Determinants of Infant Mortality in Indonesia

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List of Acronyms

CMR	Child Mortality Rate
GEE	Generalized Estimating Equations
IDHS	Indonesia Demographic and Health Survey
IMR	Infant Mortality Rate
LDCs	Less Developed Countries
MDG	Millennium Development Goal
NMR	Neonatal Mortality Rate
NSS	Nutritional and Health Surveillance System
OLS	Ordinary Least Squares
ORS	Oral Rehydration Solutions
UMR	Under-five Mortality Rate
UNICEF	United Nations Children's Fund
UNDP	United Nation Development Programme
WDI	World Development Indicators
WHO	World Health Organization

Abstract

Reduction of under-five mortality rate by two-thirds between 1990 and 2015 is a Millennium Development Goal (MDG). Indonesia has been on track in achieving the MDG target on under-five mortality. However, slower progress on infant mortality reduction shows that more attention should be given in order to improve the survival of younger children. Motivated by this situation, this study attempts to identify determinants of infant mortality in Indonesia between 1997 and 2012 using the 4th, 5th and 6th rounds of the Indonesia Demographic and Health Survey (IDHS) data. In addition, the study aims to identify externalities which may be generated by investments in mother's education, water and sanitation, and child vaccination by a household's neighbors. The conceptual framework is based on Mosley and Chen (1984). Logistic regressions are used to estimate the effect of a variety of factors on infant mortality.

The regression results shows that bio-demographic factors which include child and maternal traits are key predictors of infant mortality in Indonesia. Male sex, birth multiplicity, higher birth rank, shorter birth interval, mother age above 35 years, and complication during pregnancy are positively related to infant mortality. Behavioral practices such as institutional delivery, knowledge of Oral Rehydration Solutions (ORS), and especially contraceptive practice are also important factors that negatively related to infant mortality. Moreover, household's hygiene characteristics such as safe drinking water source, private toilet, and improved flooring materials are also important factors that increase infant survival status in Indonesia. Some socio economic variables are also found to be significant determinants of infant mortality in Indonesia. Among the various factors, the number of household members is the strongest factors related to infant mortality. At the community level, Sumatra and Kalimantan regions in 2012 have lower odds of infant mortality, whereas Sulawesi region in 2007 has higher odds of infant mortality as compare to Java and Bali. Furthermore, the study finds that immunization participation in the community has a positive spillover effect on infant survival status.

Relevance to Development Studies

Beside economic achievement, the level of development in a country is also reflected in the health status of its people. Several health indicators, including mortality rate in young children, have been used by the United Nation Development Programme (UNDP) as measurements of poverty. The literature suggests that the high numbers of Child Mortality Rate (CMR), Infant Mortality Rate (IMR), and Neonatal Mortality Rate (NMR) exist in the Less Developed Countries (LDCs). Indonesia, a middle income country in South East Asia has been successful in reducing child mortality, but has not yet made enough progress in reducing infant and neonatal mortality. Situation analysis is needed to identify factors which may provide insights on how greater progress may be achieved.

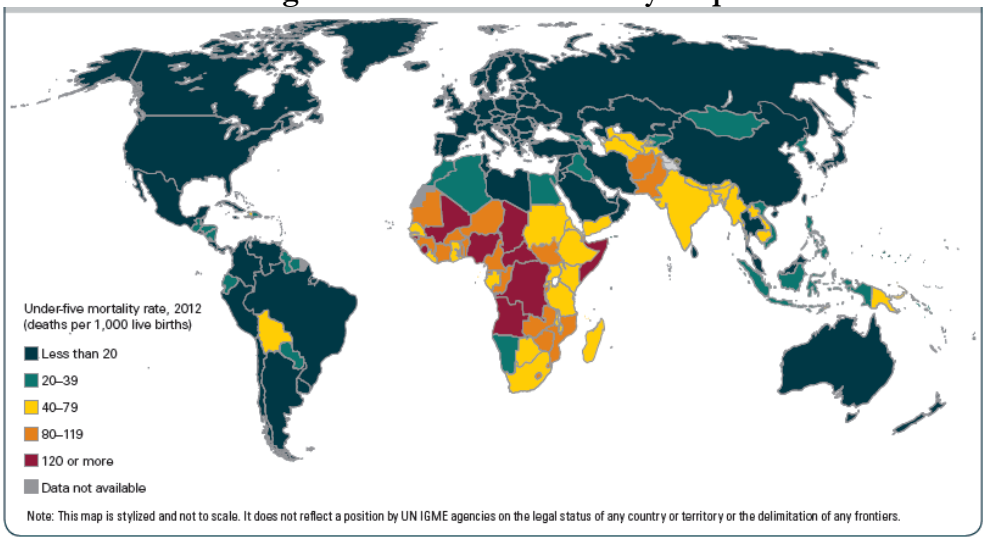
Keywords

Infant mortality, externalities, logistic regression, Indonesia, socio economic, determinants

Chapter 1
Introduction

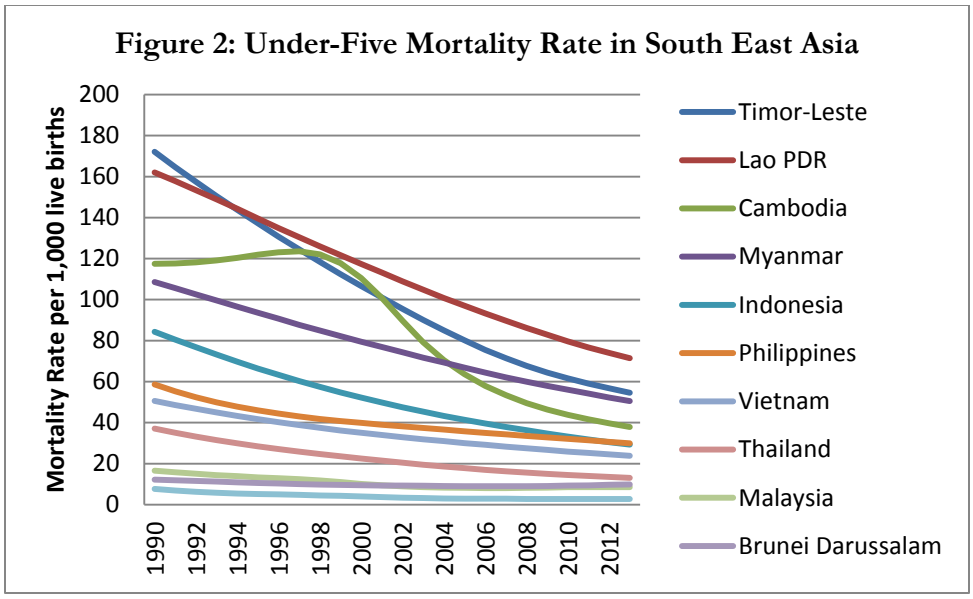
Health status of the nation is one of the important factors that represent the success of development of a country. One of the goals of UNDP (United Nation Development Programme) is to reduce child mortality. The reduction of Under-five Mortality Rate (UMR) by two third has been the target of Millennium Development Goals (MDGs) between 1990 and 2015. According to data from UNICEF (2013), as illustrated in figure 1, under-five mortality has been relatively high in Africa and the South Asia region. In South East Asia, UMRs in 2013 are generally less than 20 deaths per 1,000 live births in the countries that have shown better economic performance. On the other hand, in lower middle income and low income countries the rates vary from above 20 to below 80 per 1,000 live births.

Figure 1 Under-Five Mortality Map



Source: United Nations Children's Fund (2013)

As a developing country in South East Asia, the condition of child survival status in Indonesia has been in the middle position. The graph in figure 2 illustrates UMR in South East Asian countries from 1990 to 2013. Although the initial rate in 1990 was higher, Indonesian UMR in 2013 was at par with the Philippines in the range 29 deaths per 1,000 live births. From 1990 to 2013, the UMR in Indonesia has been lower than Lao PDR, Myanmar, Cambodia, and Timor-Leste. However, to be compared with this group of countries, the economic and political situation of Indonesia has been relatively stable for the last fifteen years. To be compared with the countries that have also been economically and politically stable after the 1997 East Asian crisis like Malaysia, Thailand, Vietnam, Singapore, and Brunei Darussalam, the condition of child survival status in Indonesia is still left behind these countries.

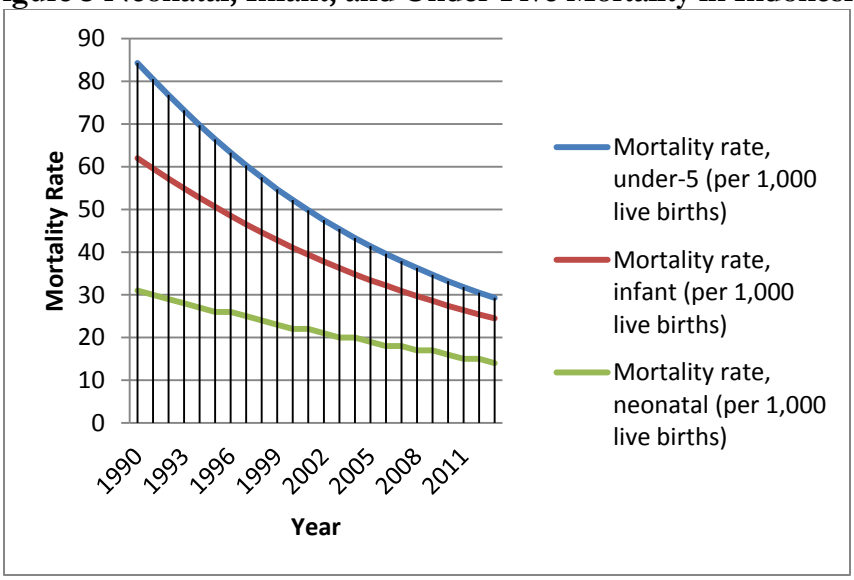


Data Source: The World Bank 2015

The trend of reduction in child, infant, and neonatal mortality in Indonesia from 1990 to 2013 shows a positive track (see figure 3). Indonesia has gradually reduced child mortality rate by 65.24% from 84.3 deaths per 1,000 live births in 1990 to become 29.3 deaths per 1,000 live births in 2013 with an average annual decline of as much as 4.49%. On the other hand, declines in infant mortality and neonatal mortality rate have been slower (3.96% and 3.40%). Infant Mortality Rate (IMR) has decreased by 60.48% from 62 per 1,000 live births in 1990 to become 24.5 per 1,000 live births in 2013. Furthermore, the reduction of children who died in the first month of their lives has declined by 54.48%; from 31 per 1,000 live births in 1990 to become 14 per 1,000 live births in 2013 (The World Bank 2015). This means that while Indonesia is on track in achieving MDGs target on reduction of under-five child mortality, the slower decline in infant and neonatal mortality shows that additional efforts are needed to accelerate improvement in infant survival status.

Although the rate of under-five mortality has sufficiently decreased, the reduction has mainly occurred in older children. The proportion of infant mortality in total child mortality has increased from 73.81% in 1990 to 83.62% in 2013.Study and analysis of infant mortality in Indonesia is needed since the factors that affect infant mortality are not identical to the determinants of under-five child mortality. Identifying the important factors that affect mortality of infants is the purpose of this study as it would help design strategies to reduce early age death in Indonesia. While there are previous studies, an updated is needed to explain the current phenomenon.

Figure 3 Neonatal, Infant, and Under-Five Mortality in Indonesia



Data Source: The World Bank data 2015

Indeed, there are not many studies that have investigated the factors that affect infant and child mortality in Indonesia using pathway analysis that links immediate and socio economic factors that directly and indirectly increase the risk of infant and child mortality. Some studies focus only on immediate factors, while other studies focus only on socio economic factors. A previous study on that usespathway analisys was conducted by Titaley et al. (2008). In the study, the authors investigate the determinants of neonatal mortality in Indonesia using a 2002-2003 IDHS data. They came with the evidence that immediate factors such as bio-demographic and behavioral factors, as well as socio economic factors significantly influence neonatal mortality in Indonesia.

This paper attempts to identify which factors amongst various sets of variables - biological, demographic**,** behavioral, environmental, social, and economic aspects -affect infant mortality in Indonesia. In order to determine trends in infant mortality determinants during the past 15 years, the study uses IDHS data that are collected in 3 waves survey (2002-2003, 2008, and 2012 survey). Furthermore, the paper also examines externalities -that is, the community effects of mother's education, water and sanitation infrastructure, and child immunization participation on infant mortality in Indonesia. As most previous studies on infant and child survival have emphasized the direct effect of own household's investment to individual health outcomes, the recent literature has given more attention to the indirect effects exerted by investments decision made by other households in the community.

The paper continues as follows. In chapter 2, this paper discusses a conceptual framework and reviews the empirical literature. Next, the research methodology that consists of empirical specification, variable definition, and descriptive statistics is discussed in chapter 3. In the fourth chapter, the paper discusses regression results on the determinant of infant mortality and the externalities impact from neighborhood investment. Finally, the conclusion of the paper is given in chapter 5.

Chapter 2
Theoretical Framework

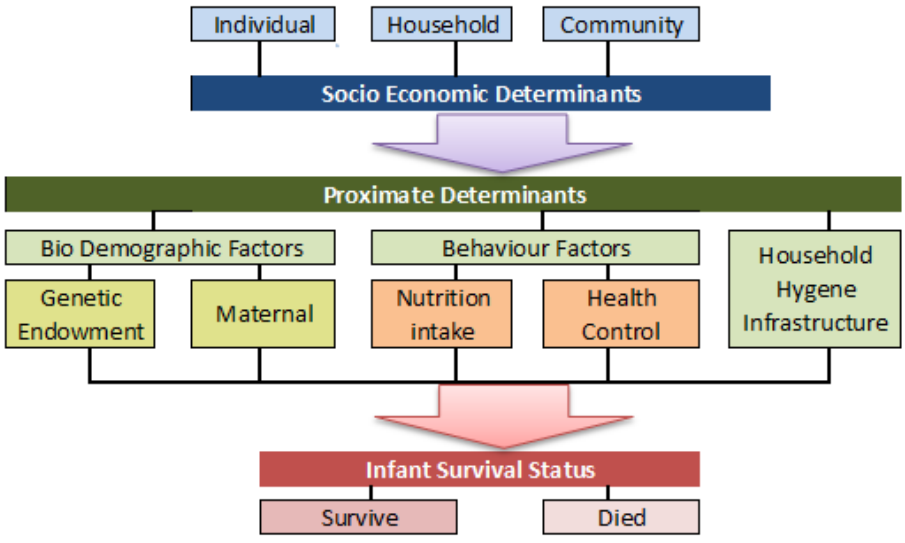
In this chapter, the conceptual framework built for the study is discussed in the first section. After that, the second section provides a review of related empirical literature.

2.1 Conceptual Framework

According to the theory of household production of health, household utility function represents "a dynamic behavioral process through which households combine their (internal) knowledge, resources, and behavioral norms and patterns with available (external) technologies, services, information, and skills to restore, maintain, and promote the health of their members" (Berman, et al. 1994 : 206). In addition, household choice and opportunity to maximize satisfaction are constrained by conditions such as socio economic factors at the individual, household, and community level. Child survival status function, derived from constrained utility maximization, is a function of several factors that may affect child mortality. These factors are classified by Mosley and Chen (1984) as intermediate causes of death, so called proximate determinants and socio economic factors that influence the risk that an infant is affected by proximate determinants.

In order to investigate the factors that determine infant mortality in Indonesia, this paper builds a conceptual framework (see figure 3) which is an adaptation of Mosley and Chen's (1984) analytical framework. Some adjustments to the framework are made based on other literature on infant and child mortality. Mosley and Chen (1984) proposed a theoretical framework for studying determinants of child survival in developing countries. They link the conceptual model of social science and medical science approach to study child survival status. While social science approach focuses on the relation of socioeconomic factors and child mortality, medical science focuses on the immediate causes of morbidity and mortality.

Figure 3: Conceptual Framework: Determinant of Infant Mortality



Source: Author, adapted from Mosley and Chen's (1984) analytical framework

In their theoretical framework, Mosley and Chen (1984) incorporated the socioeconomic factors and biological factors that may affect child mortality. The biological factors that directly cause child morbidity are the factors that increase the risk of dying in young children. They call these factors intermediate or proximate variables since socioeconomic factors indirectly affect child survival status through these variables.

In addition to the biological factors incorporated by Mosley and Chen, additional literature identifies other factors that may affect child mortality. In DHS comparative studies on infant and child mortality, Sullivan et al. (1994) classified child sex, birth rank, intervals from previous birth, birth multiplicity, and mother age at birth as biological factors that are related to the inherent risk of child mortality. Bicego and Ahmad (1996), then classified the factors as bio-demographic differentials. In this paper, bio-demographic determinants are classified into two groups. First factors are genetic endowment which represents biological factors that are genetically endowed by the child. For example sex, births rank and birth interval, being singleton or twin, birth weight, and size at birth. The second factors are biological and demographic factors that affect infant mortality trough the health and fertility status of the mother, for example mother age when deliver the baby, complications during pregnancy, and problems that occur during labor and delivery.

The second proximate determinants of infant mortality investigated in the paper are categorized into behavior factors. In this paper, the behavioral factor is divided into two categories. First category is nutrient intake factors that consist of the practice of giving nutrition to the child, for example breastfeeding practice. The next category, health control is related to the household effort in order to prevent the child illness and the medical treatment taken to cure the disease, for example taking antenatal care during pregnancy, delivering baby at medical facility, giving postnatal care for newborn, and knowledge on Oral Rehydration Solutions (ORS) to cure diarrhea. In addition, health control also includes other activities of health seeking behaviors such as using contraception to control birth spacing.

The third proximate determinants are household hygiene infrastructure. These factors are environment contaminations that affected by the hygiene condition inside the household. The contaminations can be occur in the household's source of drinking water, the practice of disposal of human excreta in the dwelling, and contacts to parasitic agents from unimproved type of flooring materials

The socio economic determinants examined in this paper are divided into three categories:

1. Individual level variable includes factors that determine productivity of child rearing. For example, parental education, maternal employment status, and women empowerment such as attitude toward beating and decision making in the household.
2. Household level variable includes household's social and economic condition that affect infant mortality trough the proximate variable. For example household's fixed assets, wealth index, and access to health care.
3. Community level variable consists of type of place of household's residence, such as rural or urban area and the region of the household that is divided into five regions according to the main islands in Indonesia. In addition, the variables also include household's investment in mother's education, water and sanitation infrastructure, and child's immunization in the community.

2.2 Empirical Review

Determinants of Infant Mortality

There are a number of cross-countries studies that have sought to identify the determinants of infant mortality in developing countries. Using 86 DHS data collected in 56 countries from 1986 to 1998, Rutstein (2000) investigated the factors related to the trends of infant mortality in Less Developed Countries (LDC) in the 1990s. The regression results from Ordinary Least Squares (OLS) method show that fertility behavior factors such as child birth rank, child birth interval, and mother age at birth are associated with the change in infant mortality in this period of time. In addition, behavioral factors such as health prevention care and treatment for diarrhea, as well as good nutritional intake practice are related to the decline of infant mortality. On the other hand, poor household hygiene such as surface water source and dirt floor related to an increase in infant mortality. Some socio-economic variable are also important to the change of infant mortality in developing countries, for example access to electricity and mother's education level.

Another cross-country study is provided by Wang (2002). He collected DHS data from 61 countries which were conducted from 1990 to 1999 and combined the survey data with macroeconomics data from the World Development Indicators (WDI). The results from OLS regressions indicate that socio- economic variables such as national income per capita, the share of health expenditure in national income, and access to electricity are important determinants of infant child mortality at national level. The other important factors are sanitation facilities and vaccination coverage. However, when the regression is separated based on the type of the region, the variables are not significant in rural area and only electricity and health expenditure are significant in urban area.

In cross-countries study on the effect of birth interval on infant mortality, Rutstein (2005) used DHS data from 17 developing countries from 1990 to 1997. He found that longer birth intervals decrease the risk of mortality. In a further study, Rutstein (2008) collected 52 DHS surveys conducted from 2000 to 2005 and found that the highest risk of infant mortality appears if the birth to pregnancy interval is less than 24 month. In addition, a conception which occurs between 24 to 59 months after previous birth has lowest risk of infant mortality.

Several individual country studies on the determinants of child mortality have been conducted using cross-sectional data obtained from national surveys. Mutunga (2007) investigated the factors associated with under-five mortality in Kenya by using a hazard rate model. Focusing on household environmental characteristics, the paper suggests that drinking water source, sanitation facilities, and source of cooking fuels are important determinants of child mortality. In addition, bio-demographic factors as well as socio-economic factors are also important. Mekonnen et al. (2013) used pooled cross-section data from 3 DHS survey to examine the determinants of neonatal mortality in Ethiopia. The results of multivariate analysis using hazard Cox model suggest that bio-demographic determinants such as child sex, mother age, and birth interval are the significant variables. Other factors such as tetanus injection, season, and mother's education are also important determinants. Other cross-sectional studies on child mortality conducted in several developing countries also found evidence that bio-demographic factors, behavioral factors, household hygiene infrastructure, and socio economic factors are closely related to neonatal, infant, and under-five mortality. For example, the study conducted by Pandey et al. (1998) in India, Agha (2000) in Pakistan, Chowdury et al. (2010) in Bangladesh, Aderinwale (2013) in Nigeria, and Dejene and Girma (2013) and Hassen (2014) in Ethiopia.

There are not many papers that have investigated mortality amongst younger children in Indonesia, and papers using relatively recent data are rare. Focusing on family income inequality, the study conducted by Poerwanto et al. (2003) examined the effect of family welfare on infant mortality in Indonesia. They used 1997 IDHS data and analyzed the data using a logistic regression model. The results from Generalized Estimating Equations (GEE) estimation show that family welfare and maternal education are important factors related to infant mortality. Poor family and lower level education of mother increased the odds of infant mortality.

The study by Frankenberg (1995) focuses on health care access and measured the effect of household's access to health personnel and medical facilities on infant mortality. The research used 1987 DHS data combined with infrastructure data collected from village level censuses. The results from OLS-fixed effect model show that the risk of dying among children younger than 1 year old is attributed to the number of doctors and maternity clinics in the village. Adding a doctor or a maternity clinic in the village might decrease the mortality risk by 1.7% and 15%.

Mellington and Cameron (2006) conducted a cross-sectional study using multivariate probit analysis to investigate the association between female education and under-five child mortality. They used 1994 IDHS data and found that primary and secondary education is important to reduce mortality in children below 5 years old. Other studies that focused on the relationship between parent education and child mortality were conducted by Breierova and Duflo (2004). They used data from inter-censal survey of Indonesia collected in 1995 combined with district level data on school construction program and analyzed the data with OLS and two stages least squares (2SLS) models. They found that both maternal and paternal educations are important factors to reduce neonatal, infant, and under-five child mortality in Indonesia.

Hatt et al. (2009) used pooled data from 1991, 1994, 1997, and 2002-2003 IDHS in a study that focused on birth attendance and early neonatal mortality in Indonesia. The results from multivariate logistic regression showed that higher risk of early neonatal mortality exists in delivery at public medical facilities, and home birth assisted by a professional attendance is not significantly different from home birth without medical personnel supervision. Similar to Hatt et al. (2009), Alamsyah (2009) also found that the presence of skilled birth attendance at delivery does not significantly affect infant mortality. Alamsyah used panel data covering the period 2001 to 2006, and taken from Indonesia's National Socioeconomic Survey combined with public health expenditure to investigate the effect of health expenditure and professional birth attendance on infant mortality in Indonesia. The results from OLS - fixed effect regression show that skilled birth attendance only gives important effect when the variable is interacted with per capita health expenditure. On the other hand, the study conducted by Shrestha (2010) found a different result. Using the data from 1993, 1997, and 2000 Indonesia Family Life Survey combined with the data from village midwife program, the result from OLS-fixed effect model indicates that existence of a village midwife in the community is negatively related to infant and neonatal mortality at 10% significance level.

The study conducted by Semba et al. (2008) measured the effect of paternal smoking on infant and under-five child mortality in Indonesia. Using data from Nutritional and Health Surveillance System (NSS) collected between 2000 and 2003, the multivariate logistic regression results show that the odds of infant and under-five mortality, both in rural and urban area are higher in the family with a father who smokes. Using the same source of the data, Campbell et al. (2009) studied the association between food insecurity and neonatal, infant, and under-five mortality. They used a multivariate logistic regression model and found that the households with lower score on food insecurity have

higher odds of neonatal and infant mortality. The other study that focused on immediate cause of under-five child mortality was conducted by Semba et al. (2011) by using the data from 1999 to 2003 NSS survey. They examined the relationship between improved sanitation with prevalence of diarrhea and under-five mortality. The results from multivariate logistic regression model indicate that unimproved latrine increased the risks of diarrhea and under-five mortality in both urban and rural area.

A previous study on younger children mortality in Indonesia that uses path analysis was conducted by Titaley et al. (2008). In the study, a logit model was used to investigate the determinants of neonatal mortality in Indonesia. The data used in the study was taken from 2002-2003 IDHS and the analytical framework built in the study was adopted from Mosley and Chen (1984). The regression results suggest that bio-demographic factors such as sex, birth size, birth weight, birth rank, birth interval, and delivery complications are the key determinants of neonatal mortality. At individual level, the socio-economic factor that related to neonatal mortality is parental employment status. At the community level, parental education, household wealth index, number of antenatal and postnatal visits in the cluster and regional effects are important determinants of neonatal mortality in Indonesia.

Effects from Neighborhood Investment

Some recent literatures suggest that there are indirect effects from access of water and sanitation in the community on child survival status. Geruso and Spears (2014) used 1992-1993, 1998-1999, and 2005-2006 Indian National Family Health Survey data and analyzed the data with OLS method. The study found that to be compared with household own practice, community practice of open defecation has greater impact on increasing infant mortality in India. Similarly, Günther and Fink (2010) who conducted cross-countries study on water and sanitation infrastructure found externalities effect from sanitation hygiene practices. The panel data were taken from 172 DHS data from 70 developing countries collected from 1986 to 2008, and OLS fixed effect models were used in the analysis. The empirical evidence suggests that there were positive externalities from access to safe excreta disposal at the village and urban community. Living in the community that has better sanitation infrastructure decreases the risk of child mortality caused by diarrhea. The study by Andres et al. (2014) also found externalities impact from sanitation. A parametric model using probit regression was used to analyze a survey data from rural Indian households. The research showed that the level of improved sanitation usage in the household neighborhood decreases the prevalence of diarrhea in rural India.

Some studies also came with the evidence that household's investment in water and sanitation infrastructure and a mother's education at the community level creates health spillovers on child nutritional status. Gragnolati (2000) conducted a cross-sectional study on child growth using a national household survey from Guatemala. He used OLS method to examine the effect of water and sanitation infrastructure in the community on children height-for-age indicators. The research showed that households' access to pipe water in the cluster improves children nutritional status. However, the contrary result appeared in rural community access to improved sanitation; access to improved toilet related to the higher risk of under nutrition A cross-sectional study conducted by Alderman et al. (2001) using national household survey in Peru also supports the externalities impact from household investment. The results from linear regression models indicate that beside household's own practice of safe drinking water and sanitation, the practice of using improved toilets in the community increases the nutritional status of Peruvian children. In addition, they also

found that educational level of other mothers in the community determines child nutritional status in Peru. Using the same theoretical framework as Alderman et al. (2001), Silva (2005) used a probit model to investigate externalities from water and sanitation infrastructures and maternal education on children nutritional status in Ethiopia. The empirical evidence suggests that the community access to safe drinking water and safe excreta disposal reduce the probability of child under nutrition in Ethiopia.

Additional cross-sectional studies have shown that investment in mother's education exerts externalities effect on child nutritional and survival status. Moestue and Huttly (2007) found that the average level of mother literacy in the household's neighborhood increase child nutritional status in Vietnam. Similarly, the study conducted by Kravdal (2003) using hazard model and logistic regression estimation found that at the community level, outcomes from increasing education of other mothers in the neighborhood significantly reduces child mortality in India.

Chapter 3
Methodology

3.1 Data Source

This study uses the 4th, 5th, and 6th rounds of the Indonesian Demographic and Health Surveys (IDHS) collected in 2002-2003, 2007 and 2012. The surveys collect information on health aspects, demographic and socio economic characteristic of the respondent and household. The datasets used in the study are taken from the child database that contains information on the birth histories of children who were born up to five years preceding the survey from mothers aged 15 to 49 years during the interview. The dataset also includes variables related to child health and survival status, for example mother's fertility behavior, parents' education and occupation, household access to healthcare, and other household characteristics.

United Nation Statistic Division (2015) define infant mortality rate as "the probability (expressed as a rate per 1,000 live births) of a child born in a specified year dying before reaching the age of one if subject to current age-specific mortality rates". Based on the definition, this study only includes children who died within the first twelve month from their birth(between 0 and 11 months of age) in order to capture infant mortality. The children who died after their first birthday (12 month or older) are categorized into survived children together with the ones who are still alive during the interview. In 2002-2003 IDHS, the sample size is 16,206. In 2007 and 2012, the sample size is 18,645 and 18,021, respectively. However, due to missing information the regression is estimated on a smaller sample size.

3.2 Empirical Specification

The study uses a logit model to estimate the effect of explanatory variables on the dichotomous dependent variable that represents incidence of infant mortality in Indonesia. The logit model is specified as follow:

$$p_i = E(Y_i = 1|Z_i) = \frac{1}{1 + e^{-Z_i}}$$

Where: $Z_i = f(\eta, M^i, E^f, N^i, P^i, I^f, H^f, C^f)$

The probability rate of infant mortality (p_i), whether mortality occurs (Y_i=1) or otherwise (Y_i=0), is treated as function of factors that affect infant survival status. The bio-demographic factors are variables that represent the inherent risk of infant mortality and include child genetics factors (η) and maternal biological factors (M^i). The intermediate factors are variables that represent the direct cause that affect child health status and include nutrients intake practices (N^i), health control behavior (P^i) and household environmental hygiene characteristic (E^f). The socio economics variables are the underlying factors that indirectly affect infant survival status trough the proximate variables and include individual factors of caregivers (I^f), household variable (H^f), and the community variable (C^f).

In order to answer the broad questions of the study, the first part of this paper discusses the important factors related to infant mortality in Indonesia based on each round of IDHS. Three models are specified to investigate the determinants of infant mortality. The first model investigates the inherent risks of infant mortality which relate to child genetic endowment and bio-demographic characteristic of mother. The first model is then expanded by including intermediate factors that

may affect child health status. The other variables included in the second model are behavioral factors dealing with nutrition intake and health control practices, and household environmental characteristics. The third model combines all proximate and socio economic factors which may influence infant mortality.

A key element of this paper is to examine whether there are spillovers effects from health investment made by other households in the community. Controlling for important factors related to child survival status, the paper analyses the externalities impact from investment in mother's education, improved drinking water source, improved sanitation, and vaccination made by the community in the cluster. These community investments are included in model 4 in order to measure the effects of externalities.

3.3 Variable Definition

The definition and categorization of each variable used to measure the dependent and independent variables in this study are listed in table 1. The expected sign of influence from each independent variable to infant mortality, as represented by coefficient (β) in logit model, is also given in the table below.

Table 1: List of Variables

Variables	Definition and Categorization	Expected sign
DEPENDENT VARIABLE		
Infant Mortality	The survival status of infant : 1= child dies before his/her first birthday 0= child is alive during interview or was still alive on first birthday	
INDEPENDENT VARIABLES		
PROXIMATE DETERMINANTS		
Bio demographic factors		
Genetic endowment		
Sex	Sex of infant	
	1=male 0=female	+
Birth multiplicity	Twin=1	+
	Singleton=0	
Birth rank	Birth order number of infant	+
Birth interval	The time interval between the child's birth and previous birth 0=24-47 month 1=shorter than 24 month 2=longer than 47 month	 + -
Birth weight	Child's weight at birth, classified into three groups: 0=2,500-3500 grams 1=below 2,500 grams 2= above 3,500 grams	 Reference +
Birth size	Size of child at birth judged by subjective valuation of mother. Classified in three groups: 0= average 1= larger than average 2= smaller than average	 Reference +

Variables	Definition and Categorization	Expected sign
Maternal factors		
Age at childbirth	Mother age at child birth	
	0= 23-35 year	Reference
	1= 22 year or below	+
	2= 36 year or above	+
Pregnancy complication	Ever had complication during pregnancy, such as: preterm birth, vaginal bleeding, fever, fainting, and other complication	
	1 = yes	+
	0= no (reference)	
Delivery complications	Ever had complication during labor/delivery, such as: water breaks to soon, excessive bleeding during and after delivery, fever, long labor, faint, convulsions, placenta does not come out, stillbirth, and other complication	
	1 = yes	+
	0= no (reference)	
Behavioral factors:		
Nutrition intake		
Pregnancy Supplement	During pregnancy, given or bought iron tablets/syrup	
	1=yes	-
	0=no (reference)	
Liquid intake practice during first three day	First 3 days, baby given only breast milk or not given any liquid if breast milk has not come out	
	1= yes	-
	0=no (reference)	
Early initiation of breastfeeding	When child put in breast after birth	
	1=immediately	-
	0=later (reference)	
Health control		
Tetanus injection	Mother received tetanus injection before birth 1=yes 0=no (reference)	-
Contraceptive use	Contraceptive method	
	1= using any method of contraception	-
	0= not using contraception	
Antenatal care	Number of antenatal visit during pregnancy	-
Postnatal care	Neonate received postnatal check up by health personnel within two month	
	1= receive	-
	0= does not receive (reference)	
Delivery assistance	Person who assist the delivery of the child	
	1=health personnel	-
	0=traditional birth attendant/other (reference)	

Variables	Definition and Categorization	Expected sign
Place of delivery	Place where the child was born	-
	1=born at health facility	
	0=born at home/other (reference)	
Diarrhea treatment practices	Heard of ORS 1=yes	-
	0=no	
Environmental contamination		
Type of Floor	Type of floor material of the house	
	1= finished material	-
	0= natural/rudimentary (reference)	
Access to improved water	Household source of drinking water	
	1=improved source (piped source connected to household)	-
	0=unimproved source (reference)	
Access to improved sanitation	Household sanitation facilities	
	1=improved (private) toilet	-
	0=unimproved toilet	
SOCIO-ECONOMIC VARIABLES		
INDIVIDUAL LEVEL FACTORS		
Maternal education	Mother years of schooling is 7 years or above (secondary schooling or higher level) 1=yes 0=no	-
Paternal education	Husband/partner's years of schooling is 7 years or above (secondary schooling or higher) 1=yes 0=no	-
Maternal employment status	Mother is working outside home	
	1=mother employed	-
	0=mother unemployed (reference)	
Women empowerment:		
a. Mother made the decision on the own health care	Mother involved in the decision making of her own health care	
	1=yes	-
	0=no (reference)	
b. Mother made the decision for household spending	Mother involved in decision making of household spending	
	1=yes	-
	0=no (reference)	
c. Beating Justification	Beating is justified if one or more certain circumstances occur: - wife goes out without telling husband/ - wife neglects the children/ - wife argues with husband/ - wife refuses to have sex with husband/ - wife burns the food	
	1=yes	+
	0=no (reference)	

Variables	Definition and Categorization	Expected sign
d. Husband permission in getting medical help for the wife	Having problem in getting permission to go to health facility (dummy variable)	
	1=big problem	+
	0= not big problem (reference)	
HOUSEHOLD LEVEL FACTORS		
Family Member	Number of household members (listed)	+/-
Access to health care		
a. Cost	Having problem in getting money needed for treatment	
	1=big problem	+
	2= not big problem	
b. Distance to health facility	Having problem with distance to health facility	
	1=big problem	+
	2= not big problem (reference)	
Wealth Index	Index of households' wealth in quintile, from poorest (1) to richest (5)	-
Electricity	Household has electricity 1=yes	-
	0=no (reference)	
Refrigerator	Household has refrigerator 1=yes	-
	0=no (reference)	
Television	Household has television 1=yes	-
	0=no(reference)	
Radio	Household has radio 1=yes	-
	0=no (reference)	
COMMUNITY LEVEL FACTORS		
Community maternal education level	Percentage of mothers in the cluster whose educational level is secondary schooling or higher level	-
Community access to improved water	Percentage of households in the cluster who have access to improved source of drinking water	-
Community access to improved water	Percentage of households in the cluster who have access to improved toilet	-
Community immunization participation	Percentage of child in the cluster who participate in national immunization program	-
Cluster type	Type of cluster (dummy variable)	
	1=urban	-/+
	0=rural (reference)	
Region	Region	
	1. Sumatra	
	2. Java & Bali (reference)	
	3. Kalimantan	
	4. Sulawesi	
	5. Nusa Tenggara, Maluku & Papua	

3.4 Descriptive Statistics

Table 2 shows the incidence of infant mortality in Indonesia in the five years preceding each round of IDHS and the average infant mortality in all rounds of the surveys. Based on the 4th round of IDHS data, the number of infants who died in the five years preceding 2002 was 37 per 1,000 live births. In the 2007 survey, the number decreased to 34 deaths per 1,000 live births. The result of t-test on mean differences within these years shows that the decline is not statistically significant. Furthermore, the infant mortality continued to decrease in 2012 to become 32 deaths per 1,000 live births. The difference between infant mortality in 2002 and 2012 is statistically significant at 1% level (p value= 0.0057).The pooled data shows that the average IMR in the three rounds is 34 deaths per 1,000 live births.

Table 2: Incidence of Infant Mortality per 1,000 live births

	Infant Mortality	Standard Deviation	Pr(|T|>|t|)	Sample Size
2002-2003	37	189		16,206
2002-2003 and 2007			0.1733	
2007	34	182		18,645
2007 and 2012			0.1417	
2012	32	175		18,021
2012 and 2002			0.0057	
Total	**34**	**182**		**52,872**

The summary statistics of the independent variables are presented in table 3. The comparison between means of each variable across time provides a dynamic description about the individual characteristics of child and parents, household environmental and socio economic factors, and the community factors related to infant survival status. The result of two sample-mean comparison-test shows whether the difference of means between 2002-2003 and 2007 and between 2007 and 2012 is statistically significant.

In bio-demographic determinants, there are various trends between variables across the time. For example, maternal factor such as the fraction of younger mothers that have higher risk on mortality decreased overtime. However, there were more numbers of mothers who gave birth when her age is above 35 years old. Similarly, the number of complications during pregnancy and delivery increased overtime. On the other hand, the genetic factor such as small birth size which is related to higher risk of mortality shows that the mean increased from 2002 to 2007, but then decreased in 2012. The total decrease of infant with small birth size from 2002 to 2012 is significant (p value=0.0137; not presented in the table).

The behavioral variables also show different trends across the periods of survey. The number of mothers who consumed pregnancy supplements decreased overtime. Meanwhile, there were fewer mothers who took tetanus injection in 2007as compared with 2002; the number then increased in 2012. However, the total change from 2002 to 2012 is not significant (p value= 0.4749; not presented in the table). On the other hand, some variables show improvement in health behavior overtime. The numbers of mother who delivered a baby at a medical facility or were assisted by a

professional birth attendant gradually increased from 2002 to 2012. Similarly, early initiation of breastfeeding practices gradually increased overtime.

Environmental characteristics show better household hygiene system from IDHS4 to IDHS5 and IDHS6. There were more households who had access to improved water and sanitation and had better flooring material in their dwellings. Similarly, community access to safe drinking water source and improved sanitation also shows that there were improvements in neighborhood access to safe water and sanitation infrastructure over time.

Socio economic characteristics of the individual and household generally show improvement from 2002 to 2012. Parents' educational levels improved as the percentage of mother and father who graduated from secondary or higher schooling gradually increased overtime. Similarly, asset ownership such as radio, television, and refrigerator as well as access to electricity increased overtime. Meanwhile, the wealth index shows that the household's socio economic condition improved from 2002 to 2007 but was relatively stable from 2007 to 2012. However, the total increase from 2002 to 2012 is significant (p value=0.0093; not presented in the table). Surprisingly, beating justification variable shows that there were more women who tolerate such domestic violence by their husbands. At the community level, there were more households in the neighborhood who invested in mother's education from 2002 to 2007 and 2012.

Table 3: Summary Statistics

	2002-2003		Mean diff. 2002-03 & 2007	2007		Mean diff. 2007 &2012	2012	
Variables	Mean	Std Dev	Pr(|T| > |t|)	Mean	Std Dev	Pr(|T| > |t|)	Mean	Std Dev
Sex (1=male)	0.515	0.500	0.0224	0.527	0.499	0.1183	0.519	0.499
Birth multiplicity (1=twin)	0.016	0.124	0.8646	0.015	0.123	0.8423	0.016	0.124
Birth rank	2.528	1.762	0.4500	2.542	1.703	0.0000	2.374	1.619
Birth interval								
1=shorter than 24 month	0.136	0.343	0.0817	0.030	0.351	0.0001	0.130	0.336
2=longer than 47 month	0.522	0.500	0.1782	0.515	0.500	0.0000	0.561	0.496
(reference:24-47 month)								
Birth weight								
1=below 2,500 grams	0.070	0 .255	0.2774	0 .074	0.261	0.8973	0.073	0.261
2=above 3,500 grams	0.180	0.384	0.0000	0.208	0.406	0.0269	0.198	0.398
(ref: 2,500-3500 grams)								
Birth size								
1=larger than average	0.298	0.458	0.0001	0.318	0.466	0.5851	0.315	0.465
2=smaller than average	0.151	0.358	0.0019	0.163	0.370	0.0000	0.141	0.384
(reference=average)								
Mother age at childbirth								
1= below 23 years	0.259	0.438	0.0000	0.235	0.424	0.0000	0.169	0.375
2= above 35 years	0.111	0.315	0.0001	0.125	0.331	0.0000	0.140	0.347
(reference: 23-35 years)								

Variables	2002-2003		Mean diff. 2002-03 & 2007	2007		Mean diff. 2007 &2012	2012	
	Mean	Std Dev	Pr(|T| > |t|)	Mean	Std Dev	Pr(|T| > |t|)	Mean	Std Dev
Pregnancy complication (1=yes)	0.075	0.264	0.0000	0.103	0.304	0.0000	0.125	0.331
Delivery complication (1=yes)	0.481	0.500	0.0000	0.529	0.499	0.0000	0.570	0.495
Pregnancy Supplement (1=yes)	0.780	0.414	0.0000	0.758	0.428	0.0043	0.744	0.436
First 3 days given nothing (1=yes)	0.455	0.498	0.0000	0.375	0.484	0.0000	0.401	0.490
Early initiation of breastfeeding (1=yes)	0.341	0.474	0.0000	0.377	0.484	0.0000	0.502	0.500
Tetanus injection (1=yes)	0.737	0.440	0.0139	0.723	0.447	0.0719	0.733	0.442
Contraceptive use (1=yes)	0.661	0.473	0.9231	0.661	0.473	0.0000	0.687	0.463
Antenatal care	6.780	3.693	0.0116	6.658	3.670	0.0000	7.318	3.745
Postnatal care (1=yes)	0.784	0.411	0.0000	0.676	0.468	0.0000	0.604	0.489
Delivery assistant (1=health practitioner)	0.671	0.470	0.0001	0.691	0.462	0.0000	0.793	0.404
Place of delivery (1=medical facility)	0.380	0.485	0.0000	0.403	0.490	0.0000	0.551	0.497
Heard of ORS (1=yes)	0.911	0.285	0.3841	0.913	0.281	0.0302	0.919	0.271
Access to improved water (1=yes)	0.171	0.376	0.0001	0.155	0.362	0.0000	0.107	0.308
Access to improved sanitation (1=yes)	0.505	0.499	0.0006	0.523	0.499	0.0000	0.633	0.481
Improved flooring materials (1=yes)	0.641	0.479	0.0000	0.664	0.472	0.0000	0.742	0.437
Maternal education (1=7 years or above)	0.492	0.500	0.0000	0.558	0.497	0.0000	0.654	0.476
Paternal education (1=7 years or above)	0.546	0.498	0.0000	0.605	0.489	0.0000	0.665	0.472
Mother is employed (1=yes)	0.445	0.497	0.0000	0.491	0.500	0.0000	0.541	0.498
Women empowerment:								
a. Mother made the decision on the own health care (1=yes)	0.863	0.343	0.0002	0.849	0.358	0.3858	0.846	0.361
b. Mother made the decision for household spending (1=yes)	0.802	0.397	0.0194	0.792	0.405	0.0000	0.826	0.378
c. Beating is justified (1=yes)	0.333	0.471	0.0000	0.368	0.482	0.0194	0.380	0.485
d. Husband permission in getting medical help for the wife (1=big problem)	0.058	0.233	0.0003	0.067	0.250	0.0159	0.061	0.239
Family Member	5.597	2.218	0.1952	5.628	2.235	0.1286	5.592	2.344
Access to health care:								
a. Cost (1=big problem)	0.300	0.458	0.0000	0.327	0.469	0.0000	0.179	0.383
b. Distance to health facility (1=big problem)	0.179	0.384	0.0000	0.210	0.407	0.0000	0.135	0.341
Wealth Index	2.618	1.472	0.0086	2.659	1.450	0.9862	2.659	1.436
Has electricity (1=yes)	0.804	0.396	0.0000	0.829	0.376	0.0000	0.918	0.274

Variables	2002-2003		Mean diff. 2002-03 & 2007	2007		Mean diff. 2007 &2012	2012	
	Mean	Std Dev	Pr(|T| > |t|)	Mean	Std Dev	Pr(|T| > |t|)	Mean	Std Dev
Has refrigerator (1=yes)	0.184	0.388	0.0000	0.266	0.442	0.0000	0.437	0.496
Has television (1=yes)	0.730	1.121	0.0000	0.801	1.104	0.0000	0.961	1.031
Has radio (1=yes)	0.664	1.148	0.0000	0.581	1.155	0.0000	0.424	1.127
Community maternal education	0.492	0.296	0.0000	0.557	0.296	0.0000	0.653	0.284
Community access to improved water	0.167	0.280	0.0000	0.151	0.257	0.0000	0.104	0.207
Community access to improved sanitation	0.492	0.335	0.0000	0.511	0.332	0.0000	0.617	0.320
Community immunization participation	0.801	0.199	0.0007	0.793	0.204	0.0000	0.836	0.186
Cluster type (1=urban)	0.405	0.490	0.0000	0.376	0.484	0.6979	0.454	0.498
Region								
1. Sumatra	0.300	0.458	0.1669	0.293	0. 455	0.9297	0.294	0.455
2. Kalimantan	0.133	0.340	0.0000	0.103	0.304	0.7232	0.104	0.305
3. Sulawesi	0.193	0.395	0.0004	0.178	0.383	0.0870	0.172	0.377
4. Nusa Tenggara, Maluku & Papua	0.077	0.267	0.0000	0.178	0.382	0.7749	0.177	0.382
(reference= Java & Bali)								

Table in appendix 1 shows the summary statistic based on infant survival status for each round of IDHS. The result of two group-mean comparison-test shows whether the difference of means within the dead and survivor groups are statistically significant. The summary statistics generally shows that higher quality of proximate and socio economic factors are related to the absence of infant mortality in all rounds of survey. For example, the group of dying infants has lower number of household with access to improved hygiene infrastructure and access to medical facility, lower parental education level, lower wealth status and ownership of assets, and more mothers who are employed. At the community level, the lower community investment on mother's education, improved drinking water source, private toilet, and immunization participation exists in the group of dying infant.

In bio-demographic factors, the factors related to inherent risk of infant mortality occurs more in the group of dying infant. Genetic endowment factors such as low birth weight, birth size smaller than average, higher birth rank, and closer birth intervals are more likely to exist in the group of dying infant. Similarly, there were more numbers of dying infant born from mothers below 23 years or above 35 years old.

The behavioral factors also shows that the survivor group has more number of parents who give better care. For example, there are more mothers in the group who took supplements during pregnancy, gave birth at medical facility or were assisted by skilled birth attendants, visited antenatal care more frequently, heard about ORS, and practiced family planning.

Chapter 4
Results

This chapter discusses the regression results on determinants of infant mortality in Indonesia based on the IDHS conducted in year 2002-2003, 2007, and 2012. In addition, the regression results on the effect of community investments on infant survival status are also discussed.

4.1 Determinants of Infant Mortality based on 2002-2003 IDHS

Based on the regression results of 3 models (see table 4 for model 3, appendix 2 for model 1 and appendix 3 for model 2), I find that bio-demographic, behavioral, and socio-economic factors are important factors associated with infant mortality in Indonesia for the birth five years preceding 2002. Some biological and demographic traits that inherently affect the risk of dying in young children are found to be significant determinants. Birth multiplicity is bio-demographic characteristic that might create strongest effect on infant mortality in this period of survey (1% level of significance and highest odds ratio). Being twin is attributed to higher risk of dying in the first year of life; as compared with singleton, twin inherently carries 29.3 times risk of dying during his/her infancy period. In addition, close interval between births also negatively related to the child survival status. I find that a child who was born less than 24 month from preceding birth has 2.6 times chance of dying before the first birthday as compared the one who was born 24 to 47 months after the previous birth (5% significance). Similarly, birth rank is found to have negative relation with infant survival status; a child who is being younger sibling in the family has inherent risk of dying 1.3 times to be compared with the older siblings (5% significance).

The findings are consistent with previous papers which found that multiple birth, higher birth rank, and short birth intervals are associated with higher risk of infant mortality (Bicego and Ahmad 1996, Hong 2006, Rutstein 2005 and 2008, Conde-Agudelo et al 2006). These researches suggest that a mother who is carrying multiple babies, carrying a baby with higher birth parity, or having pregnancy with short interval from previous birth has higher risk of having adverse effects on child and maternal health related to several complications during pregnancy, labor, and delivery. In addition this mortality risk also related to the competition between siblings; not only for the resource allocated to children, but they also compete for time and quality of caring that are given by the mother or other caregiver (Zenger 1993, Bicego and Ahmad 1996). For twin babies, sibling rivalry even occurred since the fetal period; as during pregnancy, multiple fetuses should share nutrition intake from their mother. As the consequence, twin children have higher odds of having low birth weight in compared to the singleton (Ozumba and Okafor, 2004).

I also find that child's weight and size at birth are closely related to the survival status. A baby who was born with size larger than average has lower risk of dying in his or her first year to be compared with an average sized baby (odds ratio is 0.5 and statistical significance is 10%). On the contrary, a baby who has birth weight less than 2,500 grams is 2 times more risky to be not survived in infancy period as compared with a baby who is weight 2,500 grams to 3,500 grams. However, this variable is only significant in model 1 (10% significance) and become not important after other factors are incorporated in the regression. The previous researches suggest that low birth weight is one of the strong predictors of mortality in neonates, infants, and children (Cramer 1987, Lawn et al. 2005). This condition can be resulted from premature birth and/or growth faltering (Lawn et al. 2010). According to Djaja and Soemantri (2003:1), born with preterm birth accompanied by low birth

weight is the leading cause of perinatal mortality in Indonesia. Titaley et al (2008) also came with the evidence that odds neonatal mortality is higher in baby who is born with lower weight or small size.

Furthermore, I also find that complication that is happened during pregnancy period has negative association with infant survival status. A mother who experienced any complication during pregnancy would 2 times more likely to has a dying infant as compare with a mother who has none of pregnancy complications. The statistical significance is 5%, but the variable is only important in model 1. A study conducted by Mercer, et al (2006) in Bangladesh came with the evidence that mortality risk in infant born by mother who experienced pregnancy or labor and delivery complications is higher than the infant whose mother did not bear such experience.

On the contrary, the result of regression in model 1 and 2 suggests that delivery complication significantly decrease the odds of infant mortality (5% and 10% significance). To be compared with delivery without any complication, the odds ratio of infant mortality is 0.6. A possible reason behind the finding is that the data might underestimate infant mortality related to the mother who died because of complications during birth. Since the DHS only record the history of children from survived mother, the real number of delivery complications that caused both, mother and infant mortality might be underestimated. As explained by Lawn et al. (2010: 373), Indonesia is the 8th country that has "greatest number of neonatal death, with associated maternal deaths and national plans". The other possible reason is the mother who experienced complication during delivery might have received help from a more qualified birth attendance and gave birth in a medical facility that has improved equipment. For example, mother who had prolonged birth or water break too soon might be sent to region hospital and helped by obstetrics and gynecology specialist via caesarean section. Therefore, the risk of dying because of complications could be carefully managed. On the other hand, mother who did not have any complication might prefer to deliver the baby at home attended by family member, traditional birth attendant or less competent village midwife which are associated with higher risk of neonatal death.

Moving to behavioral factors, I find that contraceptive use is the only behavioral factors that associated with infant mortality in 2002-2003. A mother who uses any method of contraception has 0.4 times risk of experiencing infant mortality to be compared with a mother who does not practice family planning. This finding indicates that contraceptive practice might reduce the incidence of infant mortality in Indonesia in this period of DHS. In accordance with studies conducted by Saha and van Soes (2013) and Tsui and Creanga (2009) the risk of infant mortality in developing countries might be reduced by family planning and contraceptive program.

The regression results in 2002-2003 data also show the evidence that household's hygiene characteristics are important determinants of infant mortality. I find that household's access to improved water is negatively associated with infant mortality. The risk of dying in infancy period in a household that has access to safe drinking water is 0.3 times to be compared with a household with unhygienic drinking water source. The statistical significance is 5% in model 2 and 10% in model 3. Similarly, improved flooring materials also yields advantages to child survival status in the family. As compared with a household which the dwelling has rudimentary or unfinished flooring material, the odds ratio of infant mortality is 0.5. Many studies came with the clear evidence that household environmental characteristic such as access to improved water, sanitation, and floor material would reduce the risk of mortality and under nutrition in young children. Access to drinking water from improved sources reduces the risk of infectious disease such as diarrhea, dysentery, and typhoid (BPS, BKKBN, Kemenkes, and ICF International 2013:10). On the one hand, natural flooring such

as earth and sand might become the source of dust and parasites that cause health problem in children (ibid:12). The empirical evidence by Godson and Nnamdi (2012) and Aderinwale (2013) found that the improved environmental characteristic support the child survival in Nigeria. Mutunga (2007) and Mulugeta (2012) came with the similar evidence for urban Kenya, and Ethiopia.

Among various factors that are associated with infant mortality, number of family member is socio economic variable that have the most important effect on infant mortality in 2002-2003. The regression results show that household with more members related to the lower odd of infant mortality (odds ratio is 0.5 and statistical significance is 1%). This finding is similar to the findings of Aderinwale's (2013) study that suggest the more members in the household decrease the probability of child mortality in Nigeria. Larger family size might give advantage on child survival status since the presence of other family members who could help parents in caring their children (Aderinwale 2013 as cited from Kaldewei and Pitterle 2011). However, some literatures suggest that the more members in the household relates to higher risk of infant and child mortality because there would be less resources to be allocated in the family. Study by Kayode et al (2012) came with the evidence that small family member reduces the risk of under five mortality in Nigeria. Similarly, Mulugeta (2012) found that the more children born by the mother increase the risk of child mortality in Ethiopia.

Checking for non linearity in the relationship between numbers of household member and infant mortality in Indonesia, I included variable family member squares in the model. The results[1] suggest that non linearity does exist; the more of household member in the family firstly negatively related with infant mortality. After the household size is reach 10 members, the more household members in the family then start increasing the risk of infant mortality. The odds ratio of family member is 0.2 (1% significance) and for the family member squares is 1.1 (1% significance); the odds ratio and significance level of other variables are virtually not effected once I included the variable family number squares in the model. Simply taking linear relationship between the number of family member and infant mortality yields negative association since the average number of household members in 2002-2003 IDHS is not too large (5.60 members).

Furthermore, the regression results show that the odds ratio of infant mortality in working mother is 1.7 times higher as compared with unemployed mother (10% significance). The positive relationship between maternal employment status and infant mortality might be explained by working mothers might spend less time for caring the children and decrease the frequency and duration of breastfeeding that is very important source of nutrition for younger infant. Previous study conducted by Bankole (1989) found that working mother, especially in the one who is employed informal sector has higher probability of having dying infant in compare to stay at home mother. Titaley et al. (2008) also found that there is higher odd of neonatal death in the family where both parents work outside home in compare to the family only husband is responsible as the breadwinner.

However, in the case of developing country, the increasing risk of infant mortality might not purely come from mother's employment status. There might be endogeneity in how maternal employment status affects infant mortality in developing countries. Berman et al. (1994:212) explained that there is complex interaction between mother's employment status with socio-economic characteristic, behavioral factors, and mother's relation with other family member. As women in developing countries work for supporting family income, maternal employment might reflect poverty status of

[1] Regression results are not presented in the paper.

the family (ibid). The risk of infant mortality might be exacerbated since the women are also responsible for domestic chores; therefore in the poor family, working mothers spend less time for nurturing their young children.

Looking the characteristic of working mother in 2002-2003 IDHS, the data shows that the working mothers have significantly lower wealth index as compared with unemployed mothers. In addition; among 49.2% women who are employed, only 12.5% work in formal sectors such as professional, technical, manager, administration, and clerical. 87.5% women's occupations in 2002-2003 IDHS are in sales, service, agricultural worker, industrial worker, and other informal sectors which in Indonesian context, is associated with low skill and earning. Maternal employment status might be an indicator of poor condition in the Indonesian family. Therefore, further research need to be done in order to measure the true effect of women employment on infant mortality in Indonesia.

Furthermore, I find that the incidence of infant mortality in 2002-2003 is attributed to the different characteristics of the regions in Indonesia. The results of regional dummies show that in model 1, Sulawesi region has significantly higher odds of infant mortality as compared to Java and Bali (odds ratio: 1.9). In model 2 and model 3, the magnitude of this variable is higher (odds ratio is 2 in model 2 and 2.8 in model 3), but statistical significance is the same at 5% level. Differently, incidence of infant mortality in Kalimantan is 0.5 times as compared to Java and Bali. The statistical significance is 10% in model 1. However, the regional effect on infant mortality in Kalimantan loses its significance once the other proximate and socio economic determinants are controlled in the models.

4.2 Determinants of Infant Mortality based on 2007 IDHS

According to the regression results, most of bio-demographic variables in 2007 are found to be significant in model 1. However, some bio-demographic factors become insignificant after other proximate and socio economic variables are incorporated in the models. Similar to the results from previous IDHS, birth multiplicity, birth rank, birth interval, birth weight, birth size, and pregnancy or delivery complication are important bio-demographic determinants of infant mortality in 2007 IDHS.

For this period of survey, I find that birth multiplicity still remains important factor that affect incidence of infant mortality in Indonesia. The risk carried by multiple births is 8.5 times higher than single birth (1% statistical significance)[2]. In 2007 IDHS, birth rank become more important factors that increase the risk of infant mortality in Indonesia as the statistical significance increases from 5% in 20002-2003 to become 1% in 2007. In this survey period, the inherent risk of infant mortality carried by later birth ranks is 1.4 times as compared with former birth. This number is about the same level with 2002-2003 IDHS.

The regression results also indicate that birth interval, birth weight, and birth size are closely related to the incidence of infant mortality in 2007. However, as compared with 2002-2003 results, the effects of these factors are also shown in different categorical variables. In previous period of IDHS, I find that shorter birth interval increase the incidence of infant mortality. Meanwhile, the finding in 2007 IDHS also indicates that longer birth interval decline the incidence. In model 3, I find that

[2] The t-test similar shows that the magnitude of this variable are not significantly different from the previous IDHS (p value=0.2787).

children with birth interval 48 month or longer from previous birth have 0.6 times odds of infancy dying to be compared with the reference group (24-47 month). The statistical significance is 5%. In addition, only in model 1 that I find that birth interval less than 24 month increases the odd of infant mortality (odds ratio is 1.6 and statistical significance is 10%). Different from the previous period of survey, the shorter birth interval in 2007 IDHS is no longer associated with infant mortality once the other factors are also being examined.

Moreover, I find that birth weight less than 2,500 grams has higher odds of infant mortality in 2007 with the odds ratio 1.6, which is relatively same level with previous IDHS. The statistical significance increases from 10% in 2002-2003 to become 1% in 2007. However, similar to the previous survey, the importance of this variable disappears once other factors are included in the regression. In addition, I find that higher birth weight is now become an important determinant of infant mortality. The results in model 3 show that children who were born with birth weight 3,500 grams or above have lower risks of infant mortality (odds ratio 0.5 and statistical significance is 10%) as compared with the reference group. As for birth size, the dummy variable birth size larger than average is no longer important determinant of infant mortality in 2007. However, birth size still shows its effect since the results show that smaller birth size increase the risk of infant mortality by 1.8 times as compared with the average ones. The statistical significance is 10% in model 3.

For the variable pregnancy and delivery complication, I also find that these variables are important determinants of infant mortality; and even have stronger significance in 2007 survey. In model 1, the odds ratio of pregnancy complication is 1.8. The statistical significance increases from 5% in 2002-2003 to 1% in 2007. Similar to previous IDHS, delivery complication also negatively related to infant mortality in Indonesia, the odds ratio is 0.7 as compared with the absence of delivery complication. Different from 2002-2003, the variable delivery complication in 2007 IDHS is still being important factor once the socio-economic factors are included in the model.

The results on the behavioral variable show a similarity with the 2002-2003 results. Mother who used contraception has lower risk of infant mortality. The statistical significance of the variables is equally strong in both rounds of survey[3]. Different from 2002-2003 results, I find that two variable that measures parent's behavioral caring practice become important factors that attribute to infant mortality in 2007. First, delivery assisted by health practitioner has odds of infant mortality 2 times higher than delivery which is not supervised by medical personnel. This finding might indicate that there is still low quality of health practitioners in Indonesia which the presence of the personnel at delivery could not decrease or even increase the incidence of infant mortality. Another possible reason is there might be the unobservable risk related to child birth; the mothers whose delivery assisted by health practitioner might be the group that carrying higher risk of adverse outcome of pregnancy. In addition, I find that the knowledge of Oral Rehydration Solution (ORS) might decrease the risk of infant mortality in 2007, which I do not find in 2002-2003. Mother who had ever heard about ORS has 0.5 times risk of losing the child in first year to be compared with mother who did not know about ORS (statistical significance is 10%). The study conducted by Wang (2003) came with the evidence that knowledge about ORS also an important factor which reduces IMR in developing countries.

[3] The t-test similar results shows that even the odds ratios of infant mortality are higher in 2007 variables, probability values indicate that differences between the effect of contraception are not significant (p value= 0.5617)

Similar to 2002-2003 IDHS, I find that household environment characteristics are also associated with infant mortality in 2007. I find that improved flooring material relates to lower incidence of infant mortality in 2007 (odds ratio is 0.6 and statistical significance is 10%). Differently, access to safe drinking water is no longer important factors in this period of survey. In addition, sanitation hygiene is now become an important factor that might reduce infant mortality. Having a private toilet at home has the risk of infant mortality 0.6 times to be compared with unimproved sanitation. However, the statistical significance of the variable is only 10%, and once socio economic factors are included in the model the variable become less importance in affecting infant mortality.

Moving to socioeconomic factors, the study found that the number of household members is an important determinant of infant mortality in 2007. Similar to 2002-2003, more household member in the family is associated with lower incidence of infant mortality. The statistical significance is equal to 2002-2003 value (1% significance) and results shows that the odds ratio of infant mortality in 2007 is 0.7. Checking for non linear relationship, I do the same method with 2002-2003 by including variable family number squares to the model. The results[4] show that odds ratio of family member and family numbers square is 0.35 and 1.05, respectively; and the statistical significance of these variables is 1% level. Similar to 2002-2003 IDHS, the more family members firstly decline the risk of infant mortality than begin to increase the risk after the household members reach 10 persons. The average number of household members in 2007 IDHS is 5.62.

Moreover, maternal employment status is also found to have negative association with infant mortality with odds ratio 2.3 as compared with unemployed mother. The variable becomes more important in 2007 as the statistical significance increase from 10% in 2002-2003 to 1% in 2007. Looking for the possible endogeneity problem, I explored the socio-economic characteristic of working mother in 2007 IDHS. The data also shows that working mothers has significantly lower wealth index with non working ones. Among 44.5% mother who is employed, only 12.7% work in formal sectors and 87.3% work in low skilled occupation.

Different from 2002-2003, I find that beating justification significantly related to higher risk of infant mortality. A mother who justify being beaten by the husband might 1.5 times experienced of having dying infant to be compared with the one who does not tolerate this behavior. Several studies, as stated by Kravdal (2003), suggest that high rate of child mortality is attributed to lack of mother autonomy in the family. Furthermore, Kravdal (2003) found that beating justification is an important factor which affects child mortality in India.

The results from regional dummies show that Kalimantan region and Nusa Tenggara, Maluku, and Papua region has significantly higher odds of infant mortality as compared to Java and Bali. The statistical significance is 5% and 10% level, and the, the incidence of infant mortality in Kalimantan is 2 times higher than in Java and Bali. While the odds ratio of infant mortality in Nusa Tenggara, Maluku, and Papua region is 1.7 times to be compared with the reference region. However, the regional effect on infant mortality in 2007 is only found in model 1. The variable loses its significance once the other proximate and socio economic determinants are controlled in the models.

[4] Regression results are not presented in the paper.

4.3 Determinants of Infant Mortality based on 2012 IDHS

The results from logit regression estimations suggest that bio-demographic factors are still among the key indicators of infant mortality in 2012. Male infant, higher birth rank, birth weight less than 2,500 grams, birth size smaller than average, mother age at birth older than 35 years, and pregnancy complications increase the risk of infant mortality in 2012. On the other hand, longer birth interval decreases the incidence of infant mortality in 2012. Among these factors, experiencing complication during pregnancy appears to be the most important factor associated with infant mortality (1% statistical significance and highest odds ratio). However, birth multiple birth is no longer being good predictor of infant mortality in 2012.

Moreover, different results are found in child sex variable. Only in 2012 data that the findings indicate male sex is importantly associated with higher risk of infant mortality (odds ratio is 1.9 and statistical significance is 5%). In the cultures where parents do not discriminate in caring children with different sex, female child has lower risk of dying since the biological factors put the girls in favorable condition during their early month of live (Rutstein 2008, Lawn et al. 2010). Lawn et al. (2005) found that in African countries, female baby is more likely to survive in compared to baby boy. Mekonnen, et al (2013) also came with the similar evidence in Ethiopia.

Similar to the previous period of surveys, the higher birth rank is attributed to higher risk of infant mortality. Being younger sibling has 1.45 times inherent risk of dying in the first year of life to be compared with being older sibling. The statistical significance of the variable in 2012 is 1%. Similar to 2007 results, I find that birth interval longer than 47 month significantly (10%) has 0.6 times lower risk of infant mortality as compared with the reference group.

For the birth weight and birth size, I find that birth weight lower than 2,500 grams are positively associated with infant mortality in 2012 (odds ratio is 2.5). This finding is similar to the finding in 2002-2003 and 2007 data, but the effect of low birth weight is stronger in 2012 as the variable is still significance (10%) when other factors are incorporated in the regression. In addition, birth weight higher than 3,500 grams is no longer being important determinant of infant mortality in 2012. Similar to 2007 IDHS I found the negative effect of small birth size to infant survival in 2012, but the effect is less significant since the variable is only significant (10%) in model 1. The risk carried by baby with small birth size is 1.6 as compare with the one with average size.

In 2002-2003 and 2007, I find that pregnancy complication might increase infant mortality but the effect become weaker as the regression models are expanded. Differently, for the 2012 DHS, I find that the effect of pregnancy complication on infant mortality remains strong in model 3. The risk of dying under age one is 2.8 times higher in children born from mother who experienced any complication during pregnancy. Meanwhile, delivery complication is no longer being important determinant of infant mortality in 2012.

In addition, mother age older than 35 years increase the risk of infant mortality 1.6 times to be compared with mother whose age is 23 to 35 years old at the child birth. However, I find that the variable is only important in model 1 (5% significance). Previous studies suggest that as her fecundity is decreasing, older women have a higher risk of adverse pregnancy outcomes (Finlay et al., 2011). Semba et al. (2011) found that maternal age older than 32 years increase the risk of under-five mortality in Indonesia. Similarly, Hassen (2014) found that mother age older than 34 years increase the probability of under-five mortality in Ethiopia.

Moving to behavioral factors, I find a similar result with 2007 data which indicates that knowledge on ORS negatively associated with infant mortality (odds ratio is 0.28). The results suggest that the variable becomes more important in this period of DHS, as the statistical significance increases from 10% in 2007 to 5% in 2012. Other behavioral variable that associated with lower risk infant mortality in 2012 is delivery at medical facility. A child who was given birth at health facility has risk of infant mortality 0.5 times to be compared with the one who was delivered at home or other place. This factor is only significant only in model 2 (5% level), and the variable is not significant in the previous IDHSs. Moreover, I find that contraceptive use is still being important factor that reduces infant mortality in 2012. However the variable becomes less importance as compared with the previous surveys since the 1% statistical significance in model 2 is disappear when socio-economic variables are included in model 3. The use of contraceptive method by the parents might reduce the risk of infant mortality to become 0.3 times lower as compared with the absence of the practice.

For the variable first 3 days given nothing if breast milk has not come out, the summary statistics indicate that the safe practice might give different result from the literature. The regression results show that the odds ratio between the one who is given only breast milk or not given any liquid if breast milk has not come out is 1.7 times higher than the newborn that is given liquid such as water, glucose, honey, juice, tea, other milk, or infant formulas for the first three days of life. This finding might not be concluded that given any liquid other than breast milk might reduce the risk of infant mortality since according to the medical science, giving only breast milk which is rich in colostrum is the best and safest feeding practice for early newborn infants (Lawrence 1994; Huffman et al. 2001; MacDonald 2003; Ojofeitimi and Elegbe 1982; Jatrana 2003). The reason might be the high mean number of infants who were given nothing in their first three days in the dead group is related to the high number of infants who died in the first three days of life due to complications which occurred during the perinatal period. According to 2012 IDHS data, the percentages of infant who died in the first three days are 41% from all infant mortality; 17.5% happened on the day of birth, 17.5% happened on the day after birth, and 6% happened the next day.

Continuing the discussion on socio-economic factors, I find consistent finding in the number of family member. A larger household size is associated with a lower risk of infant mortality in 2012. The regression results show that the variable is statistical significant at the 1% level in decreasing infant mortality in Indonesia. A child who lives in large household size has 0.5 times risk of dying in infancy period to be compared with a child in small household size. The average of household size in 2012 IDHS is 5.59 Checking for non linear relationship[5], I find that odds ratio of family member and family numbers square is 0.27 and 1.05, respectively; and the statistical significance of these variables is 1% level. The more family members firstly decline the risk of infant mortality than begin to increase the risk after the household members reach 13 persons.

Similar to the previous surveys, employed mother has higher odds ratio of infant mortality. The importance of the variable is stronger than in 2002-2003 but weaker than 2007 as the statistical significance is 10% in 2002, 1% in 2007, and 5% in 2012. The odds ratio shows that the incidence of infant mortality in 2012 that is associated with working mother is 2 times higher to be compared with unemployed mother. However; when I check the wealth index, the working mothers in 2012 have significantly higher wealth index as compared with unemployed mothers. Seems contradictory, looking for the proportion of mothers who work in formal and informal sector, the data shows that among 54.1% mothers who are employed, only 20.5% work in occupation associated with high skill

[5] Regression results are not presented in the paper.

labor. The rest 79.5% mothers taking job associated with lower skill and earning. This might indicate that actually maternal employment status can be better indicator of poverty as compared with wealth index.

A puzzling finding is found in woman empowerment variables. Woman who could take the decision to get her own health care 2.4 times more likely experienced infant mortality to be compared with the woman who does not have such autonomy (10% significance). The results might come from unobservable factors that are not measured in the study. According to the data, the women that have more autonomy in decision making of getting health service are the more educated women and women in wealthier family. The difference of mean values of education level and wealth index between the empowered and less empowered groups are significant. However, the summary statistics based on infant survival status in appendix 1 show that in 2012, the mean value of mother decision on the own health care in the group of survived infant is not significantly different than the mean value of dead group.

The results from regional dummies in model 2 and model 3 show that Sumatra and Kalimantan regions has significantly lower odds of infant mortality as compared to Java and Bali. The statistical significance is 1% and 5% level, and the odds ratio 0.26 and 0.24 indicates that in 2012, the incidence of infant mortality in Sumatra and Kalimantan are for about four times lower than in Java and Bali.

In addition, to check whether there are also time effects in the decline on infant mortality from 2002-2003 to 2012, I run pooled data regression and set the time dummies with 2002-2003 as the reference. The results (see appendix 4) show that the time dummies, 2007 and 2012, are found to be insignificant variables. This finding suggests that the reduction on infant mortality in Indonesia from 2002 to 2012 is not a pure time trend once various variables associated with infant mortality are set as control variables.

Table 4 Determinants of Infant Mortality

Variables	2002-2003		2007		2012	
	OR	**SE**	**OR**	**SE**	**OR**	**SE**
Sex (0=female)	0.968	(0.277)	1.110	(0.257)	1.919**	(0.537)
Birth Multiplicity (0=singleton)	29.2662***	(19.056)	8.457***	(4.474)	3.613	(2.934)
Birth Rank	1.303**	(0.163)	1.377***	(0.127)	1.454***	(0.151)
Birth Interval						
ref: 24-47 month						
<24 month	2.631**	(1.093)	1.415	(0.463)	0.753	(0.346)
>47 month	0.987	(0.355)	0.572**	(0.154)	0.552*	(0.170)
Birth weight						
ref=2500-3500 grams						
<2500 grams	0.764	(0.440)	1.140	(0.454)	2.461*	(1.150)
>3500 grams	0.466	(0.255)	0.518*	(0.200)	0.590	(0.248)
Birth size						
ref=average						
larger than average	0.494*	(0.207)	0.876	(0.268)	1.208	(0.404)
smaller than average	1.052	(0.471)	1.810*	(0.594)	1.120	(0.489)

Variables	2002-2003		2007		2012	
	OR	SE	OR	SE	OR	SE
Age at childbirth						
ref=23-35years						
<23	0.398	(0.256)	1.434	(0.591)	0.970	(0.746)
>35	0.465	(0.243)	1.524	(0.451)	1.590	(0.530)
Pregnancy complication (0=no)	1.599	(0.772)	0.989	(0.371)	2.828***	(0.898)
Delivery complication (0=no)	0.604	(0.187)	0.550**	(0.134)	1.112	(0.334)
Pregnancy Supplement (0=no)	1.012	(0.403)	1.203	(0.381)	0.671	(0.212)
First 3 days given nothing (0=no)	1.437	(0.468)	1.411	(0.374)	1.745*	(0.517)
Early initiation of breastfeeding (0=no)	0.778	(0.272)	0.813	(0.218)	0.751	(0.220)
Tetanus injection (0=no)	1.028	(0.420)	0.924	(0.278)	0.834	(0.269)
Contraceptive use (0=no)	0.357***	(0.107)	0.444***	(0.105)	0.350	(0.096)
Antenatal care	0.991	(0.052)	1.040	(0.040)	0.970	(0.043)
Postnatal care (0=no)	0.779	(0.407)	0.672	(0.220)	0.991	(0.282)
Delivery assisted by health practitioner (0=no)	0.749	(0.370)	1.965*	(0.745)	1.395	(0.611)
Deliver at medical facility (0=no)	0.555	(0.222)	0.831	(0.233)	0.603	(0.196)
Heard of ORS (0=no)	0.754	(0.424)	0.515*	(0.204)	0.286**	(0.139)
Access to improved water (0=no)	0.322*	(0.203)	1.341	(0.455)	0.859	(0.423)
Access to improved sanitation (0=no)	1.009	(0.369)	0.643	(0.206)	1.175	(0.445)
Improved flooring materials (0=no)	0.518*	(0.189)	0.813	(0.248)	1.119	(0.436)
Maternal education (0=less than 7 years)	1.050	(0.371)	1.503	(0.435)	0.907	(0.315)
Paternal education (0=less than 7 years)	0.963	(0.328)	0.947	(0.268)	1.049	(0.353)
Maternal Employment Status (ref=unemployed)	1.726*	(0.524)	2.325***	(0.599)	2.017**	(0.589)
Women empowerment:						
a. Mother made the decision on the own health care (0=no)	1.093	(0.502)	0.970	(0.348)	2.356*	(1.147)
b. Mother made the decision for household spending (0=no)	0.754	(0.286)	1.483	(0.524)	0.648	(0.236)
c. Beating is justified (0=no)	0.771	(0.250)	1.523*	(0.363)	1.149	(0.324)
d. Husband permission in getting medical help for the wife (ref=not big problem)	0.720	(0.481)	0.552	(0.314)	0.415	(0.285)
Family Member	0.525***	(0.072)	0.728***	(0.065)	0.477***	(0.060)
Access to health care:						
a. Cost (ref=not big problem)	0.985	(0.364)	0.744	(0.220)	1.052	(0.411)
b. Distance to health facility (ref= not big problem)	1.496	(0.636)	1.550	(0.489)	1.947	(0.795)
Wealth Index	1.183	(0.287)	0.777	(0.155)	1.034	(0.195)
Has electricity (0=no)	1.595	(0.697)	0.719	(0.239)	1.308	(0.886)
Has refrigerator (0=no)	0.767	(0.416)	2.688**	(1.030)	1.446	(0.539)
Has television (0=no)	0.775	(0.298)	1.056	(0.314)	1.636	(0.762)
Has radio (0=no)	0.925	(0.226)	0.911	(0.223)	1.038	(0.335)
Cluster type (ref=rural)	1.009	(0.378)	1.000	(0.311)	0.745	(0.237)
Region						

Variables	2002-2003		2007		2012	
	OR	SE	OR	SE	OR	SE
(ref= Java & Bali)						
1. Sumatra	1.410	(0.617)	0.934	(0.351)	0.256***	(0.111)
2. Kalimantan	0.591	(0.384)	1.184	(0.546)	0.235**	(0.159)
3. Sulawesi	2.812**	(1.324)	0.940	(0.416)	0.948	(0.383)
4. Nusa Tenggara, Maluku & Papua	0.714	(0.501)	0.920	(0.403)	0.591	(0.272)
_cons	0.503	(0.629)	0.046***	(0.043)	0.168	(0.191)
Sample size		**5,302**		**6,746**		**7,054**
Prob> chi2		**0.0000**		**0.000**		**0.0000**
Peseudo R2		**0.2025**		**0.1613**		**0.2063**
Correctly classified		**98.94%**		**98.78%**		**99.11%**

Notes: - Statistical significances are written in parenthesis: *** p<0.01, ** p<0.05, * p<0.1

- As a robustness check, the models are also estimated by using probit and Linear Probability Model (LPM). Both regression techniques yield virtually similar results with the results of logit model in the table.

4.4The Effects of Neighborhood Investment

The section discusses the regression results on externalities generated by the investment of other households in the cluster. Four variables which measure community investment in mother's education, water and sanitation infrastructure, and immunization participation are included in the 4th models. The logit regression estimation results are presented in table 5. The regression results show that there aren't many differences in the statistical significance and odds ratio of the control variables in model 3 once the community variables are included in the model. The bio-demographic factors, behavioral factors, and socio-economic factors which are important in affecting infant mortality in previous models are still significant. Similarly, the regional dummies indicate that lower odds of infant mortality in 2012 exist in Sumatra region, Kalimantan region, and Nusa Tenggara, Maluku, and Papua region and higher odds of infant mortality in 2002-2003 exist in Sulawesi region.

According to the empirical findings in all periods of survey, household own investment in female education and safe sanitation facility does not decrease the risk of infant mortality in the household. Similarly, investments made by the other households in the cluster are also found to be insignificant. On the other hand, household's access to safe drinking water is found to be significant in decreasing the risk of infant mortality in 2002-2003. The odds ratio of infant mortality indicates that access to improved water has 0.17 times lower risk of infancy dying in 2002-2003. However, improved drinking water infrastructure in the community is not significant in all data.

The logit regression results suggest that immunization participation in the cluster is the only community variable that yields externalities. The variable is significant at 1% level in all rounds of the survey, as well as in the pooled data. The odds ratios are 0.048 in 2002-2003, 0.077 in 2007, and 0.087 in 2012; however the probability values from t-test similar indicate that there are no differences between the effects of immunization participation in the community on infant mortality in three periods of survey. The values of odds ratios suggest that living in a community where children participated in a national immunization program reduce the risk of infant mortality by as much as 11.57 to 20.8 times as compared to living in a cluster where children are not immunized.

Table 5: Effect of Neighborhood Investment

Variables	2002-2003		2007		2012	
	Odds Ratio	Std. Err.	Odds Ratio	Std. Err.	Odds Ratio	Std. Err.
Sex (0=female)	1.044	(0.303)	1.142	(0.267)	1.934**	(0.546)
Birth Multiplicity (0=singleton)	22.886***	(15.312)	6.268***	(3.406)	3.530	(2.886)
Birth Rank	1.236	(0.159)	1.350***	(0.126)	1.430***	(0.150)
Birth Interval						
ref: 24-47 month						
<24 month	2.660**	(1.121)	1.316	(0.435)	0.679	(0.315)
>47 month	1.035	(0.378)	0.596*	(0.161)	0.549*	(0.170)
Birth weight						
ref=2500-3500 grams						
<2500 grams	0.845	(0.491)	1.116	(0.446)	2.406*	(1.125)
>3500 grams	0.482	(0.266)	0.526*	(0.204)	0.595	(0.252)
Birth size						
ref=average						
larger than average	0.509	(0.219)	0.848	(0.263)	1.239	(0.418)
smaller than average	0.987	(0.447)	1.843*	(0.606)	1.143	(0.499)
Age at childbirth						
ref=23-35years						
<23	0.424	(0.273)	1.295	(0.542)	0.938	(0.724)
>35	0.566	(0.293)	1.501	(0.451)	1.635	(0.550)
Pregnancy complication (0=no)	1.590	(0.788)	0.972	(0.370)	2.829***	(0.903)
Delivery complication (0=no)	0.627	(0.198)	0.572**	(0.140)	1.114	(0.334)
Pregnancy Supplement (0=no)	1.090	(0.448)	1.270	(0.409)	0.722	(0.230)
First 3 days given nothing (0=no)	1.388	(0.460)	1.469	(0.392)	1.809**	(0.542)
Early initiation of breastfeeding (0=no)	0.793	(0.285)	0.764	(0.208)	0.761	(0.225)
Tetanus injection (0=no)	1.285	(0.552)	1.109	(0.347)	0.938	(0.307)
Contraceptive use (0=no)	0.380***	(0.116)	0.459***	(0.110)	0.359***	(0.099)
Antenatal care	1.012	(0.054)	1.045	(0.041)	0.972	(0.043)
Postnatal care (0=no)	0.800	(0.434)	0.728	(0.241)	1.068	(0.309)
Delivery assisted by health practitioner (0=no)	0.744	(0.382)	1.803	(0.690)	1.563	(0.699)
Deliver at medical facility (0=no)	0.573	(0.232)	0.878	(0.247)	0.650	(0.214)
Heard of ORS (0=no)	0.845	(0.487)	0.543	(0.219)	0.293**	(0.145)
Access to improved water (0=no)	0.171**	(0.132)	0.922	(0.420)	0.981	(0.636)
Access to improved sanitation (0=no)	0.852	(0.358)	0.677	(0.242)	1.449	(0.623)
Improved flooring materials (0=no)	0.554	(0.205)	0.874	(0.270)	1.263	(0.504)
Maternal education (0=less than 7 yers)	0.901	(0.354)	1.292	(0.410)	0.955	(0.357)
Paternal education (0=less than 7 years)	0.884	(0.305)	0.922	(0.261)	1.104	(0.380)
Maternal Employment Status (ref=unemployed)	1.743*	(0.535)	2.436***	(0.634)	2.019**	(0.593)
Women empowerment:						
a. Mother made the decision on the own health care (0=no)	1.138	(0.525)	0.917	(0.333)	2.474*	(1.216)
b. Mother made the decision for household spending (0=no)	0.727	(0.278)	1.584	(0.569)	0.638	(0.235)
c. Beating is justified (0=no)	0.816	(0.268)	1.614**	(0.387)	1.190	(0.340)
d. Husband permission in getting medical help for the wife (ref=not big	0.734	(0.499)	0.601	(0.340)	0.416	(0.286)

Variables	2002-2003		2007		2012	
	Odds Ratio	Std. Err.	Odds Ratio	Std. Err.	Odds Ratio	Std. Err.
problem)						
Family Member	0.533***	(0.075)	0.7415***	(0.065)	0.477***	(0.060)
Access to health care:						
a. Cost (ref=not big problem)	1.003	(0.380)	0.745	(0.221)	1.091	(0.435)
b. Distance to health facility (ref= not big problem)	1.555	(0.684)	1.502	(0.479)	1.858	(0.767)
Wealth Index	1.100	(0.268)	0.750	(0.151)	1.020	(0.193)
Has electricity (0=no)	1.405	(0.622)	0.707	(0.238)	1.330	(0.899)
Has refrigerator (0=no)	0.706	(0.392)	2.598**	(0.996)	1.469	(0.544)
Has television (0=no)	0.884	(0.341)	1.079	(0.329)	1.515	(0.708)
Has radio (0=no)	0.921	(0.198)	0.924	(0.228)	1.039	(0.335)
Community maternal education level	2.121	(1.736)	2.245	(1.413)	0.920	(0.659)
Community access of improved water	3.331	(2.645)	2.106	(1.367)	0.846	(0.861)
Community access of improved sanitation	1.669	(1.219)	0.980	(0.563)	0.613	(0.417)
Immunization participation in the cluster	0.048***	(0.042)	0.077***	(0.047)	0.087***	(0.074)
Cluster type (ref=rural)	0.857	(0.357)	0.860	(0.295)	0.862	(0.295)
Region						
(ref= Java & Bali)						
1. Sumatra	1.314	(0.593)	0.719	(0.280)	0.237***	(0.105)
2. Kalimantan	0.434	(0.290)	1.077	(0.499)	0.204**	(0.141)
3. Sulawesi	2.461*	(1.200)	0.734	(0.332)	0.806	(0.333)
4. Nusa Tenggara, Maluku & Papua	0.968	(0.691)	0.719	(0.319)	0.452*	(0.214)
_cons	2.491	(3.285)	0.198	(0.196)	1.029	(1.292)
Sample size		**5302**		**6746**		**7054**
Prob> chi2		**0.0000**		**0.0000**		**0.0000**
Peseudo R2		**0.2266**		**0.1811**		**0.2202**
Correctly classified		**98.98%**		**98.75%**		**99.11%**

Notes:

-Statistical significances are written in parenthesis:*** p<0.01, ** p<0.05, * p<0.1

- As a robustness check, the models are also estimated by using probit and Linear Probability Model (LPM). Both regression techniques yield almost similar results with the results of logit model in the table.

Chapter 5
Conclusion

Despite the satisfied progress on under-five mortality reduction, the relatively slow progress on infant mortality reduction in Indonesia from 1990 to 2012 shows that the more attention should be given in order to improve survival status in younger children. Motivated by the situation, this study is aimed to know the important factors associated with infant mortality in Indonesia. The individual cross sectional data collected in 2002-2003, 2007, and 2012 IDHS are analyzed using logit regression in order to identify the determinant of infant mortality in Indonesia for nationality birth five years preceding the surveys. In addition, the study is focused to know whether there are the health spillovers from investments in mother's education, water and sanitation infrastructure, and children vaccination participation made by community.

The regression results shows that bio-demographic factors that consist of child genetics factor and maternal factors are one of the key predictors of Infant mortality in Indonesia. Child sex is important determinant of mortality only in 2012 IDHS; in which male infant have higher odds of dying in compare to female. Birth multiplicity variable is significant in 2002-2003 and 2007, and the magnitudes show that being twin increases the risk of dying before first birth day with relatively equal effect within these years. Birth rank is also important factors associated with infant mortality. The higher birth rank or the closer time space between births increases the risk of infant mortality in all periods of survey. The regression results suggest that the variable was getting stronger in 2007 and continue to bring important effect in 2012. In addition, the study finds that birth interval less than 24 month associated with higher risk of infant mortality in 2002-2003, but the variable become less important in 2007 and no longer important in 2012. On the other hand, birth interval longer than 47 month is found to be significant in 2007 and 2008 and has lower risk of infant mortality as compared with birth interval 24 to 47 month.

Similar to the other genetic endowments, low birth weight and birth size smaller than average are the good predictors of infant mortality while higher birth weight or birth size larger than average decrease the odds of infant mortality. As compared with birth weight ranging from 2,500 grams to 3,500 grams, birth weight lower than 2,500 grams is associated with higher risk of infant mortality in all periods of survey. The variable is strongest in 2012. On the other hand, birth weight higher than 3,500 grams is closely related to the lower risk of infant mortality only in 2007. Moreover, the study finds that birth size smaller than average increases incidence of infant mortality in 2007 and 2012, but the significance of the variable decreases in 2012. On the contrary, only in 2002-2003 IDHS the regression results suggest that birth size larger than average has lower odds of infant mortality as compared with average size. Maternal factor such as mother age at birth above 35 years is related to infant mortality only in 2012. The complication during pregnancy appears to significantly increase the incidence of infant mortality in all data, and become even stronger in 2012. In contrast, complication during labor and delivery is associated with lower risk of infant mortality in 2002-2003 and 2007 IDHS. Possible reasons on this puzzling finding are there might be underestimate rate of delivery complication that caused infant and maternal mortality in IDHS data, or mother who experienced delivery complication reduced the risk by getting better quality of medical help.

The several variables of behavioral practices are found to be important determinant of infant mortality. The finding from safe practice of giving only breast milk or not giving any liquid if breast milk has not come out at the first three days of life has higher odds of infant mortality in compare to

unsafe practice. This variable is significant only in 2012. Among other health control behavior, contraception has strongest influence on infant mortality in all periods of survey. Delivery at medical facility decreases the risk of infant mortality in 2012, but delivery assisted by health practitioner increases the odds of infant mortality in 2007. The knowledge on ORS shows that the knowledge on diarrhea treatment practice declines the odds of infant mortality in 2007, and the variable become more important in 2012.

This study also finds that improved household hygiene characteristics reduce the risk of infant mortality. Access to improved water has negative association with infant mortality only in 2002-2003 IDHS. In addition, having private toilet reduces the odds of infant mortality only in 2007. Moreover, improved flooring material also declines the risk of infant mortality in 2002-2003 and 2007. Household environment characteristics are not significant in 2012.

Some socio economic variable also found to be significant determinants of infant mortality in Indonesia. Among all factors, the number of household members is the most important factors related to infant mortality in all data. The more household member is negatively related to infant mortality. However, in non linear relationship, the association between household size and infant mortality become positive after the number of family members reach 10 persons in 2002-2003 and 2007 and 13 persons in 2012. Moreover, the research finds that as compared to unemployed mother, working mother has higher odds of infant mortality in all data. However the data show that the number of mothers who works in informal sectors with less earning and lower skill is 4 to 7 times as compared with mothers who work in formal sectors. Therefore, the higher risk of infant mortality might not purely come from mother's decision to take a job, and maternal employment status might indicate poverty condition in the household. Woman empowerment such as mother decision on her health care in 2012 data and beating justification in 2007 data are found to be significant in determining infant mortality. However, while beating justification increase the risk of infant mortality, mother's decision absence to get own health care is related to lower risk of infant mortality.

Several community level variables also appear to have important influence of infant mortality. Sumatra and Kalimantan regions in 2012 have lower odds of infant mortality as compared with Java and Bali. On the other hand, higher odd of infant mortality in 2002-2003 occurs in Sulawesi region. Furthermore, the study found that the variable that measured community investment in immunization participation generates positive spillover to infant survival status. The influence of vaccination variable is significant in all data, and the odds ratios indicate that the risk of infant mortality could substantially be decreased by the immunization participation in the clusters.

The results suggest that proximate factors such as bio-demographic and behavioral factors as well as individual, household, and community level socio economic factors are important determinants of infant mortality in Indonesia for national births between 1997 and 2012. The strong risk factor related to bio-demographic factors such as low birth weight and complication during pregnancy might be reduced with effective strategies such as providing more quality of prenatal care, especially the one that is provided by village midwife; since poor family in rural area could not afford antenatal care provided by doctor or specialist. As the number of antenatal care is not significant in all data, there are no differences effect resulted by the number of antenatal visit during pregnancy. However, measuring the quantity is not enough. The complication that happened during maternity periods and growth faltering of the fetus might be avoided if medical personnel taking more care and supervision to the mother during antenatal visit. Educating mother to maintain healthy pregnancy and taking

adequate nutrition intake is also the important part of this strategy. In addition, adverse outcome of pregnancy caused by older age of mother could also be reduced by promoting mother who has lower health status to take family planning program since the contraceptive practice has been an important determinant of infant mortality in Indonesia. In addition, the quantity of medical facilities is also needed to be increased, especially in the remote area where the households have big problems to get medical service. Women empowerment, as well as maternal education is also important channel to reduce the risk of infant mortality although formal education is not significantly affect infant mortality. Giving sufficient knowledge on feeding practices and treatment for major childhood disease, and creating environment that support working mother in childcare system are also some possible approach that could be taken by the government in order to decline infant mortality. Looking for the difference of characteristic of the region, it is found that Sumatra and Kalimantan have lower incidence of infant mortality as compared with Java and Bali. In general, the provinces in Sumatra and Kalimantan have lower population populations per kilometer squares as compared with Java, Bali, and Sulawesi and the regions have better infrastructures as compared with Nusa Tenggara, Maluku, and Papua. Along with development agenda, the national and regional government needs to manage the congestion in the most populous island, not only by encouraging family planning program. Development of infrastructure especially in eastern area of Indonesia and improving regional equality could be the effective way out. Household who live in the region with worse infrastructure condition might get better socio-economic condition and therefore migration to the rich regions such as in Java and Jakarta provinces could be declined. Finally, immunization has been very important preventive intervention in reducing infant mortality in Indonesia and the program need to be continued in the future period.

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Appendix 1
Summary Statistics Based on Infant Survival Status

Variables	2002-2003					2007					2012				
	Dead			Alive		Dead			Alive		Dead			Alive	
	Mean	St Dev	Pr(|T| > |t|)	Mean	St Dev	Mean	St Dev	Pr(|T| > |t|)	Mean	St Dev	Mean	St Dev	Pr(|T| > |t|)	Mean	St Dev
Sex (1=male)	0.56	0.50	0.0181	0.51	0.50	0.62	0.49	0.0000	0.52	0.50	0.59	0.49	0.0002	0.52	0.50
Single/Multiple Delivery (1=twin)	0.07	0.26	0.0000	0.01	0.12	0.07	0.26	0.0000	0.01	0.11	0.10	0.30	0.0000	0.01	0.11
Birth rank	2.90	2.12	0.0000	2.50	1.74	2.75	1.94	0.0048	2.53	1.69	2.69	1.99	0.0001	2.36	1.60
Birth interval															
1=shorter than 24 month	0.24	0.43	0.0000	0.13	0.34	0.24	0.43	0.0000	0.14	0.35	0.24	0.43	0.0000	0.13	0.33
2=longer than 47 month (reference:24-47 month)	0.44	0.50	0.0006	0.53	0.50	0.43	0.50	0.0002	0.52	0.50	0.46	0.50	0.0002	0.56	0.50
Birth weight															
1=below 2,500 grams	0.22	0.42	0.0000	0.07	0.25	0.28	0.45	0.0000	0.07	0.26	0.30	0.46	0.0000	0.07	0.25
2=above 3,500 grams (reference= 2,500-3500 grams)	0.11	0.32	0.0009	0.18	0.39	0.15	0.35	0.0021	0.21	0.41	0.15	0.36	0.0119	0.20	0.40
Birth size															
1=larger than average	0.18	0.38	0.0000	0.30	0.46	0.21	0.41	0.0000	0.32	0.47	0.21	0.41	0.0000	0.32	0.47
2=smaller than average (reference=average)	0.32	0.47	0.0000	0.15	0.35	0.35	0.48	0.0000	0.16	0.37	0.34	0.47	0.0000	0.14	0.34
Mother age at childbirth															
1= below 23 years	0.28	0.45	0.2387	0.26	0.44	0.30	0.46	0.0006	0.23	0.42	0.20	0.40	0.0544	0.17	0.37
2= above 35 years (reference: 23-35 years)	0.11	0.32	0.8069	0.11	0.31	0.15	0.36	0.0960	0.12	0.33	0.18	0.38	0.0151	0.14	0.35
Pregnancy complication (1=yes)	0.10	0.30	0.1693	0.07	0.26	0.17	0.37	0.0029	0.10	0.30	0.20	0.40	0.0013	0.12	0.33
Delivery complication (1=yes)	0.41	0.49	0.0003	0.48	0.50	0.44	0.50	0.0000	0.53	0.50	0.51	0.50	0.0030	0.57	0.49
Pregnancy Supplement (1=yes)	0.69	0.46	0.0015	0.78	0.41	0.65	0.48	0.0002	0.76	0.43	0.66	0.48	0.0020	0.75	0.44
First 3 days given nothing (1=yes)	0.71	0.45	0.0000	0.45	0.50	0.43	0.50	0.0398	0.37	0.48	0.54	0.50	0.0135	0.40	0.49
Early initiation of breastfeeding (1=yes)	0.39	0.49	0.0386	0.34	0.47	0.35	0.48	0.2651	0.38	0.48	0.50	0.50	0.9502	0.50	0.50

Variables	2002-2003					2007					2012				
	Dead			Alive		Dead			Alive		Dead			Alive	
	Mean	St Dev	Pr(|T| > |t|)	Mean	St Dev	Mean	St Dev	Pr(|T| > |t|)	Mean	St Dev	Mean	St Dev	Pr(|T| > |t|)	Mean	St Dev
Tetanus injection (1=yes)	0.66	0.47	0.0071	0.74	0.44	0.63	0.48	0.0010	0.73	0.45	0.65	0.48	0.0042	0.73	0.44
Contraceptive use (1=yes)	0.47	0.50	0.0000	0.67	0.47	0.48	0.50	0.0000	0.67	0.47	0.51	0.50	0.0000	0.69	0.46
Antenatal care	5.13	3.47	0.0000	6.81	3.69	5.19	3.50	0.0000	6.69	3.67	5.42	3.81	0.0000	7.36	3.73
Postnatal care (1=yes)	0.62	0.41	0.0000	0.79	0.41	0.51	0.50	0.0000	0.68	0.47	0.35	0.48	0.0000	0.61	0.49
Delivery assistant (1=health practitioner)	0.57	0.50	0.0000	0.68	0.47	0.54	0.50	0.0000	0.70	0.46	0.71	0.45	0.0001	0.80	0.40
Place of delivery (1=medical facility)	0.23	0.42	0.0000	0.38	0.49	0.33	0.47	0.0003	0.41	0.49	0.47	0.50	0.0005	0.55	0.50
Heard of ORS (1=yes)	0.87	0.33	0.0038	0.91	0.28	0.83	0.38	0.0000	0.92	0.28	0.84	0.37	0.0000	0.92	0.27
Access to improved water (1=yes)	0.12	0.32	0.0000	0.17	0.38	0.13	0.33	0.0334	0.16	0.36	0.09	0.29	0.2599	0.11	0.31
Access to improved sanitation (1=yes)	0.40	0.49	0.0000	0.51	0.50	0.40	0.49	0.0000	0.53	0.50	0.52	0.50	0.0000	0.64	0.48
Improved flooring materials (1=yes)	0.56	0.50	0.0001	0.64	0.48	0.56	0.50	0.0000	0.67	0.47	0.65	0.48	0.0000	0.75	0.44
SOCIO ECONOMIC DETERMINANTS															
Maternal education level (1=7 years or above)	0.37	0.48	0.0000	0.50	0.50	0.42	0.49	0.0000	0.56	0.50	0.53	0.50	0.0000	0.66	0.47
Paternal education level (1=7 years or above)	0.42	0.49	0.0000	0.55	0.50	0.53	0.50	0.0000	0.61	0.49	0.56	0.50	0.0000	0.67	0.47
Maternal Employment Status (1=employed)	0.47	0.50	0.1626	0.44	0.50	0.53	0.50	0.0777	0.49	0.50	0.65	0.48	0.0000	0.54	0.50
Women empowerment:															
a. Mother made the decision on the own health care (1=yes)	0.85	0.36	0.2739	0.86	0.34	0.82	0.38	0.0621	0.85	0.36	0.83	0.38	0.2342	0.85	0.36
b. Mother made the decision for household spending (1=yes)	0.78	0.42	0.1070	0.80	0.40	0.76	0.43	0.0400	0.79	0.40	0.83	0.37	0.7183	0.83	0.38
c. Beating is justified (1=yes)	0.42	0.49	0.0000	0.33	0.47	0.45	0.50	0.0000	0.37	0.48	0.40	0.49	0.3891	0.38	0.49

Variables	2002-2003					2007					2012				
	Dead			Alive		Dead			Alive		Dead			Alive	
	Mean	St Dev	Pr(|T| > |t|)	Mean	St Dev	Mean	St Dev	Pr(|T| > |t|)	Mean	St Dev	Mean	St Dev	Pr(|T| > |t|)	Mean	St Dev
d. Husband permission in getting medical help for the wife (1=big problem)	0.08	0.27	0.0756	0.06	0.23	0.08	0.27	0.3061	0.07	0.25	0.08	0.27	0.1065	0.06	0.24
Family Member	5.03	2.39	0.0000	5.62	2.21	5.13	2.44	0.0000	5.65	2.23	4.93	2.25	0.0000	5.61	2.34
Access to health care:															
a. Cost (1=big problem)	0.34	0.47	0.0307	0.30	0.46	0.37	0.48	0.0140	0.33	0.47	0.22	0.41	0.0203	0.18	0.38
b. Distance to health facility (1=big problem)	0.22	0.42	0.0126	0.18	0.38	0.27	0.44	0.0010	0.21	0.41	0.17	0.38	0.0231	0.13	0.34
Wealth Index	2.15	1.30	0.0000	2.64	1.48	2.25	1.35	0.0000	2.67	1.45	2.25	1.37	0.0000	2.67	1.44
Has electricity (1=yes)	0.69	0.46	0.0000	0.81	0.39	0.75	0.43	0.0000	0.83	0.37	0.87	0.34	0.0008	0.92	0.27
Has refrigerator (1=yes)	0.11	0.31	0.0000	0.19	0.39	0.19	0.39	0.0000	0.27	0.44	0.31	0.46	0.0000	0.44	0.50
Has television (1=yes)	0.58	1.04	0.0002	0.74	1.12	0.70	1.08	0.0154	0.81	1.11	0.87	1.00	0.0278	0.96	1.03
Has radio (1=yes)	0.56	1.04	0.0118	0.67	1.15	0.52	1.10	0.1660	0.58	1.16	0.37	1.06	0.2069	0.43	1.13
Community level of maternal education	0.40	0.29	0.0000	0.50	0.30	0.49	0.30	0.0000	0.56	0.30	0.56	0.31	0.0000	0.66	0.28
Community access to improved water	0.12	0.25	0.0000	0.17	0.28	0.13	0.24	0.0127	0.15	0.26	0.09	0.20	0.0476	0.10	0.21
Community access to improved sanitation	0.40	0.33	0.0000	0.50	0.34	0.43	0.34	0.0000	0.51	0.33	0.52	0.34	0.0000	0.62	0.31
Community immunization participation	0.69	0.20	0.0000	0.80	0.20	0.67	0.20	0.0000	0.79	0.20	0.71	0.19	0.0000	0.84	0.18
Cluster type (1=urban)	0.29	0.45	0.0000	0.41	0.49	0.28	0.45	0.0000	0.38	0.49	0.35	0.48	0.0000	0.46	0.50
Region (ref=Java & Bali)															
1. Sumatra	0.29	0.46	0.6920	0.30	0.46	0.28	0.45	0.3705	0.29	0.46	0.24	0.43	0.0110	0.30	0.46
2. Kalimantan	0.13	0.34	0.7384	0.13	0.34	0.10	0.31	0.9250	0.10	0.30	0.09	0.29	0.4164	0.10	0.31
3. Sulawesi	0.26	0.44	0.0001	0.19	0.39	0.19	0.39	0.5319	0.18	0.38	0.21	0.40	0.0391	0.17	0.38
4. Nusa Tenggara, Maluku & Papua	0.09	0.29	0.1830	0.08	0.27	0.26	0.44	0.0000	0.18	0.38	0.23	0.42	0.0016	0.18	0.38

Appendix 2

Regression Results: Bio-demographic Determinants

Variables	2002-2003		2007		2012	
	OR	**Std. Err.**	**OR**	**Std. Err.**	**OR**	**Std. Err.**
Sex (0=female)	1.292	(0.263)	1.302	(0.236)	1.353*	(0.245)
Birth Multiplicity (0=singleton)	5.103***	(2.376)	5.617***	(2.112)	1.535	(0.848)
Birth Rank	1.060	(0.076)	1.119*	(0.071)	1.119*	(0.070)
Birth Interval						
ref: 24-47 month						
<24 month	1.597	(0.477)	1.612*	(0.401)	1.303	(0.369)
>47 month	0.827	(0.198)	0.672*	(0.143)	0.819	(0.173)
Birth weight						
ref=2500-3500 grams						
<2500 grams	1.987*	(0.725)	2.271***	(0.663)	3.158***	(0.922)
>3500 grams	0.675	(0.237)	0.895	(0.250)	0.984	(0.273)
Birth size						
ref=average						
larger than average	0.645	(0.179)	0.919	(0.228)	0.967	(0.239)
smaller than average	1.085	(0.347)	1.812**	(0.481)	1.610*	(0.447)
Age at childbirth						
ref=23-35years						
<23	0.498	(0.241)	1.322	(0.431)	1.191	(0.572)
>35	1.033	(0.311)	1.430	(0.339)	1.567**	(0.346)
Pregnancy complication (0=no)	2.046**	(0.599)	1.842***	(0.431)	1.976***	(0.418)
Delivery complication (0=no)	0.595**	(0.124)	0.665**	(0.121)	1.146	(0.219)
Region						
(ref= Java & Bali)						
1. Sumatra	0.955	(0.249)	1.542	(0.408)	0.625*	(0.155)
2. Kalimantan	0.474*	(0.213)	2.019**	(0.635)	0.694	(0.241)
3. Sulawesi	1.897**	(0.510)	1.343	(0.417)	0.979	(0.253)
4. Nusa Tenggara, Maluku & Papua	1.092	(0.467)	1.698*	(0.521)	1.006	(0.274)
_cons	0.015***	(0.006)	0.007***	(0.003)	0.007***	(0.002)
Sample size		**6,468**		**7,747**		**8,311**
Prob> chi2		**0.0000**		**0.000**		**0.0000**
Peseudo R2		**0.0637**		**0.0857**		**0.0672**
Correctly classified		**98.42%**		**98.30%**		**98.42%**

Notes: -Statistical significances are written in parenthesis: *** p<0.01, ** p<0.05, * p<0.1

- Probit and LPM regression techniques yield virtually similar results with the results of logit model in the table.

Appendix 3
Regression Results: Proximate Determinants

Variables	2002-2003		2007		2012	
	OR	**SE**	**OR**	**SE**	**OR**	**SE**
Sex (0=female)	1.094	(0.302)	1.232	(0.276)	2.099***	(0.569)
Birth Multiplicity (0=singleton)	19.388***	(12.035)	7.115***	(3.604)	2.613	(2.074)
Birth Rank	0.956	(0.106)	1.155*	(0.087)	1.076	(0.094)
Birth Interval						
ref: 24-47 month						
<24 month	2.229**	(0.889)	1.381	(0.431)	0.835	(0.369)
>47 month	1.005	(0.345)	0.6216*	(0.161)	0.734	(0.213)
Birth weight						
ref=2500-3500 grams						
<2500 grams	0.832	(0.470)	1.169	(0.454)	2.072	(0.960)
>3500 grams	0.609	(0.305)	0.518*	(0.197)	0.584	(0.230)
Birth size						
ref=average						
larger than average	0.502*	(0.200)	0.856	(0.256)	1.175	(0.373)
smaller than average	0.995	(0.431)	1.866**	(0.590)	1.025	(0.446)
Age at childbirth						
ref=23-35years						
<23	0.449	(0.282)	1.406	(0.557)	0.738	(0.558)
>35	0.593	(0.286)	1.550	(0.460)	1.539	(0.491)
Pregnancy complication (0=no)	1.729	(0.799)	0.985	(0.359)	2.534***	(0.769)
Delivery complication (0=no)	0.609*	(0.180)	0.629**	(0.145)	1.039	(0.291)
Pregnancy Supplement (0=no)	1.071	(0.418)	1.163	(0.351)	0.710	(0.211)
First 3 days given nothing (0=no)	1.548	(0.485)	1.365	(0.350)	1.516	(0.434)
Early initiation of breastfeeding (0=no)	0.754	(0.257)	0.796	(0.208)	0.870	(0.248)
Tetanus injection (0=no)	1.108	(0.439)	1.135	(0.334)	0.874	(0.270)
Contraceptive use (0=no)	0.4261***	(0.124)	0.476***	(0.110)	0.347***	(0.091)
Antenatal care	0.988	(0.049)	1.035	(0.039)	0.989	(0.039)
Postnatal care (0=no)	0.672	(0.326)	0.722	(0.226)	0.974	(0.266)
Delivery assisted by health practitioner						
(0=no)	0.793	(0.368)	1.898*	(0.683)	1.662	(0.693)
Deliver at medical facility (0=no)	0.541	(0.203)	0.749	(0.198)	0.520**	(0.157)
Heard of ORS (0=no)	0.773	(0.423)	0.603	(0.232)	0.336**	(0.144)
Access to improved water (0=no)	0.280**	(0.171)	1.040	(0.334)	0.714	(0.342)
Access to improved sanitation (0=no)	1.143	(0.345)	0.613*	(0.154)	0.993	(0.288)
Improved flooring materials (0=no)	0.503**	(0.156)	0.640*	(0.165)	1.077	(0.368)
Region						
(ref= Java & Bali)						
1. Sumatra	1.101	(0.423)	1.294	(0.442)	0.279***	(0.111)
2. Kalimantan	0.403	(0.246)	1.426	(0.615)	0.331***	(0.193)
3. Sulawesi	1.979*	(0.794)	1.097	(0.437)	0.791	(0.291)
4. Nusa Tenggara, Maluku & Papua	0.592	(0.391)	1.330	(0.518)	0.567	(0.227)
_cons	0.100**	(0.090)	0.018***	(0.013)	0.045***	(0.034)
Sample size		**5,376**		**6,852**		**7,339**
Prob> chi2		**0.0000**		**0.000**		**0.0000**
Peseudo R2		**0.1430**		**0.1059**		**0.1153**
Correctly classified		**98.94%**		**98.74%**		**99.11%**

Notes: -Statistical significances are written in parenthesis: *** p<0.01, ** p<0.05, * p<0.1
- Probit and LPM regression techniques yield virtually similar results with the results of logit model in the table.

Appendix 4
Regression Results: Pooled data

Variables	Pooled data	
	OR	**SE**
Sex (0=female)	1.289***	(0.189)
Birth Multiplicity (0=singleton)	8.687*	(2.962)
Birth Rank	1.335***	(0.076)
Birth Interval		
ref: 24-47 month		
<24 month	1.512*	(0.323)
>47 month	0.647**	(0.111)
Birth weight		
ref=2500-3500 grams		
<2500 grams	1.286	(0.340)
>3500 grams	0.509***	(0.127)
Birth size		
ref=average		
larger than average	0.829	(0.160)
smaller than average	1.362	(0.301)
Age at childbirth		
ref=23-35years		
<23	0.867	(0.264)
>35	1.231	(0.244)
Pregnancy complication (0=no)	1.773***	(0.365)
Delivery complication (0=no)	0.709**	(0.110)
Pregnancy Supplement (0=no)	0.931**	(0.176)
First 3 days given nothing (0=no)	1.465	(0.240)
Early initiation of breastfeeding (0=no)	0.783	(0.130)
Tetanus injection (0=no)	0.938	(0.178)
Contraceptive use (0=no)	0.411***	(0.062)
Antenatal care	0.993	(0.025)
Postnatal care (0=no)	0.796	(0.152)
Delivery assisted by health practitioner (0=no)	1.381	(0.311)
Deliver at medical facility (0=no)	0.696**	(0.127)
Heard of ORS (0=no)	0.556**	(0.144)
Access to improved water (0=no)	0.811	(0.199)
Access to improved sanitation (0=no)	0.894	(0.174)
Improved flooring materials (0=no)	0.797	(0.153)
Maternal education (0=less than 7 years)	1.106	(0.204)
Paternal education (0=less than 7 years)	1.046	(0.188)
Maternal Employment Status (ref=unemployed)	1.877***	(0.294)
Women empowerment:		
a. Mother made the decision on the own health care (0=no)	0.961	(0.199)
b. Mother made the decision for household spending (0=no)	1.111	(0.170)

Variables	Pooled data	
	OR	**SE**
c. Beating is justified (0=no)	0.659	(0.234)
d. Husband permission in getting medical help for the wife (ref=not big problem)	0.606	(0.038)
Family Member	0.616***	(0.217)
Access to health care:		
a. Cost (ref=not big problem)	0.881	(0.172)
b. Distance to health facility (ref= not big problem)	1.551**	(0.326)
Wealth Index	0.962	(0.110)
Has electricity (0=no)	0.943	(0.221)
Has refrigerator (0=no)	1.565**	(0.354)
Has television (0=no)	0.981	(0.197)
Has radio (0=no)	0.978	(0.144)
Cluster type (ref=rural)	0.895	(0.168)
Region		
(ref= Java & Bali)		
1. Sumatra	0.688*	(0.153)
2. Kalimantan	0.581*	(0.177)
3. Sulawesi	1.167	(0.282)
4. Nusa Tenggara, Maluku & Papua	0.779	(0.212)
2007	1.147	(0.210)
2012	0.782	(0.177)
_cons	0.193***	(0.116)
Sample size		**19,102**
Prob> chi2		**0.000**
Peseudo R2		**0.1380**
Correctly classified		**98.93%**

Notes: -Statistical significances are written in parenthesis: *** p<0.01, ** p<0.05, * p<0.1