shocks.

In addition, parental investments in human capital can reinforce or mitigate early disadvantages, and there is little evidence about how these investments respond to endowment shocks (Almond and Mazumder, 2013). Theoretically, according to the traditional intra-household resource allocation literature, family investment decisions depend on efficiency concerns and preferences regarding aversion to inequality, and this trade-off predicts ambiguous responses (Becker and Tomes, 1976; Berhman, Pollack and Taubman, 1982). Also, according to the framework of technology of skill formation by Heckman and Cunha (2007), the dynamic complementarities between skills and investments imply that early endowments influence the return of later human capital investments, which could provide incentives for parents to reinforce negative shocks to child endowments.

This paper contributes to the literature on early life influences by addressing these two questions using a household panel data from Indonesia, collected between 1993 and 2007. We first analyze the relative magnitudes of two types of early life shocks, and then analyze the parental responses to these shocks. The first set of outcomes of interest includes health and cognitive outcomes. The second set of outcomes includes parents' investments on children's health and education. We exploit geographic and time (cohort) variation in exposure to two shocks: the severe forest fires during el Nino in 1997, and the following economic crisis in 1997-1998.

II. Data and Method

Data

This paper uses four waves of the Indonesian Family Life Survey (IFLS). The first wave was conducted in 1993 (IFLS1), followed by the second wave in 1997 (IFLS2), the third wave in 2000 (IFLS3), and the fourth one in 2007 (IFLS4). The IFLS is representative of about 83% of the Indonesian population in 1993. The survey oversampled urban areas and areas outside of the main island of Java. The IFLS contains rich information on community, household, and individual characteristics. Individual characteristics include height and weight, age, education, marital status, as well as complete pregnancy history for women between the ages of 15 and 49. In addition to the household surveys, the IFLS includes community surveys for the village head, the head of the women's group, schools, and health practitioners. Information from these sources is then combined to create a Service Availability Roster (SAR) for each community from the second wave onwards.

IFLS1 included 7,224 households residing in 321 enumeration areas in 312 communities in 13 of Indonesia's 26 provinces in 1993. Subsequent waves of the survey sought to re-interview all households in IFLS1, as well as split-off households. About 90% of households were re-interviewed, these high rates lessen the risk of bias due to non-random attrition.

There are two types of outcomes of interest in this study. The first group is children's human capital outcomes: birth weight, anemia status, height for age, and cognitive skills. Cognitive assessments correspond to the Raven's Colored Progressive Matrices (CPM). The second group is parental investments and behavioral responses. We consider investments related to health (vaccinations), and education (attendance and age at elementary school entry, and hours spent studying). We also look at parental response in birth spacing. Birth spacing is an outcome of interest because the effect may be ambiguous in relation to the income shock. On the one hand, the income effect from the lower income means that parents will delay the conception of the next child if children are considered a normal good. On the other hand, the negative income shock generates a substitution effect, which lowers the opportunity cost of time. This implies that conception of the next child would be sooner since time at home is cheaper. Thus the birth spacing responses to the income shock are ambiguous. For the case of the pollution shock, one would expect that because of the health consequences on the affected child, families may delay the next pregnancy.

To assess exposure to the two types of shocks, we match the IFLS data with gridded information on ozone levels from the Earth Probe Total Ozone Mapping Spectrometer – NASA, and with information on inflation at the province level from Statistics Indonesia (*Badan Pusat Statistik*).

Preliminary analysis

Table 1. Children's human capital outcomes

	Unexposed children			Exposed children			
	Mean	SD	N	Mean	SD	N	p-value
Any prenatal care	0.939	0.239	788	0.942	0.234	654	0.85
Trained delivery assistance	0.598	0.491	788	0.627	0.484	654	0.29
Facility-based delivery	0.437	0.496	788	0.462	0.499	654	0.40
Gestational age (weeks)	36.055	1.760	717	36.382	2.558	591	0.01**
Birth weight (grams)	3,189.5	583.2	602	3,118.9	549.4	522	0.04**
Low birth weight (<2,500 gr)	0.128	0.334	602	0.161	0.368	522	0.10*
Newborn was smaller	0.157	0.364	783	0.164	0.370	653	0.79
Height for age in 2000	-1.740	1.267	761	-1.880	1.516	663	0.05*
Weight for age in 2000	-1.499	0.914	733	-1.648	1.110	617	0.01**
Weight for height in 2000	-0.592	1.079	723	-0.717	1.280	589	0.01**

Notes: Exposed children are the ones born in 1998, they are potentially exposed to el Nino forest fires , economic crisis, or both. Unexposed children are those born in 1996, before the shocks occurred. *p<0.1, **p<0.05, ***p<0.01.

For this preliminary analysis, we define the exposed children as those born in 1998 while the unexposed children are the ones born in 1996. Children born in 1998 are potentially exposed and unexposed to any of the shocks considered here—pollution from el Nino forest fires, income losses from the economic crisis, or both. Table 1 presents the comparison between the health outcomes of the exposed and unexposed children. In-utero investment in the form of prenatal care is similar in both groups, as well as the use of trained delivery assistance and facility-based birth. Although the average gestational age is slightly higher in the exposed group, this group has a lower average birth weight and the incidence of low birth weight is higher. This may suggest that the deterioration of health at birth is not coming from shorter gestational age but from intrauterine growth restriction, which is related to nutrition. When we compare children in these groups in 2000, exposed children (at age two years) are worse off in terms of their nutritional status compared to the unexposed children (at age four years)[1]: the z-scores for height for age, weight for age, and weight for height are lower in the exposed group. These suggest the negative effects of the 1997-98 shocks on children's outcomes.

From this preliminary descriptive analysis, we cannot infer causality, and we cannot distinguish exposure to the two different types of shocks. The next section describes the methodology we will use to study the relative magnitude of these shocks on children human capital and parental responses.

III. Empirical strategy

We merge the household and children data from the IFLS with detailed pollution data at the district level and unemployment and inflation at the province level.

This paper relies on variation to negative conditions during early childhood from two natural experiments: pollution from the forest fires in 1997 and income shock from the economic crisis in 1997-98. We exploit birth cohort variation (detailed information on month and year of birth), and geographic variation in the exposure to the shocks.

$$Y_{i,b,p,d} = \alpha_0 + \sum_{k=-1}^{5} \delta_k Exp\_Fires97_{i,b,d,k} + \sum_{k=-1}^{5} \gamma_k Exp\_crisis97\_98_{i,b,p,k} + X_{i,b,p,d}\beta + \theta_b + \mu_d + \varepsilon_{i,b,p,d}$$

i represents child, *b* birth cohort (defined by month and year of birth), *p* province of birth, and *d* district of birth.

Definition of the exposure variables:
$Exp\_Fires97_{i,b,d,k}$ = this variable captures exposure to high pollution levels during de episode of forest fires between August 1997 and November 1997. Because the IFLS contain information of children born several years before this shock, they can be exposed at different developmental periods. Therefore, we distinguish from exposure in utero (k=-1), and yearly during early childhood (from age 0 to 5).

Following Jayachandran (2009), to calculate exposure, we rely on daily data of the aerosol index from the Earth Probe Total Ozone Mapping Spectrometer - NASA. This index captures information of the level of smoke, dust and volcanic ashes based on satellite measurements. The data is arranged in a grid format with resolution 1^0 latitudes X 1.25 ^{0} longitudes.
The index ranges from -2 to 7. Forest fires are one of the largest sources of aerosol, which cause an increase in the index (Asiati and Hidayati). According to Jayachandran (2009), the

[1] Anthropometric measures are only available in the survey years. While the children are not compared at the same age, the same WHO standardization is used for the z-scores.

mean of the index during the 1997 fires period (August-October 1997) was 0.58, while the mean was 0.05 during the same months a year before.

To compute the measures of exposure, we perform the following steps. From daily data on the index, we get a monthly measure as the median of the daily values (as in Jayachandran (2009)). We will use alternative approaches instead of the median. Then, we aggregate them at the in utero or year level by taking an average of the monthly measures.

Similarly, $Exp\_crisis97\_98_{i,b,p,k}$ measures exposure to the economic crisis for each child and each developmental period of early childhood. To calculate this variable, we use the year-to-year inflation rate for each month in each period at the province of birth. To aggregate the monthly inflation at the in utero or year after birth level, we take the average. Before the crisis, inflation was less than 10% and during 1998 prices increased around 57% (food prices increased by 97%). This translates into a decrease in real wages between 30-50%, which meant a significant income shock (Jones and Mardsen (2010) based on ILO, data 1996-2000).

We control for family child and regional socio demographic characteristics (X) such as child gender, birth order, and maternal education. We also add year of birth fixed effects and district fixed effects. Y represents the outcome of interest: children's human capital, and parental investments in health, education, and birth spacing.

This empirical strategy will compare the average outcome of children suffering a negative shock in a particular developmental period with both: 1) children in different birth cohorts that did not suffer that shock in that period and were born in the same district, and 2) same cohort children born in places less affected by the shock. By including exposure to two different types of shocks on the same population we can compare the relative magnitudes.

We will also explore heterogeneous effects by socio-economic status, since we expect financially constrained households to not be able to protect their human capital investments. Lower socio-economic status families may reinforce the shocks to endowments while higher status families may be able to compensate or mitigate children's early disadvantage. This potentially translates to more persistent effects on later childhood outcomes for children from disadvantaged families. In terms of the relative magnitude of the two shocks, we expect pollution to be more detrimental in-utero and in infancy, when their immune system is still under development (Currie et. al, 2013). However, the income shock from the crisis may be detrimental for both younger and older children.

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