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Determinant of Fertility in Lao PDR: The Role of maternal education

Alay PHONVISAY*

Abstract

Fertility has first begun to decline in developed countries and now it is also declining in developing countries (Schultz, 1980). Fertility has been studied since the 19th century in order to find patterns of reproduction, because declining rates in fertility have positively affected development, such as human capital and child's health, especially in developing countries. In the case of Lao PDR, although the fertility rate in Lao PDR has declined to the same degree as other developing countries, its rank (2nd in ASEAN and 63rd in the world) is still considered among the groups of higher rates (UN, 2010). Notwithstanding its importance, research studies on fertility for Lao PDR are still sparse. However, knowledge on fertility and its determinants is indispensable for enhancing maternal and child health. In particular, the impact of mother's education on fertility could be one channel to improving overall health in Lao PDR.

This paper analyzes the determinants of fertility focusing mainly focus on an impact of mother educational levels on fertility of Lao women aged between 15 to 49 years old. The investigation is mainly based on the data from Lao Reproductive Health Survey 2005. Women, who have some primary education, completed primary level, lower secondary, and higher education, are likely to have fewer children by 0.23, 0.41, 0.49 and 0.53 respectively as educational level rises.

Key words: Fertility, Maternal Education, Lao PDR
JEL Classification: I130, I250

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1 Introduction

Fertility has first begun to decline in developed countries and now it is also declining in developing countries (Schultz, 1980). Fertility has been studied since the 19th century in order to find patterns of reproduction, because declining rates in fertility have positively affected development, such as human capital and child's health, especially in developing countries. Because mother and child's health tend to be improved while child's schooling tends to be increased in a family with fewer members (Schultz, 2008).

In the case of Lao PDR, the health sector continues to be one of the top priorities in the National Growth and Poverty Eradication Strategy. Over the past decade, health indicators of maternal and children's health have been continuously improved. However, the maternal mortality rate of 410 per 100,000 births and the under-five child mortality rate of 61 per 1000 live births are considerably high when comparing with other countries in the region (UNCIEF, 2010b). The evidence in the literature has shown that high fertility is a leading cause of maternal and child mortality (Parnell, 1990).

Although the fertility rate in Lao PDR has declined to the same degree as other developing countries, its rank (2nd in ASEAN and 63rd in the world) is still considered among the groups of higher rates (UN, 2010). On the other hand, for a small population like Lao a moderate fertility rate would contribute to the expansion of labor forces, market and overall economic growth, if to certain extent the quality of human resource and human capital can satisfy the requirements in modern society. However, the most serious counterargument against high fertility is the persistent mass poverty and the lack of adequate health services for mothers and children, especially those living in rural areas. According the Lao Reproduction and Health Survey 2005 (LRHS-2005), about 90% of women in rural areas and 50% of women in urban areas deliver at home, which implies a considerable risk factor for maternal and child mortality in the country.

Notwithstanding its importance, research studies on fertility for Lao PDR are still sparse. However, knowledge on fertility and its determinants is indispensable for enhancing maternal and child health. In particular, the impact of mother's education and child mortality on fertility could be one channel to improving education

and health. In order to fill this study gap, this paper analyzes the determinants of fertility focusing mainly on the impacts of child mortality, parents' educational levels, knowledge of contraceptive methods, household wealth, job specification and regional differences on fertility of Lao women aged between 15 to 49 years old. The investigation is mainly based on the data from LRHS-2005.

2 LITERATURE REVIEW

2.1 TREND OF FERTILITY IN THE WORLD

According to Schultz (2002), the demographic transition is divided into 3 stages. In the first stage, there are high birth rates and death rates which highly fluctuate with shocks such as disease outbreaks and crop failures. In this period, there is not much difference between birth rates and death rates. For fertility, there is no family planning for controlling fertility, thus the birth rate is determined by the ability of women's child bearing. In the second stage, the transition occurs when there is a sharp decline in mortality, and an increase in population with improvement of life expectancy. Life expectancy increases from 30-35 years to 70-75 years when the transition occurred in the current high income countries, while rising from 25-30 years to 45-73 years in low income countries. For the third stage, there is a steady and large decline in fertility rates as a result of population stability. In this stage, generally the fertility rate reduces about more than half from the previous stage.

According to history, demographic transition first occurred in developed countries in 1750, and then in low-income countries during the 1920s when mortality rates sharply declined (Schultz, 2009). Fertility started to decline during the end of the 19th century in high-income countries and during the 1970s in low-income countries (Schultz, 2002). From the early 1950s and 2009, the world total fertility rate has declined from about 5.0 to 2.5 births per woman while the total fertility rate in Asia has also dropped from 5.7 to 2.3 births per woman (UN, 2010).

There are many frameworks that attempt to explain the cause of decline in fertility. One hypothesis assumes that demand for children depends on the value and cost of children (Bulatao, 1984). Becker and Lewis (1974) propose the concept of interaction between children quality and quantity by assuming that demand for children quality is higher than children quantity when a family's income increases.

Moreover, Caldwell (1976) argues that the demographic transition occurs because of the direction of wealth flow between parents and children have changed. He asserts that in a primitive society, wealth flows from children to parents whereas in modern or industrial based societies wealth flows go from parents to children. In addition, the economies based on agriculture have higher fertility since young children have to engage in household and agricultural works (Harris, 1989). Therefore, the fertility rate decreases when economies move towards industrialization. In the second hypothesis, parents adjust fertility rates according to the level of the infant mortality rate occurring in their society (Matthiessen and Mccann, 1978; Sanderson and Dubrow, 2000). Over the past decade, the fertility rate has substantially declined in many countries as a result of a reduction in child mortality worldwide. The last explanation of decline in fertility is that it is a result of the increasing empowerment of women. The rate of women's participation outside the family in the wage labor force has increased in many countries (Schultz, 1990), which results in lower fertility because women have less time for child bearing.

2.2 DETERMINANTS OF FERTILITY

From the large and growing literature on fertility, mother education has played an important role for the decline in reproductive rates (Benefo and Schultz, 1996; Bongaarts et al., 1984; Osili and Long, 2007). This happens through the concept of opportunity cost. Mincer (1963) asserts that an increase in women's wages creates greater opportunity cost to women which discourages them from having children. Women with a higher education level has a greater opportunity cost on child bearing (Schultz, 1974). In addition, educated women tend to be more open minded to modern social norms and family planning. Education also gives women more power to bargain the number of births within the family (Dreze and Murthi, 2000). Using cross-sectional data, Benefo and Schultz (1996) find that a mother's educational level above primary school has a significant impact on lowering fertility in Cote d'Ivoire and Ghana. This reverse relationship can also be found in Vietnam (Nguyen-Dinh, 1997), in Indonesia (Breierova and Duflo, 2004), in Philippine (Bautista, 2007) and in Columbia (Gamboa and Ramirez, 2008). Generally, the difference in fertility rates among women who have least education and those having the highest education level are about 0.5

children (Cochrane, 1983).

Child mortality has a positive relation with fertility. It induces mother to have more children to replace dead children. In addition, in some regions, where the mortality rate is stable or has slowly declined for a long period, parents tend to have fewer children because they adjust their demand for children according to level of child mortality they will face (Schultz, 1980; Benefo and Schultz, 1996). Moreover, the mother who has experienced child mortality has higher fertility because she has a shorter birth interval comparing with mothers who have not experienced child mortality (Randall and Legrand, 2000).

On the other hand, the relationship between fertility and household income is still controversial depending on countries and region. According to household income hypothesis, increased income induces increased fertility because having children is viewed as a household consumption (Blake, 1968). For instance, a family's permanent income has a positive effect on fertility in Cote d'Ivoire while it affects fertility negatively in Ghana (Benefo and Schultz, 1996) and Jamaica (Handa, 2000). Children might be valued as normal good or inferior goods for the family. Wealthier families tend to want more children if children are viewed as a normal good for the family. However, if parents consider having children as a quantity-quality tradeoff, higher income families tend to have fewer children because they tend to invest in children's quality rather than increasing the number of children (Becker and Lewis, 1974). Nguyen-Dinh (1997) finds that men's educational level, as a proxy of household income in Vietnam, has negative impact on fertility. This same impact is also found in the Philippines (Bautista, 2007).

Women's age and age at marriage have a positive relation with fertility. Mothers who marry at a younger age tend to have more children than women who marry at an older age since younger married women have earlier to exposure and a longer period for child bearing (Mohammad, 1985). In terms of urbanization, there is a belief that urbanization has contributed to reducing fertility because child labor is less likely to be required for household production in urban areas. Moreover, women in urban areas have better accessibility to the use and information of modern contraceptive methods compared to women in rural areas. Contraceptives are considered an important factor influencing the decline of fertility (Balatao, 1984).

However, the usage of modern contraceptives still varies among countries and regions.

According to the literature, there are endogeneity problems concerning unobserved variables that correlate with parental education such as parents' ability and family background (educational level of parents' family and family's wealth). There is a concern that girls might have less opportunity to study than boys because of family background (Breierova and Duflo, 2004, Schultz, 2009). Wolfe and Behrman (1987) argue that there is no effect of mother's education on fertility and child health after controlling for mother's family background. In addition, a possible endogeneity problem concerning child mortality and fertility is addressed in the study of fertility and child mortality in Cote d'Ivoire and Ghana. Instrumental Variables (IV) is used to overcome this problem (Benefo and Schultz, 1996). High rate of child mortality can increase fertility because of died-child replacement mechanism of parents. On the other hand, high fertility might induce high child mortality because having more children means having higher risk of child mortality.

3 FERTILITY AND THE EDUCATIONAL SITUATION IN LAO PDR

3.1 FERTILITY SITUATION

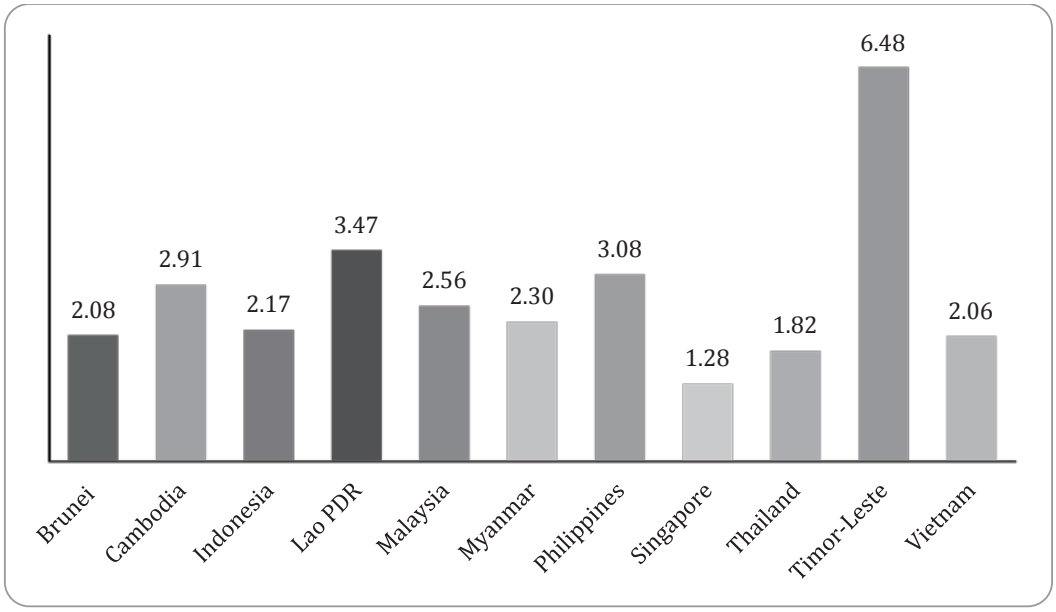
Before 1988, the Lao government had a pronatalist population policy and any distribution of any contraceptive was illegal because the Lao government believed that Lao PDR still had a low population per area. However, after facing massive poverty problems and high fertility being identified as one of the major causes of poverty and poor health, especially for women and children, the Lao government approved birth spacing by legalization of the sale and distribution of contraceptives as an instrument for improving maternal and child health. In the 1990, Ministry of health started to provide birth spacing services but the service was still limited and in 1995, the Lao government officially adopted birth spacing policy and later on changed the name to "family planning" policy.

The population of Lao PDR has reached 5.6 million, and has a natural growth rate of 2.5 percent. Lao PDR has a young population structure with about half of the total population under the age of 20. The average household size is 5.9 persons and about 10% of household heads are women (NSC, 2005a). The Total Fertility Rate

(TFR) has been steadily declining during the past decade. During 1990-1995, TFR dropped from 6.4 to 5, and it is continuing to fall to 4.8 and 4.5 in 2000 and in 2005, respectively (LRHS 2005). Comparing with other Southeast Asia countries (Figure 1), Lao PDR ranks 2nd highest fertility rate per women after Timor-Leste (UN, 2010).

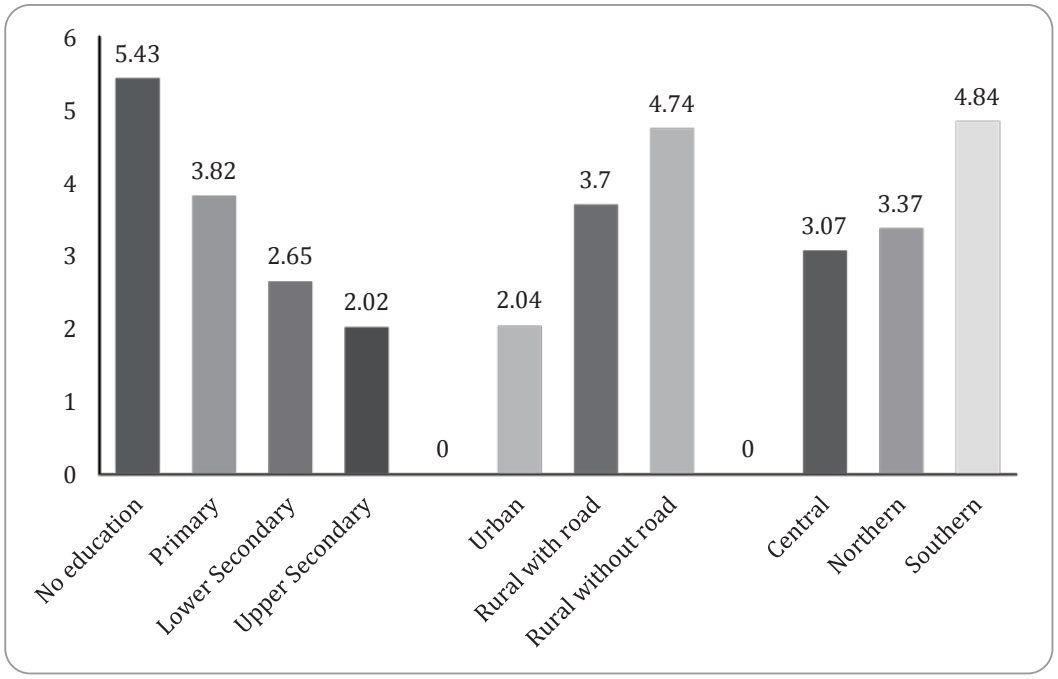
Even though fertility in Lao PDR has substantially declined over the past decade, there are differences in fertility rates among urban and rural areas, geographical regions, and mothers' educational levels. In Figure 2, the highest fertility rate is found among uneducated women (5.43 children/mother), rural areas without roads (4.74) and in Southern region (4.84). The lowest fertility is 2.02 for mothers with upper secondary education, and 2.04 for mothers in Vientiane Capital (LRHS 2005).

In terms of Age specific fertility rates (ASFR), comparing among three regions, women in Southern region have higher ASFR and start child bearing slightly earlier than Northern and Central regions. The peak childbearing age for all regions is between 20-24 years old and it decreases significantly after the age of 30. The median length of birth interval is 34 months. Interestingly, the early child bearing age among married women in Lao PDR is relatively high. About 10 percent of women have given birth before the age of 15 years old, while 37% had not given birth before age 18. At the age of 25, four fifths of married women have already had their first birth (LRHS 2005).



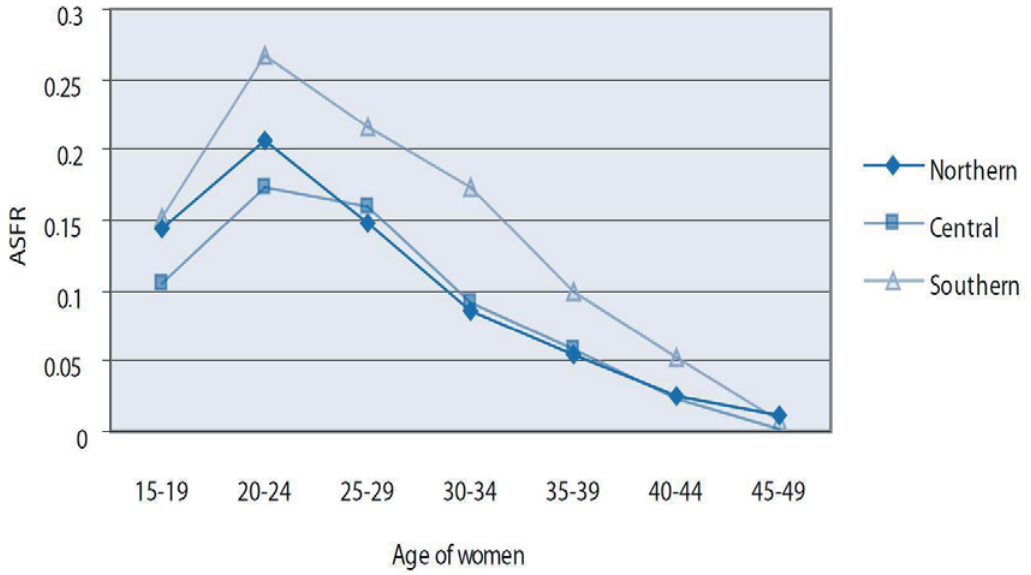
Source: UN, 2009

Figure 1: Total fertility rates in selected countries in Southeast Asia, 2008



Source: Lao Reproductive Health Survey 2005

Figure 2: Total Fertility Rates by women's background and characteristics



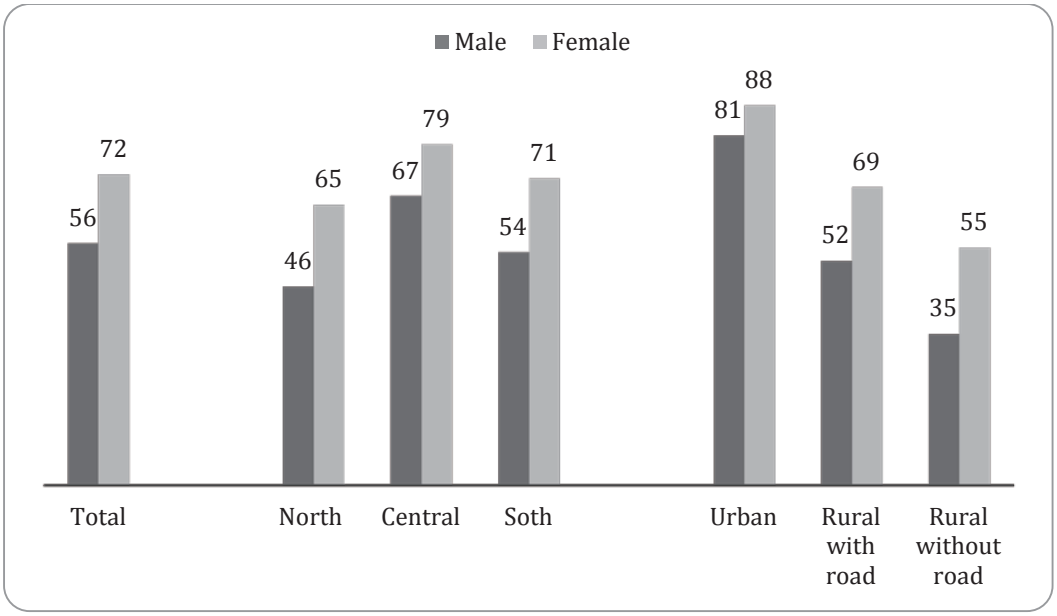
Source: Lao Reproductive Health Survey 2005

Figure 3: Age specific fertility rates (ASFR) by region

3.2 EDUCATION SITUATION

The education system in Lao PDR consists of preschool (age 3 to 5), five years of primary education, three years of lower secondary school education, three years of upper secondary school education, one to three years of vocational/ technical education, and four to six years of university education, depending on majors. Comparing between 2002 and 2008, the number of primary schools and lower secondary schools in villages raise about 10% which are 89% and 18% respectively (NSC, 2008). Since 1990, education has been dramatically improved. Net primary enrollment has also substantially increased for both males and females from 1990 to 2008. It has risen from 57% to 84% for females and 67% to 87.5% for males, respectively. Generally, there is not much difference of net enrollment rates for children aged 6-15 years between boys and girls. In the north, the difference between boys and girls enrolment rates is about 3 to 5% where it is about 4% in central and southern region (NSC, 2008). Moreover, total primary completion rate has significantly increased from 46% to 75% during 1990-2006 (UN, 2008). However, access to primary education is not guaranteed for all children, especially for girls in

minority ethnic groups, delayed enrollment and grade repetition rates remain very high. In terms of literacy rate, there is still a lot of difference between gender and region. The literacy rate in Lao PDR is about 64% of the population, of which 72% is male and 56% is female (Figure 4). By region, the literacy rate in urban areas is 84%, while the only 45% for the population in rural areas without roads (NSC, 2008). Moreover, the population in the northern region has the lowest literacy rate for both males (65%) and females (46%) while the highest rate is in central region (79% of males and 67% for females).



Source: Lao Reproductive Health Surveys 2008

Figure 4: Literacy rate by gender and region

4 THEORETICAL FRAMEWORK, EMPIRICAL MODEL AND DATA DESCRIPTION

4.1 THEORETICAL FRAMEWORK

Fertility is determined in a dynamic environment of human lifecycle. Parents look beyond their current condition in deciding the number children they would like to have. They consider both the cost of having children, which would incur at present and in future, and the merit they will receive in future. In other words, the rationale for determining fertility relates to the assessment of future benefit in the current

condition. For example, farmers in developing countries would consider having more children a source of labor for agricultural production in future. Also, in the absence of an appropriate social security system, children are considered life security for their future, especially after retirement. Hence, demand for children varies greatly among urban and rural households. Specifically, the fertility rate in rural areas is usually higher than that of urban families. In addition, the fertility rate depends on family characteristics, such as education level, wealth and the like, and preferences.

According to Schultz (1973, 1981) and Benefo and Schultz (1996), demand for children (F) depends on both father's and mother's wage through the concept of opportunity cost. Generally, the husband's wage is assumed to be family income and the mother's wage is assumed be the price variable, because women spend more time on childrearing than male and time has an opportunity cost in the market place. When income rises, the demand for children is expected to increase, since family can afford to buy more goods including having more children. On the other hand, when mother's wage rises, the demand for children is expected to drop due to an increase in mother's opportunity cost. In literature, father's and mother's education levels (E_f and E_m, respectively) are used as a proxy of their wage levels. In addition to parents' opportunity cost, child mortality level (CS), household asset (A), exchange prices of commodity at local market (P), and access to public services (G) also affect the fertility level. The demand for children used in this paper can be written as:

$F = f(E_f, E_m, CS, A, P, G)$

4.2 EMPIRICAL MODEL

From the theoretical framework above, we have the reduced form of fertility function as follows:

$$CEB = \beta_0 + \beta_1 x_1 + \beta_2 x_2 + \beta_3 x_3 + \beta_4 x_4 + \beta_5 x_5 + \beta_6 x_6 + \beta_7 x_7 + \beta_8 x_8 + \beta_9 x_9 + \beta_9 x_{10} + \beta_9 x_{11} + \beta_9 x_{12} \quad (1)$$

where CEB is the number of children born which is used as a proxy of fertility or demand for children (F); $x_1$and x_2 are women's age at married and women's age; x_3 and x_4 are men's and women's educational level; x_5 experiencing of child mortality; x_6 is contraceptive knowledge; x_7 is the number of Medical Workers in the district; x_8 and x_9 are dummies of men's and women's jobs; x_{10} is the dummy of rural area; and ; x_{11} is the dummy of region.

With respect to the endogeneity problem of parents' unobserved variables such as family background and ability, the problem concerning education of parents' family is considered very minor or even non-existent in the Lao PDR context. After the war, very well constructed and well-to-do families have most likely escaped the country. Thus, education influenced by mother's parents' educational level would not exist because most households have a very short history, especially in rural areas. In addition, the level of education in Lao PDR is deemed very low. Therefore, the difference in terms of education is very marginal. In terms of family background respect to family's wealth, it is attempted to control by using Asset Index.

Regarding possible endogeneity problem between fertility and child mortality, this analysis applies two procedures to deal with the problem. First child mortality is treated as exogenous and used as normal independent variable without using Instrument Variable (IV) method. The results from this model serve as the main findings in this Paper. Second, in view of providing persuasive statistical inferences attempts have been made to apply the IV method to the empirical analysis by using access to safety water and type of toilet as instrumental variables, because these two variables closely relate to child mortality, while a relation with fertility is practically absent.

For the analytical method in Equation (1), the OLS and 2SLS method are applied to estimate the explanatory variables on the number of children born to a mother.

4.3 DATA DESCRIPTIVE

4.3.1 STATISTICAL DATA

Statistical data used for the empirical analysis in this Paper is obtained from the Lao Reproductive Health Survey 2005, which was conducted from March 2004 to February 2005 by the National Statistics Centre (NSC) with the support of UNFPA. The Lao Reproductive Health Survey 2005 sample was made up of 10218 married women aged between 15-49 years covering all 17 provinces. It provides information on household conditions, reproduction, mortality and socio-economic background.

Upon removing incomplete samples, the econometric analysis is based on 8,689 observations covering roughly 85% of the original number, which is considered

a very high ratio by any standard. Therefore, this sample size is deemed sufficient for analyzing the determinants of fertility. The definition of each variable is presented in the next section.

4.3.2 VARIABLE DEFINITION

- CEB is the number of children born alive. This number accounts for all the children who were born alive and later died, children who are living with or living elsewhere of the sample women (range from 1 to 15 children).
- Women's age at married is the age of the sample at the time of getting married. This variable is expected to have a positive correlation with fertility and that the younger the age of the sample at marriage, the higher the rate of fertility will be. It is used as a proxy to control biological endowment.
- Women's age is the current age of women in the sample. The age of women is categorized into 5 age groups (15-24; 25-29; 30-34; 35-39; 40-49) in order to control impact of each age range on fertility level. It is used as a proxy of biological endowment. This variable is expected to have positive effect on fertility because older women tend to have given birth to a higher number of children.
- Men's and Women's educational levels are the highest educational levels of the samples. This variable is used as a proxy of parents' opportunity cost. The educational levels are divided into 5 categories which are: No education, Have some primary educational level; Completed primary school level, Have lower secondary school level, and Have upper secondary school level or higher. The sign of women's educational level is expected to be positive because a higher education means a higher opportunity cost. Moreover, women with higher education are able to utilized contraceptive information and methods more effectively. On the other hand, the sign of men's education is controversial because it is used as proxy of household income. Thus the fertility level depends on the perspective of men on a value of the children.
- Experiencing child mortality is a dummy variable and defined as 1 if a woman has experienced child mortality and 0 otherwise. From the well-documented literature, this variable is expected to have positive correlation with fertility because of the replacement effect.

- Contraceptive knowledge is a dummy variable and defined as 1 if a woman has ever heard about any modern contraceptive method and 0 otherwise. This variable is used to capture the impact of contraception on fertility.
- The number of Medical Workers in a district is number of Medical Worker in the district where a woman lives. This variable is used as a proxy of government health public service.
- Dummy of men's and women's jobs are dummy variables of husband and wife and defined as 1 if a man or woman has wage earner job and 0 otherwise.
- The dummy of rural is defined as 1 if a woman lives in a rural area and 0 otherwise.
- Region is a dummy variable used for identify which regional a woman lives. It is classified into 3 regions: Northern region, Central region, and Southern region.
- Asset index is used as a proxy of family nonhuman capital wealth to control family's wealth (which is one of family's backgrounds). It is categorized into 5 quintiles. Because most Demographic Health Surveys (DHS) lack income and consumption data, there is an introduction of Principal Component Analysis (PCA) to construct an index based on the selected variables from DHS data to be used as proxy for household wealth (Filmer and Pritchett, 2001).

  However, this method has been criticized for being not appropriate for categorical variables (Booysen, Maltitz, and Rand, 2007). Therefore, by using LRHS-2005, the Asset Index in this Paper is constructed based on the Polychoric PCA method in Table 1. Polychoric PCA is more appropriate for categorical data and its coefficients are more accurately estimated (Moser and Felton, 2007).

  The asset index used in this analysis is calculated as follows:

$$C_n^i = \sum_{j=1}^{J} w_t^{i,j} a_n^{i,j}$$

Where C_n^i is type capital index (Asset index) of household n,

$a_n^{i,j}$ is type of asset a^i from household n which a is measured by a binary, ordinal, or cardinal variable.

w is the weigh assigned to each type of asset (a). w is calculated by means of Polychoric PCA.

The variables are used for construct the asset index in this Paper includes: having a radio, television and a newspaper subscription, the type of drinking water sources and toilet, the type of source for electricity and cooking heat, and roof, wall, and floor material for houses (see appendix, Table A1).

4.3.3 VARIABLE DEFINITION

The variables for empirical analysis are calculated and compiled from LRHS 2005 data applying the definitions in the previous section. Table 1 presents the means and standard deviations of certain variables.

Table 1: Basic characteristics of variables in fertility analysis

Variable	Obs	Mean	Min	Max
CEB（Total number of children ever born alive to a woman）	9395	3.508	1	15
Women's age at first married	9395	19.575	10	44
women age（Year）	9395	32.692	15	49
Women's education（Year）	9395	3.407	0	11
No education	9395	0.326	0	1
Some priamry（1-4years）	9395	0.271	0	1
Complete primry school（5-7years）	9395	0.258	0	1
Complete lower secondary school（8-10years）	9395	0.100	0	1
Complete upper secondary school and higher（11 + years）	9395	0.044	0	1
Men's education	9395	4.706	0	11
No education	9395	0.203	0	1
Some priamry（1-4years）	9395	0.244	0	1
Complete primry school（5-7years）	9395	0.293	0	1
Complete lower secondary school（8-10years）	9395	0.150	0	1
Complete upper secondary school and higher（11 + years）	9395	0.110	0	1
Experiencing under-five mortality	9395	0.148	0	1
Heard of modern contraceptive method	9395	0.910	0	1
Number of health worker in a district	9395	43.076	0	113
Wage-earner jobs（Men）	8865	0.138	0	1
Wage-earner jobs（Women）	9395	0.044	0	1
Rural areas	9395	0.795	0	1
Norther region	9395	0.401	0	1
Central region	9395	0.379	0	1
Souther region	9395	0.220	0	1

Source: Author's calculations, data from LRHS-2005, National statistical Centre, Lao RDR

On average, CEB are 3.5 children per mother. Women with no education have the highest rate of children (3.9 children per mother) while mothers with upper secondary school and higher educational levels have the lowest rate of children (2.2 children per mother). There is not much difference between CEB among regions. The highest CEB is found in the South (3.7 children per mother), while it in is about 3.4 per mother Northern and Central regions.

About 15% of samples have experienced under-five child mortality. 90% of samples have heard of modern contraceptive methods. The average number of Medical Workers is 43 people per district. About 86.2% and 90.6% of men and women, respectively, are self-employed worker. The average age of married is 19.5 years and the average age of women is 32.6 years.

With respect to educational level, women's year of education is 3.4 years, on average. About 32.6% of married women have no education, while 27% could not finish the primary level. Men's educational level is 4.7 years and 20% have no education, while about 24.3% have only some primary educational level, on average.

5 EMPIRICAL RESULTS

The empirical analysis consists of six cases. The first three cases show the analysis of fertility in all areas and separately between urban and rural areas. The remaining three cases compare the situation among northern, central, and southern regions. Equation (1) is estimated by using OLS regression and the results are summarized in Table 2 and 3.

On average, education is found to have a strong negative impact on fertility. Less educated women have more children (reference group). Women, who have some primary education, completed primary level, lower secondary, and higher education, are likely to have fewer children by 0.23, 0.41, 0.49 and 0.53 respectively as educational level rises. This finding emphasizes the importance of basic education in Lao PDR. Only some primary educational level has already had some impact on reducing fertility, while it has been found that women would need to finish at least the primary level in Cote d'Ivoire and Ghana (Benefo and Schultz, 1996) and secondary school level in Vietnam and the Philippines (Nguyen-Dinh, 1997; Bautista, 2007) if education is to exert any impact on fertility. Also, the magnitude of the impact

of women's secondary education is higher in Lao PDR (coefficient of 0.5) than in Vietnam (0.1) and the Philippines (0.4). The magnitude of the impact of education on fertility appears to be stronger at higher levels of education. This might be attributable to two main reasons.

First, due to the lack of a non-farm labor market, women who have only some primary and completed primary education may face many disadvantages in finding a wage-earning job. About 57% of women with a completed lower secondary level or higher can find a non-farm job, as compared with 22% of women with a completed primary or less do so (LRHS-2005). Second, mothers with higher education would be able to use health information, such as contraceptive methods, to avoid unwanted pregnancy more effectively.

Comparing between urban and rural areas, the result shows that women with some primary education in urban areas have no impact on fertility reduction while all educational levels still have strong negative correlation with fertility. This is attributable to the fact that there are more wage-earning jobs available in urban areas. When comparing among regions, education has a weaker negative effect on fertility in the South. Comparing uneducated women with educated women, the only effect on a decline in fertility is for women who complete primary school. Moreover, among the three regions, mother's education in the central region tends to have higher magnitude of negative impact on fertility. The reason behind this is that the central region has a higher proportion of wage-earner mothers and more wage-earning job availability than other regions.

Overall, family income tends to have a strong positive effect on fertility in Lao PDR. It is shown through the strong positive impact of husband's educational level and men with wage-earning jobs on fertility. Men with some primary education and completed primary education[i] have higher fertility comparing with uneducated men at the country level (by 0.12 and 0.17 respectively), rural areas (0.13 and 0.18 respectively) and the Northern region (0.28 and 0.33 respectively), while men with wage-earning jobs also have statistically positive significant correlation with fertility at the country level, urban areas and Northern region by 0.08, 0.19 and 0.17 respectively. Interestingly, this finding contradicts previous studies on fertility in Vietnam (Nguyen-Dinh, 1997) and Philippine (Bautista, 2007). This may come from

the fact that the cultures of people in Philippine and Vietnam are completely different from the culture of Lao people even though Lao PDR and Vietnam are neighbors. The positive relation between family income and fertility lends support to Benefo and Schultz (1996) and Handa (2000). This finding also shows that men in the North want to have more children when the level of income increased. The assumption behind this is due to most husbands in the samples are farmers (90%) and the result from our field survey showed that farmers tend to buy more land in order to increase production when their income levels increase. Moreover, due to the geography of agricultural land being in upland areas, the amount of labor can significantly influence agricultural productivity compared to other regions, which are mostly lowland areas and have a lower demand for children because machines can be more efficiently utilized.

In general, experiencing child mortality has a strong positive correlation with fertility. This positive impact lends support to previous literature, such as Schultz (1980) and Benefo and Schultz (1996). However, in this case it is difficult to point out the causality between child mortality and fertility due to endogeneity problem. Women with experience of child mortality in urban areas have a smaller coefficient compared to their counterparts in rural areas. In terms of regional difference, the highest negative coefficient of experience of child mortality correlate with fertility is found in the North and in rural areas. The assumption behind this is that child mortality rates in rural areas and northern regions are relatively higher than urban areas and other regions (LRHS-2005).

Knowledge of contraceptives has negative correlation with fertility, but is not statistically significant. Interestingly, when comparing among regions, however, knowledge of contraceptives is statistically significant with a decline in fertility in the South even though the usage rate of contraceptives is lowest (22.8%) compared to the Northern (33.8%) and Central (42.6%) regions (LRHS-2005). Women who have heard about modern contraceptives in the Southern region have fewer children than women who have not heard of any method of modern contraceptives by 0.3 children at the 5% statistical significance. On the other hand, the number of Medical Workers has no impact on fertility in any cases.

Mother's age and her age at first marriage have a strong positive effect on

fertility for all age groups. Compared with women aged 15-24 (reference group), fertility increases significantly in each age group. The cause for such an impact is that CEB is a cumulative measure of fertility, i.e. it is the number of children ever born alive to women at the time of the survey. Thus, women at a higher age would generally have more children than those who are younger.

In terms of family's wealth, Asset Index tends to have a negative correlation with fertility in the Lao PDR. By comparing with the 20% lowest asset-group, households belonging to the 3^{rd}, 4^{th}, 5^{th} asset index quintile group tend to have lower fertility in rural areas, the Northern region, and Central region. This means that a wealthy family tends to have fewer children.

Table 2 and Table 3 also show results of the estimation using IV method by assuming that accessibility to safe water and usage of toilet as instrument variables to overcome endogeneity problem between fertility and child mortality. After running the Hausman test, the null hypothesis of child mortality being exogenous cannot be rejected [Chi-square (25)＝1.23]. The regression results from the Two Stages Least Square (2SLS) are consistent with those of the OLS analysis. Interestingly, the striking difference between the OLS results and 2SLS coefficients lies in the impact of child mortality on fertility. More specifically, from the 2SLS results under-five child mortality does not seem to be associated with fertility in urban areas, while such impact is significant in rural areas and nationwide. This is finding is attributable to the fact that child mortality in rural villages is higher than that of urban areas, which would constitute a rationale for having more children for replacement, particularly for labor-intensive agricultural production. Generally, the effect of women education remains strong except for urban areas. Women's education in urban areas becomes statistically insignificant, while the impact of women education on fertility in rural areas, Northern region and Central regions remain strong. This can imply that women's education has a direct effect on the fertility level. At country level, the positive impact of men's education on fertility becomes statistically insignificant. On the other hand, the degree of men's educational effect in the Northern region is getting larger. For other variables, such as mother age at birth, mother age, wealth index and regional dummies, the coefficients are only slightly different from those of the OLS results.

Table 2: Fertility at national level, the difference between urban and rural areas

CEB（Total number of children）	Total(b/t)		Urban(b/t)		Rural(b/t)	
	OLS	2SLS	OLS	2SLS	OLS	2SLS
Women's age at forst arroed（years）	−0.109***	−0.098***	−0.1***	−0.067***	−0.111***	−0.103***
	(−18.37)	(−7.74)	(−8.23)	(−1.8)	(−16.51)	(−8)
Women's age 15-24（Base category）						
25-29 years	1.002***	0.96***	0.737***	0.595***	1.038***	1.009***
	(27.44)	(16.61)	(10.85)	(3.27)	(25.09)	(17.22)
30-34 years	2.066***	1.947***	1.576***	1.284***	2.153***	2.064***
	(46.43)	(15.31)	(20.52)	(4)	(41.71)	(15.79)
35-39 years	2.76***	2.587***	2.16***	1.753***	2.883***	2.751***
	(53.64)	(14.36)	(23.97)	(4.1)	(48.06)	(14.75)
40-49 years	3.488***	3.247***	2.978***	2.216***	3.591***	3.415***
	(58.43)	(13.22)	(29.44)	(2.88)	(51.08)	(13.93)
Wife's Education（0 years is Base category）						
Some priamry（1-4 years）	−0.234***	−0.245***	−0.1	0.036	−0.243***	−0.256***
	(−4.54)	(−4.52)	(−0.65)	(0.14)	(−4.45)	(−4.44)
Complete primry school（5-7 years）	−0.412***	−0.367***	−0.306**	−0.146	−0.415***	−0.383***
	(−8)	(−5.19)	(−2.18)	(−0.57)	(−7.38)	(−5.26)
Complete lower secondary school (8-10 years)	−0.491***	−0.412***	−0.363**	−0.109	−0.564***	−0.499***
	(−7.74)	(−4.03)	(−2.51)	(−0.34)	(−7.37)	(−4.24)
Complete upper secondary school and higher（11 + years）	−0.539***	−0.481***	−0.583***	−0.274	−0.373***	−0.34**
	(−6.56)	(−4.58)	(−3.74)	(−0.72)	(−3.04)	(−2.51)
Husband's Education（0year is Base category）						
Some priamry（1-4 years）	0.129**	0.079	0.166	−0.04	0.137**	0.102
	(2.14)	(0.99)	(0.82)	(−0.11)	(2.16)	(1.27)
Complete primry school（5-7 years）	0.172***	0.129	0.222	−0.022	0.182***	0.153**
	(2.77)	(1.64)	(1.18)	(−0.06)	(2.77)	(1.96)
Complete lower secondary school (8-10 years)	0.053***	0.035	0.124	−0.092	0.066	0.057
	(0.78)	(0.47)	(0.67)	(−0.27)	(0.88)	(0.73)
Complete upper secondary school and higher（11 + years）	0.024***	−0.01	0.064	−0.269	0.03	0.029
	(0.32)	(−0.11)	(0.34)	(−0.65)	(0.33)	(0.31)
Having child mortality*	1.649***	2.916**	1.395***	6.44	1.677***	2.56**
	(27.85)	(2.34)	(9.68)	(1.28)	(26.08)	(2.19)
Heard contraceptive	−0.112	−0.103	−0.205	−0.633	−0.109	−0.1
	(−1.52)	(−1.36)	(−0.55)	(−0.97)	(−1.45)	(−1.31)
No.health worker	0.001	−0.001	0.002	0.002	0.001	0.001
	(1.01)	(1.18)	(0.95)	(0.93)	(0.84)	(0.95)
Wage earner men	0.085*	0.077	0.196***	0.247**	−0.03	−0.047
	(1.68)	(1.4)	(2.86)	(2.02)	(−0.41)	(−0.59)
Wage earner women	−0.17**	−0.152***	−0.244***	−0.228*	−0.077	−0.041
	(−2.5)	(−2.02)	(−2.99)	(1.72)	(−0.65)	(−0.3)
Lowest quintile（Base category）						
Quintile 2	0.013	−0.006	0.007	−0.513	0.015	0.003
	(0.24)	(−0.09)	(0.03)	(−0.74)	(0.26)	(0.05)
Quintile 3	−0.13**	−0.149**	0.408	0.126	−0.162***	−0.175***
	(−2.27)	(−2.36)	(1.49)	(0.26)	(−2.73)	(−2.76)
Quintile 4	−0.295***	−0.27***	−0.045	−0.148	−0.289***	−0.273***
	(−4.92)	(−4)	(−0.18)	(−0.37)	(−4.53)	(−3.97)
Quintile 5	−0.725***	−0.672***	−0.331	−0.279	−0.809***	−0.776***
	(−10.51)	(−7.5)	(−1.3)	(−0.69)	(−10.03)	(−8.23)
Rural	0.157***	0.124**	-	-	-	-
	(3.3)	(2.03)				
Northern（Base category）						
Central region	0.273***	0.33***	0.207***	0.415*	0.288***	0.328***
	(6.98)	(4.88)	(2.87)	(1.74)	(6.31)	(4.78)
Sounthern region	0.362***	0.384***	0.374***	0.347**	0.356***	0.376***
	(8.02)	(7.38)	(4.03)	(2.27)	(7)	(6.39)
Constant	3.522***	3.23***	3.404***	3.109***	3.646***	3.426***
	(21.95)	(9.72)	(6.19)	(3.91)	(18.41)	(9.54)
Observation	8689	8689	1780	1780	6909	6909
R-square	0.491	0.448	0.488		0.4852	0.4637

Notes: 1) Heterosketdasticity has been tested and corrected. 2) Corrected t-statistics in parentheses. 3) * significant at 10% level. 4) ** significant at 5% level. 5) *** significant at 1% level.

6) The variable "Having child mortality" is instrumented by access to safe drinking water and access to latrine in 2SLS model

Table 3: The difference of fertility among regions

CEB（Total number of children）	Northem region(b/t)		Central region(b/t)		Southern region(b/t)	
	OLS	2SLS	OLS	2SLS	OLS	2SLS
Women's age at first married（years）	− 0.088***	− 0.102***	− 0.104***	− 0.106***	− 0.159***	− 0.136***
	(− 10.04)	(− 5.65)	(− 9.84)	(− 6.88)	(− 14.22)	(− 6.56)
Women's age 15-24（Base category）						
25-29 years	0.972***	1.004***	0.996***	1.005***	1.164***	1.031***
	(16.57)	(14.97)	(16.82)	(14)	(14.87)	(7.71)
30-34 years	1.972***	2.121***	1.969***	1.997***	2.5***	2.285***
	(27.18)	(11.77)	(28.57)	(13.13)	(25.41)	(11.54)
35-39 years	2.615***	2.819***	2.746***	2.792***	3.139***	2.822***
	(32.32)	(11.79)	(33.39)	(11.59)	(27.08)	(10.27
40-49 years	3.449***	3.739***	3.325***	3.386***	3.925***	3.493***
	(35.64)	(11.12)	(36.51)	(10.86)	(29.38)	(9.69)
Wife's Education（0 years is Base category）						
Some priamry（1-4 years）	− 0.282***	− 0.258***	− 0.384**	− 0.385**	0.004	− 0.009
	(− 3.59)	(− 2.96)	(− 4.17)	(− 4.14)	(0.04)	(− 0.08)
Complete primry school（5-7 years）	− 0.376***	− 0.422***	− 0.561***	− 0.574***	− 0.231***	− 0.115
	(− 4.65)	(− 4.17)	(− 6.58)	(− 5.35)	(− 2.05)	(− 0.72)
Complete lower secondary school	− 0.499***	− 0.593***	− 0.65***	− 0.666***	− 0.242	0.005
(8-10 years)	(− 4.8)	(− 3.99)	(− 6.51)	(− 5.08)	(− 1.64)	(0.02)
Complete upper secondary school	− 0.511***	− 0.573***	− 0.737***	− 0.751***	− 0.096	0.121
and higher（11 + years）	(− 3.44)	(− 3.51)	(− 6)	(− 5.23)	(− 0.56)	(0.45)
Husband's Education（0year is Base category）						
Some priamry（1-4 years）	0.282***	0.403**	0.009	0.014	− 0.039	0.001
	(3.26)	(2.47)	(0.08)	(0.12)	(− 0.31)	(0.01)
Complete primry school（5-7 years）	0.337***	0.422***	0.038	0.036	− 0.015	− 0.059
	(3.72)	(3.13)	(0.34)	(0.32)	(− 0.11)	(− 0.39)
Complete lower secondary school	0.165	0.245***	− 0.079	− 0.094	− 0.081	− 0.09
(8-10 years)	(1.56)	(1.71)	(− 0.69)	(− 0.7)	(− 0.53)	(− 0.54)
Complete upper secondary school	0.183	0.276	− 0.071	− 0.077	− 0.235	− 0.219
and higher（11 + years）	(1.39)	(1.59)	(− 0.59)	(− 0.62)	(− 1.39)	(− 1.15)
Having child mortality *	1.71***	0.321	1.615***	1.225	1.523***	3.521**
	(20.06)	(0.21)	(14.34)	(0.63)	(12.63)	(2.25)
Heard contraceptive	− 0.028	− 0.039	− 0.203	− 0.213	− 0.304**	− 0.31**
	(− 0.26)	(− 0.35)	(− 1.21)	(− 1.24)	(− 2.22)	(− 2.15)
No.health worker	− 0.001	− 0.001	0	0	0.003	0.002
	(− 0.55)	(− 0.45)	(0.28)	(0.13)	(1.13)	(0.79)
Wage earner men	0.174**	0.215**	0.023	0.025	0.078	0.123
	(1.98)	(2.15)	(0.34)	(0.36)	(0.61)	(0.84)
Wage earner women	− 0.15	− 0.198	− 0.185*	− 0.189*	− 0.165	− 0.205
	(− 1.29)	(− 1.55)	(− 1.89)	(− 1.87)	(− 1.03)	(− 1.02)
Lowest quintile（Base category）						
Quintile 2	0.03	0.055	− 0.105	− 0.09	0.088	0.118
	(0.38)	(0.61)	(− 0.98)	(− 0.74)	(0.74)	(0.9)
Quintile 3	− 0.181**	− 0.182**	− 0.24**	− 0.231**	0.085	0.03
	(− 2.19)	(− 2.1)	(− 2.23)	(− 2.1)	(0.68)	(0.21)
Quintile 4	− 0.457***	− 0.495***	− 0.361***	− 0.361***	0.034	0.103
	(− 5.22)	(− 4.84)	(− 3.36)	(− 3.34)	(0.25)	(0.65)
Quintile 5	− 0.674***	− 0.746***	− 0.772***	− 0.786***	− 0.72***	− 0.679***
	(− 6.31)	(− 5.41)	(− 6.59)	(− 5.53)	(− 4.25)	(− 3.5)
Rural	0.241***	0.308**	0.116	0.124	0.055	0.056
	(3.18)	(2.81)	(1.61)	(1.5)	(0.47)	(0.4)
Constant	3.119***	3.378***	4.145***	4.227***	4.651***	4.076***
	(12.55)	(8.75)	(13.91)	(8.68)	(14.4)	(7.23)
Observation	3484	3484	3304	3304	1901	1901
R-square	0.4842	0.4254	0.4961	0.4926	0.5142	0.4106

Notes: 1) Heterosketdasticity has been tested and corrected. 2) Corrected t-statistics in parentheses. 3) * significant at 10% level. 4) ** significant at 5% level. 5) *** significant at 1% level.
6) The variable "Having child mortality" is instrumented by access to safe drinking water and access to latrine in 2SLS model

6. CONCLUSION

Improving maternal and child health is a crucial issue that needs to be addressed if the well-being of the population is to be improved. Healthy mothers deliver healthy children and healthy children have a greater potential to become productive labor force in the future. Thus, both maternal and child health problems have to be solved together.

One factor which is directly related to these issues is fertility. With fewer births, mother's health would not deteriorate and the exposure to various risks would be lower. Also, she would have more time to work to earn extra income to support her family and children. The findings imply that women's education would contribute a great deal to fertility reduction in all areas. Such contributions would occur through many channels, such as increasing mother's wages and the associated opportunity cost and the effectiveness of information utilization. Both mothers and children are exposed to greater risks when giving birth at a very young age. Moreover, educated mothers would utilize health information such as contraceptive method from the government or health organizations more effectively.

In addition, the upward pressure of child mortality on fertility found in the analysis would reflect the rationale of mothers for securing future family labor force and for their own security in retirement age, especially for women in rural areas where a social security system is absent.

Therefore, along with other poverty reduction policies, education at the grassroots level, especially for mothers, and child health care deserve more attention. Moreover, the study also finds that an effect of contraceptives on fertility varies among regions. Therefore, government should consider the differences among regions as an important factor in order to achieve greater efficient family planning policy.

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APPENDIX A 1: Polychoric PCA Score of Asset Index

Table A 3.1: Polychoric PCA score of Asset index

Variable	Categories	Score
Roof	Wood/Bamboo/Grass	− 0.3697
	Zinc	0.0905
	Tile	0.5411
Wall	Bamboo	− 0.3694
	Wood	0.1249
	Cement	0.5936
Floor	Wood/Bamboo	− 0.1253
	Cement	0.5484
	Tile	0.9377
Electricity	No electricity	− 0.3380
	Other	− 0.0317
	Generator	0.0405
	Share miter	0.0972
	Own miter	0.3728
Cooking heat	Wood/sawdust	− 0.0661
	Fuel/Charcoal	0.5530
	Gas	0.8532
	Electricity	0.9884
Latrine	No toilet	− 0.2651
	Other	0.0300
	Dry toilet	0.2904
	Normal toilet	0.8467
Water sources	Ripe water/dam/stream	− 0.1632
	Well with cover	0.0525
	Bore	0.1739
	Pipe water	0.3508
Radio	Not own radio	− 0.0030
	Own radio	0.0036
Television	Not own Television	− 0.2277
	Own Television	0.4185
Newspaper	Not own newspaper	− 0.0080
	Own newspaper	0.4978

Source: Author's calculation

i This finding is consistent with the finding of Onphanhdala(2009,2010) about the productivity of famer in Lao PDR.. He finds that farmer with some primary and complete primary school educational level has higher agricultural productivity comparing to other educational level.