Theory and Evidence of the Effect of Modern Contraceptives on Birth Spacing

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A Rough Draft
(comments welcome)

Abstract

This paper examines the effect of family planning programs on birth spacing both theoretically and empirically. Despite the recent development of dynamic models of fertility, there is no general prediction regarding the effect of modern birth control methods on birth spacing. By considering a simple dynamic model of fertility first introduced by Heckman and Willis (1975), I derive conditions under which an introduction of modern contraceptives leads to women having either longer or shorter birth intervals. The empirical findings in Indonesia suggest that the introduction of modern methods of birth control led to shorter birth intervals in the 1970s and longer birth intervals in the 1990s. Then, I discuss the validity of the conditions of the model in understanding Indonesian experience.

Keywords: Family Planning Programs, Birth Spacing, Indonesia.
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1 Introduction

The effect of the introduction of modern contraceptives on birth spacing is not straightforward because of the dynamic nature of the decision to have children (Heckman and Willis (1975), Newman (1988)). This problem has limited the theoretical models used to study birth spacing and contraception use, which, in turn, has lead to few studies that examined the impact of modern contraception on birth spacing empirically. Therefore, the aim of this paper is to expand the understanding of the impact of an increase in contraceptive efficiency on one aspect of fertility, namely, birth spacing.

Specifically, the paper has two objectives. The first is to derive a set of conditions under which an introduction of modern contraceptives leads to a couple increasing or decreasing their level of contraception use. Secondly, it investigates the validity of these conditions empirically by examining the effect of family planning programs on birth spacing in Indonesia from 1974 to 1990.

The building block of the theoretical consideration is the model introduced by Heckman and Willis (1975) that discuss the necessary conditions for a couple to engage in precautionary contraception before they reach the optimal number of children. This paper goes beyond the Heckman and Willis paper in that their discussion is focused on the choice of using contraceptives or not, whereas this study examines the effect of an increase in the efficiency of contraception on birth spacing, given that a couple engages in contraception use. The introduction of modern methods of birth control can be viewed as an increase in efficiency of contraception given the existing traditional contraceptive methods. Therefore, the model in this paper pays close attention to the impact of an introduction of modern methods of contraception on birth intervals.

Assuming a quadratic form of utility, Newman (1988) derives a closed-form solution for the optimal level of contraceptive efficiency in a stochastic dynamic model of fertility. Although it generates implications regarding mortality, income and variations in fecundity, the effect of a decrease in the price of contraceptives is a complicated function of many variables. By considering only the final two periods of a woman's reproduction life, the model in this paper generates intuitive implications regarding the introduction of modern contraceptives.

As McFadden (1975) pointed out, Heckman and Willis' theoretical model regarding the imperfection of contraceptive techniques and its costs is not empirically tested in their paper. Therefore, this study is unique in that it presents empirical findings regarding the effect of family planning programs on birth spacing.

In the theoretical part of this paper, I will derive a set of conditions under which an increase in efficiency of contraceptives leads to a couple changing birth intervals. The model shows that an introduction of modern contraceptives directly increases the marginal benefit from using contraceptives in the current period, and decreases the marginal benefit of using contraceptives by increasing the efficiency of contraception in the next period. The net effect depends on the relative magnitude of utility loss from having too many children and that from having too few children. That is, a couple will decrease the level of contraceptive use with an increase in its efficiency when the utility loss from having too many children is relatively bigger than that from having too few children. In the empirical part, I examine the effect of family planning programs on second birth intervals using the 1993 Indonesian Family Life Survey. It is found that the Indonesian family planning programs lead to women having shorter birth intervals in the 1970s but longer birth intervals in the 1990s. Then, I discuss the interpretation of the finding and its implications in the context of the Indonesian fertility decline.

The rest of paper is organized as follows. Section 2 introduces a theoretical model regarding imperfect birth control and its cost. Section 3 gives a brief explanation on the Indonesian family planning program. Section 4 provides a description of the data. Section 5 presents the empirical findings regarding the effect of family planning programs on birth intervals. Section 6 discusses further implications of the model in understanding the empirical findings.

2 A Simple Dynamic Model of Fertility with Imperfect Birth Control

In order to derive the effect of efficiency of contraceptives on the optimal level of contraception effort, a modified version of Heckman and Willis (1975) is considered. A couple has a choice of contraception efforts given the effectiveness of contraception. Then, the probability of giving birth at time t may be described as

$$p_t^* = p(1 - ae_t) \tag{1}$$

where, p is the probability of having a birth without contraception (natural fertility), a is the efficiency of a unit contraception effort, and e is the level of contraception effort ($e \in [0, 1/a]$). [1]The utility cost to making contraception efforts at time t, f_t,can be thought of as a function of the level of efforts.

$$f_t = f(e_t) \tag{2}$$

It is assumed that zero effort incurs no cost and that the cost is an increasing in the level of effort ($f(0) = 0, f'(e_t) > 0$). A couple is facing a problem of choosing the level of contraception effort and consumption good other than children in each period from marriage to menopause. For simplicity, all the children are assumed to live until the end of the reproductive period. Formally, the problem is

$$\max_{e_t, C_t} \sum_{t=0}^{T} \delta^t (U(N_t, C_t) - f(e_t)) \tag{3}$$

$$\begin{aligned} \text{subject to} \quad C_t + P_n N_t &\leq Y_t \\ C_t &\geq 0 \end{aligned}$$

[1]The model used by Heckman and Willis (1975) has only contraceptive efficiency, whereas the model presented here separates the contraceptive efficiency from the contraception efforts.

where δ is the time discounting rate, N_t is the number of children at time t, C_t is the amount of consumption good at time t, Y_t is income at time t, and P_n is the cost to having each child.

The optimal choice of contraception effort in each period involves the dynamic programming over all the periods, and the model does not produce a general implication on the effect of an increase in contraceptive efficiency on the optimal contraception effort. Therefore, I will examine the final two periods of the model in order to illustrate the dynamic nature of the relationship between the efficiency of contraceptives and the optimal choice contraception efforts.

It is assumed that the time discounting rate is one. The budget constraint is also assumed to be binding at each period. Then, the utility in each period can be considered as an indirect utility with respect to the number of children ($U(N_t, C_t) = U(N_t, Y_t - P_n N_t) = V(N_t)$). A simplest case is considered where there is no uncertainty regarding income and price of having child in each period.

The timing of the model is the following. At the beginning of each period, a couple considers how much effort to make for contraception, which incurs a cost in that period. At the end of the period, a birth outcome is realized. A couple has $N_t^* - 1$ children at the beginning of the first period, where N_t^* is the optimal number of children in the final period ($V(N_t^* - 1) < V(N_t^*) > V(N_t^* + 1)$).

There are two states of the world for a couple at the beginning of the second period: having $N_t^* - 1$ children or N_t^* children.

When the couple has $N_t^* - 1$ at the beginning of the second period, then using no contraceptives is optimal in order to reach the optimal number of children.. Therefore, the expected utility at the beginning of period 2 is

$$V(\tilde{}b_2) = V(N_t^* - 1) + pV(N_t) + (1 - p)V(N_t^* - 1) \tag{4}$$

When the couple has N^* at the beginning of the second period, then using contraceptives is optimal in order to avoid excess fertility. Therefore, the expected utility at the beginning of period 2 is

$$V(b_2) = V(N_t^*) - f(e_2^*) + p_2^* V(N_t^* + 1) + (1 - p_2^*)V(N_t^*) \tag{5}$$

where $p_2^* = p(1 - ae_2^*)$ and e_2^* solves the following first order condition.

$$\frac{\partial V(b_2)}{\partial e_2} = -f'(e_2^*) + pa[V(N_t^*) - V(N_t^* + 1)] = 0 \tag{6}$$

Then, the problem in the first period becomes

$$\max_{e_1} V = V(N_t^* - 1) - f(e_1) + (1 - p_1^*)V(\tilde{b}_2) + p_1^* V(b_2). \tag{7}$$

The first order condition is

$$\begin{aligned} \frac{\partial V}{\partial e_1} &= -f'(e_1) + ap(V(\tilde{b}_2) - V(b_2)) \\ &= -f'(e_1) + ap\Delta V(\tilde{b}_2) \\ &= 0, \end{aligned} \tag{8}$$

and the second order condition is

$$\frac{\partial^2 V}{\partial e_1^2} = -f''(e_1) < 0. \tag{9}$$

The first order condition implies that the couple will choose a level of contraception such that the marginal cost equals the expected marginal benefit. The second order condition states that the cost function of contraception should be convex in order to ensure the interior solution. Note that the sign of the expected marginal benefit depends on the sign of $\Delta V(\tilde{b}_2)$.

$$\begin{aligned} \Delta V(\tilde{b}_2) &= V(\tilde{b}_2) - V(b_2) \\ &= -(2 - p)[V(N_t^*) - V(N_t - 1)] + p_2^*[V(N_t^*) - V(N_t^* + 1)] + f(e_2^*) \end{aligned} \tag{10}$$

If the utility loss from having too many children is substantially greater than that from having too few children, then $\Delta V(\tilde{b}_2)$ is positive. Therefore, the couple will engage in contraception in the first period. Otherwise the benefit is negative, and a couple will use no contraception in the first period. As it is pointed out by Heckman and Willis (1975), given the effectiveness and cost of contraceptives, a couple will use contraceptives before reaching a desired number of children if the utility loss from having too many children is substantially greater than the one from having too few children. Although Heckman and Willis (1975) also noted that this cannot be generalized in a multi-period model because of the possibility of having higher levels of excess fertility, this model can still generate the comparative dynamics regarding the effect of an increase in the efficiency of contraception on the contraception in the first and second period. Consider the case in which the couple has N^* at the beginning of the second period. Then using contraceptives is optimal. Therefore, the expected utility at the beginning of period 2 is

$$V(b_2) = V(N_t^*) - f(e_2^*) + p_2^* V(N_t^* + 1) + (1 - p_2^*)V(N_t^*) \tag{11}$$

where $p_2^* = p(1 - ae_2^*)$ and e_2^* solves the following first order condition.

$$\frac{\partial V(b_2)}{\partial e_2} = -f'(e_2^*) + pa[V(N_t^*) - V(N_t^* + 1)] = 0 \tag{12}$$

Taking a total derivative of the FOC with respect to the efficiency of contraceptives, a, gives the following result.

$$0 = -f''(e_2^*)\frac{\partial e_2^*}{\partial a} + p[V(N_t^*) - V(N_t^* + 1)] \tag{13}$$

$$\Leftrightarrow \frac{\partial e_2^*}{\partial a} = \frac{p[V(N_t^*) - V(N_t^* + 1)]}{f''(e_2^*)} > 0 \tag{14}$$

Equation (14) implies, given that a couple is engaging in contraception in the final period, an increase in the efficiency of contraception will increase the marginal benefit from using birth control methods. Therefore, a couple will increase the level of contraception efforts unambiguously. Next, consider the case in the first period. Applying the implicit function theorem to the first order condition in equation (12), the comparative dynamics regarding the effect of an increase in the contraceptive efficiency on the optimal level of contraception effort in the first period becomes

$$\begin{aligned}\frac{\partial e_1}{\partial a} &= -\frac{\frac{\partial(ap\Delta V(\tilde{}b_2))}{\partial a}}{-f''(e_1)} \\ &= \frac{1}{f''(e_1)}\left\{p\Delta V(\tilde{}b_2) + ap\frac{\partial \Delta V(\tilde{}b_2)}{\partial a}\right\} \qquad (15)\end{aligned}$$

Recall that the second order condition for an interior solution of e_1 is $f''(e_1) > 0$. The sign of $\frac{\partial e_1}{\partial a}$ depends on two opposite effects. The first term in equation (18), $p\Delta V(\tilde{}b_2)$, represents the positive effect through the contraception in the first period, which comes from the necessary condition for a couple to make a positive level of contraception efforts in the first period ($\Delta V(\tilde{}b_2) > 0$). The second term, $ap\frac{\partial \Delta V(\tilde{}b_2)}{\partial a}$, shows the negative effect through the increase in the contraception efficiency on the second period as shown in the following.

$$\begin{aligned}\frac{\partial \Delta V(\tilde{}b_2)}{\partial a} &= -p(e_2^* + a\frac{\partial e_2^*}{\partial a})[V(N_t^*) - V(N_t^* + 1)] + f'(e_2^*)\frac{\partial e_2^*}{\partial a} \\ &= -pe_2^*[V(N_t^*) - V(N_t^* + 1)] + [-pa[V(N_t^*) - V(N_t^* + 1)] + f'(e_2^*)]\frac{\partial e_2^*}{\partial a} \\ &= -pe_2^*[V(N_t^*) - V(N_t^* + 1)] \\ &< 0 \qquad (16)\end{aligned}$$

Therefore, as a second order effect, the increase in the efficiency of contraception will increase the contraception effort in the second period, which, in turn, reduces the marginal benefit of using contraception in the first period. The precise conditions for assigning the sign of $\frac{\partial e_1}{\partial a}$ are the following. The missing steps are shown in Appendix A.

$$\frac{\partial e_1}{\partial a} < 0 \quad \text{if} \quad \frac{V(N_t^*) - V(N_t^* - 1)}{V(N_t^*) - V(N_t^* + 1)} < pae_2^* \qquad (17)$$

$$\frac{\partial e_1}{\partial a} > 0 \quad \text{if} \quad \frac{V(N_t^*) - V(N_t^* - 1)}{V(N_t^*) - V(N_t^* + 1)} > pae_2^* \qquad (18)$$

The conditions in equation (17) and (18) states that, if the utility loss from having one child less than the optimal number of children is relatively smaller than that from having one child more, an increase in contraceptive efficiency will decrease the level of contraceptive effort in the first period given that there exists an interior solution for e_1^* in the first period ($0 < e_1^* < 1/a$). Otherwise, the reverse holds. When the utility function has Cobb-Douglas form, equation (17) holds when the weight on child good is substantially greater than that on other consumption good. This relates to one explanation for the reversal of the effect of family planning programs on birth spacing for the period 1970 to 1993. That is, couples in the 1970s had more weights on the child service than on other consumption goods, and with economic development, couples in the 1990s have increasingly more weights on consumption goods other than children.

3 Indonesian Family Planning Programs

Although a voluntary organization, the Indonesian Planned Parenthood Association (PKBI) was formed in 1957, and promoted family planning programs through the sales of contraceptives throughout the 1960s. A serious national level program was not implemented until the Indonesian government invited a group of foreign experts, sponsored by the UN, World Bank, and WHO, to evaluate the country's family planning program in 1969. With the detailed recommendations of the group, the Indonesian government initiated a Five-year Family Planning Program (1971-5) for Java and Bali (stage I). In the fiscal year 1970/71, the family planning program received an equivalent of US$1.3 million from the government and over US$3 million from foreign donors. The funding for the family planning program increased dramatically over time. In 1984, it was estimated that the funding from the government was about US$65 million, that US$25 million was from foreign donors (USAID, 1984:15).

With the beginning of the Second Five-Year Development Plan, the family planning program expanded beyond Java and Bali to ten large provinces in 1974 (stage II). At the same time, the National Family Planning Coordinating Board (BKKBN) increased the intensity of the program in Java and Bali through a village family planning system. In 1977, all the remaining provinces were included in the family planning program, and the village family planning program began to be extended beyond Java and Bali (stage III). The development of the family planning program is well illustrated by the contraceptive-use rates in Table 1. The estimated proportion of married women of reproduction age using contraception in stage I provinces increased from two to seven percent in 1971/72 to between 39 and 60 percent in 1985. Stage II provinces experienced an increase from one to four percent in 1974/1975 to between 22 and 60 percent in 1985. The contraceptive-use rates for stage III provinces also increased from one to nine percent in 1979/1980 to between 10 to 42 percent in 1985.

The dramatic increase in the availability of contraceptives over last three decades provides a natural ground for examining the effect of family planning programs on birth spacing. Given that the total fertility rate in Indonesia declined from 5.6 in 1971 to 3.3 in 1990, the next sections provide empirical findings regarding the Indonesian family planning program and its impact on second birth intervals.[2]

4 Data

The data analyzed is found in the 1993 Indonesian Family Life Survey (IFLS 93), which provides data at the individual and household level on fertility, health, education, migration, and employment, as well as data at the community level on health facilities, schools and other community characteristics. The IFLS 93 consists of a sample of 7,224 households spread across 13 provinces on the islands of Java, Sumatra, Bali, West Nusa Tenggara, Kalimantan, and Sulawesi. The sample covers approximately 83% of the Indonesian population and much of its heterogeneity. One of the strengths of the IFLS 93 is the fact that it has extensive and reliable retrospective data at each level.[3] This is especially important for the purpose of this study because the fact to be explained

[2]The total fertility rates are from BPS, and the sources are 1971, 1980, and 1990 Population Censuses.

[3]The IFLS 93 has a feature of cross-checking. The same question was asked to the respondent repeatedly (at individual level) and to different people (at community level).

Table 1: Indonesia: Estimated Proportion of Married Women of Reproductive Age Using Contraception, by Province, in Selected Years under Successive Development Plans

	Province	1971/2 Repelita Third Year	1974/5 Repelita II First Year	1979/80 Repelita III First Year	1984/5 Repelita IV Revised Figures July 1985	1985 Supas
	Indonesia	3	13	29	51	38
Stage I						
1	DKI Jakarta	4	10	20	46	44
2	Jawa Barat	2	11	21	54	44
3	Jawa Tengah	2	13	43	57	39
4	Daerah Istimewa Yogyakarta	4	16	57	57	53
5	Jawa Timur	4	27	51	58	40
6	Bali	7	28	50	75	60
Stage II						
1	Daerah Istimewa Aceh		2	7	44	22
2	Sumatera Utara		2	14	45	30
3	Sumatera Barat		1	15	41	26
4	Sumatera Selatan		2	8	49	29
5	Lampung		1	18	41	42
6	Nusa Tenggara Barat		1	13	45	25
7	Kalimantan Barat		1	7	42	22
8	Kalimantan Selatan		2	17	48	39
9	Sulawesi Utara		4	32	45	60
10	Sulawesi Selatan		2	14	41	23
Stage III						
1	Riau			1	23	21
2	Jambi			4	32	38
3	Bengkulu			9	40	42
4	Nusa Tenggara Timur			1	20	29
5	Kalimantan Tengah			4	27	29
6	Kalimantan Timur			5	35	37
7	Sulawesi Tengah			3	34	38
8	Sulawesi Tenggara			3	31	24
9	Maluku			2	21	17
10	Irian Jaya			1	17	17
11	Timor Timur				6	10

Notes: BKKBN Monthly Service Statistics, July 1985; BPS, 1986. (Requoted from Hugo et. al. (1995) p.145.

involves the change of individual behavior over three decades.

There are three reasons why I choose the second birth interval as a measure of birth spacing. First, there is likely to be occurrence-dependence within birth intervals of an individual, as Heckman and Walker (1987) concluded using the goodness of fit tests in their study on Hutterite data.[4] Second, in a society like Indonesia where people expect a couple to have a baby soon after the marriage, the first birth interval is likely to be governed by incentives other than those based on economics considerations. In addition, first birth intervals are not a good measure due to arranged marriages or pregnancies before marriage. Finally, given the two reasons above, the second birth interval leaves the least amount of sample selection (married women without any children are discarded). As will be discussed next, the selection process appears to be minor from the sample used in this study.

Since I am examining the second birth interval, there is a potential sample selection issue due to removing married women without any children at the time of the survey year. There are 4,980 ever-married women in the pregnancy history section in the IFLS 93. After constructing the basic characteristics, there are 4,776 observations available. When limiting the sample to women who have at least one birth, this leaves 4,553 observations. The comparison of the total sample of married women and the subsample of women with at least one birth is presented in Table 2. Both samples have similar distributions regarding age, schooling, and age at marriage. The full sample has the average age of 34.1 years and the average schooling of 5.04 years, whereas women in the subsample are 34.5 years old and have 5.00 years of schooling on average. Age at first marriage is 18.09 years for the total sample and 18.02 years for the subsample. The percentage of women with complete primary education is 26.2 % for the total sample and 25.8 % for the subsample. The age distributions of the both samples are also similar to each other. Therefore, the selection from all

[4]The Hutterites are a Mennonite population living in the Upper Midwest in the U.S. and Canada. They are considered a benchmark Western natural fertility population.

the married women to the married women with at least one child seems to be small in terms of age and education.

Table 3 provides descriptive statistics of schooling groups and birth cohorts groups. On average, women who are more educated marry later and have their first baby later than the less educated women. The average age at marriage of women with complete primary education is 21.0 years whereas it is 16.3 years for women with less than primary education. The average age at first birth is 22.2 years for the primary education group and 17.0 years for less-than-primary education group. Birth cohorts do not differ substantially in terms of average age at marriage and age at first birth. However, there was an increase of average years of schooling over time. The early cohort (women in their 40s in 1993) completed on average 4.4 years of schooling, while the later cohort (women in their 20s in 1993) finished 5.8 years of schooling on average. Similarly, the percentage of women with complete primary education among each cohort increased from 22.6 % for the early cohort to 31.7 % for the later cohort.

5 Empirical Findings

5.1 Duration Analysis

The setup of birth process follows that of Kim (2003) and Heckman and Walker (1990a, 1990b, and 1991). In this study, the second birth interval is estimated in order to examine the effect of family planning programs on the second birth interval separately. Further, a logit hazard model is used with a year as a unit of time,

$$h_2(t|H(\tau(2)+t),\theta) = \Lambda(\alpha_t + x_t'\beta + \theta) = \frac{\exp(\alpha_t + x_t'\beta + \theta)}{1+\exp(\alpha_t + x_t'\beta + \theta)}. \quad (19)$$

Table 2: Sample Statistics I

Variable	Ever Married Women	Women with at least one birth
No. Obs	4,776	4,553
Mean		
age	34.14	34.45
schooling	5.04	5.00
age at 1st marriage	18.09	18.02
age at 1st birth		19.96
Schooling Distribution		
less than primary	73.8	74.2
complete primary	26.2	25.8
Total	100.0	100.0
Age Distribution		
50s	1.3	1.3
40s	26.6	27.3
30s	41.4	42.3
20s	29.1	28.3
10s	1.7	0.9
Total	100.0	100.0

Notes: The data used is the 1993 Indonesian Family Life Survey.

Table 3: Sample Statistics II

Education groups	Age at marriage	Age at 1st birth		
Less than Primary	17.0	19.2		
Complete Primary	21.0	22.2		
Age groups	Age at marriage	Age at 1st birth	Schooling	% of Primary Education
40s	18.1	20.5	4.41	22.6
30s	18.2	20.1	4.87	24.1
20s	17.7	19.2	5.77	31.7

Notes: The data used is the 1993 Indonesian Family Life Survey.

The effect of duration on hazard, α_t, implies the baseline hazard, and x_t gives the observed characteristics of individuals.[5] As long as unobserved heterogeneity, θ, is orthogonal to the observed characteristics, the existence of θ affects only inferences regarding time variation (Lancaster 1979).[6] It is not possible to identify time variation without further assumptions about functional form of time variation and distribution of θ in the case of estimating a single birth interval. For correct inference when calculating standard errors of coefficients, the correlation between observations from the same woman due to unobserved heterogeneity is allowed.[7]

The nature of a family planning program is to reduce the price of contraceptives (efficiency) by introducing modern birth control methods. The price of contraceptives is specified, in addition to the individual characteristics in the hazard model,

$$h_2(t|H(\tau(2)+t),\theta) = \Lambda(\alpha_t + \beta' x_{it} + \rho P_Z + \theta). \tag{20}$$

Kim (2003) shows that women's education is a single most important determinant of second birth interval in Indonesia over the period 1974 to 1990, and that the main channel is through its interaction with family planning programs. Therefore, the price of contraception is considered as a function of the family planning program, calendar time, and individual education as in equation (21),

$$P_z = g(FP, Year, Edu). \tag{21}$$

The availability of the family planning program is measured at the village, provincial, and national level, and the village-level family planning program interacted with calendar year and women's education are also included as in equation (22),

$$h_2(t|H(\tau(2)+t),\theta) = \tag{22}$$

[5]As the interval width becomes smaller, the logit hazard model converges to the proportional hazard model (Thompson, 1977).

[6]It is unlikely that there is a systematic correlation between fecundity and women's primary education.

[7]The cluster (woman id) option is utilized in the logit estimation in the STATA program.

$$\Lambda(\alpha_t + \beta' x_{it} + \rho_1 FP_{vil,t} + \rho_2 Yr_t + \rho_3 FP_{vil,t} \times Yr_t + \rho_4 FP_{vil,t} \times Edu_i + \rho_5 FP_{prov,t} + \rho_6 FP_{nation,t} + \theta).$$

As discussed in previous studies (e.g., Pitt, Rosenzweig and Gibbons(1993), Gertler and Molyneaux (1994), and Gertler and Molyneaux(2000)), the Indonesian family planning program has not been expanded over time in a random manner. Rather, it has reflected the local demand through an allocation of the budget at each administrative level. Therefore, it is likely that unobserved heterogeneity in the propensity to conceive at the village level is correlated with the level of the family planning program. This correlation can be removed by using a village fixed-effects estimation if the policy rule reflects the local unobserved propensity.

5.2 The Effect of Family Planning Programs on Birth Hazard

The results are presented in Table 4, which shows the results when only the existence of a family planning (FP) clinic is used as a measure of the FP program. Since the data on the history of the FP program are available for the villages covered in IFLS 93, this analysis is restricted to the women who have not migrated after their first birth. This restriction, combined with the availability of the measure of the FP program, leaves us with 40% of the total sample.

According to column (1) in Table 4, age at first birth has a significantly negative effect on second birth hazard, which implies that women tend to have a longer birth interval as they give first birth later in their lives. The duration since the first birth exhibits a nonlinearity. That is, the birth hazard initially increases with duration, and then it decreases after five years of duration. Neither women's own educational attainment and husband's schooling are significant in column (1). The gender of first baby does not significant effect on second birth hazard, which suggests that son-preference is not prevalent in Indonesia. As a woman gets married later, she is more likely to have second birth. Being Muslim, which is the case for about 85% of Indonesian population, is associated with longer birth intervals, but its effect is not precisely estimated. Living with parents-in-law right after marriage has a significantly positive impact on second birth hazard, which suggests that women tend to receive a pressure to give birth from husband's family.

Without the village fixed-effects, the effect of the FP clinic is positive and significant as shown in column (2) in Table 4, which implies that family planning programs tend to help women having longer birth intervals. With a community fixed effect, however, the effect of the FP clinic becomes insignificant. This suggests that the placement of the Indonesian Family Planning program is not random given that the Hausman test rejects the null hypothesis that the fixed-effects specification is not different from the one without it. The correlation of the FP program and the unobserved propensity to conceive at the village level appears to be negative, which implies that there are more FP program inputs in areas where women have a higher propensity to delay births. This is counterintuitive, but women with a higher propensity to delay births have a higher demand for contraceptives. Therefore, the FP program was placed more intensively in areas with higher demand for contraceptives, which implies an efficiency criterion.

In column (3), the effect of women's primary education has a significantly negative impact on birth hazard. As discussed earlier, I investigate the indirect effect of family planning programs on birth hazard through education in addition to their direct effect following Kim (2003). The estimation result including interaction between FP clinic and women's education as in equation (22) is shown in column (5). While the coefficient on own education becomes insignificant, the interaction term between FP clinic and its interaction with women's education becomes significantly negative. The average proportion of women with complete primary education increases monotonically from 13.4% in 1975 to 37.1% in 1991. Therefore, the marginal effect of FP clinic in a community on birth hazard is positive in the 1970s and negative in the 1990s as plotted in Figure 1. In other words, FP clinics helped women have shorter birth intervals in the 1970s and longer birth intervals in the 1990s.

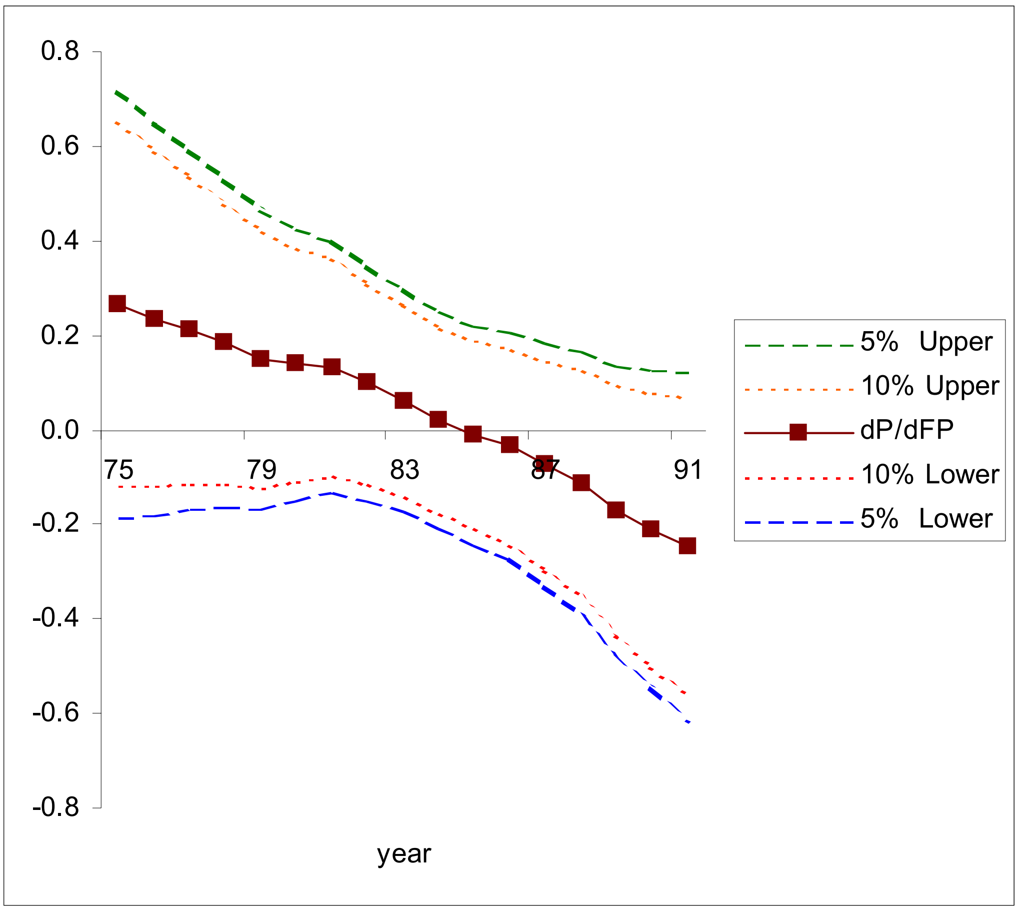
Table 4: Effect of Family Planning Program on Second Birth Hazard

	(1) Logit Coef.	(2) Logit Coef.	(3) FE Logit Coef.	(4) Logit Coef.	(5) FE Logit Coef.
age at 1st birth	-0.0436	-0.0436	-0.0493	-0.0435	-0.0492
	(3.57)	(3.58)	(3.36)	(3.57)	(3.35)
duration	0.3438	0.3447	0.5335	0.3447	0.5371
	(8.28)	(8.29)	(11.80)	(8.29)	(11.86)
duration^2	-0.0345	-0.0345	-0.0433	-0.0345	-0.0436
	(8.44)	(8.43)	(9.94)	(8.43)	(10.00)
year	-0.0460	-0.0505	-0.0767	-0.0693	-0.0378
	(6.98)	(1.34)	(1.88)	(1.49)	(0.74)
Primary education	-0.0975	-0.0799	-0.2858	0.0820	-0.0153
	(1.02)	(0.83)	(2.56)	(0.62)	(0.10)
husband's schooling	0.0110	0.0108	-0.0004	0.0105	-0.0012
	(1.24)	(1.22)	(0.04)	(1.19)	(0.11)
FP clinic		-0.1511	0.0132	-1.2472	2.2113
		(2.01)	(0.11)	(0.83)	(1.22)
FP clinic*year				0.0137	-0.0251
				(0.77)	(1.17)
FP clinic*Primary edu				-0.2811	-0.4687
				(1.79)	(2.53)
FP province		-0.1223	0.5953	-0.0384	0.6662
		(0.20)	(0.58)	(0.06)	(0.65)
FP nation		1.5480	2.4144	3.0028	-0.7759
		(0.38)	(0.55)	(0.64)	(0.15)
1st baby female	-0.0905	-0.0898	-0.0923	-0.0867	-0.0895
	(1.49)	(1.47)	(1.32)	(1.42)	(1.28)
age at 1st marriage	0.0396	0.0407	0.0391	0.0408	0.0396
	(3.25)	(3.33)	(2.68)	(3.34)	(2.72)
Muslim	-0.1273	-0.1081	-0.0476	-0.1122	-0.0504
	(1.31)	(1.05)	(0.25)	(1.09)	(0.26)
living w/ own parents	-0.0550	-0.0605	0.0303	-0.0637	0.0198
	(0.79)	(0.86)	(0.35)	(0.91)	(0.23)
living w/ parents-in-law	0.1963	0.1874	0.1935	0.1876	0.1827
	(2.44)	(2.32)	(2.02)	(2.31)	(1.91)
Constant	2.4500	2.6386		3.9309	
	(4.48)	(1.05)		(1.24)	
no. of observations	6,127	6,127	6,114	6,127	6,114
no. of groups			274		274

Notes: 1) This is the result from estimating the duration model of the event of second birth since the first birth.

2) The t-statistics are in parentheses.

Figure 1. The Marginal Effect of Family Planning Programs on Second Birth



The theory developed in section two suggests that couples were more afraid of having too many children in the 1970s and that they were more afraid of having too few children in the 1990s when they choose the timing of a second birth. Whether this interpretation is consistent with the existing theory of fertility is discussed in the next section.

Pitt, Rosenzweig, and Gibbons (1993) suggest that, in the evaluation of FP program on fertility, the effects of other government programs should also be considered because these programs may come as a package. Therefore, two other health institutions are taken into account. They are the Integrated Health Post (Posyandu) and the community health center (Puskesmas). Although these two institutions are run by the Department of Health clinics, they function as a complementary to FP clinic on many occasions. In practice, around 75% of contraceptives are distributed through Puskesmas in Indonesia. The same analysis is conducted, including the measures of Posyandu and Puskesmas. The results, presented in Table 5 (Appendix B), are qualitatively the same as in Table 3.[8]

6 Discussion

The finding in the previous section suggests that the effect of FP clinics helped women have shorter birth intervals in the 1970s and longer birth intervals in the 1990s. The interpretation based on the theoretical consideration in section two is that the utility loss from having one child more than the optimal number of children was relatively bigger than that from having one child less in the 1970s. In the 1990s, however, the opposite can be considered. That is, the utility loss from having

[8]Comparing the specifications with and without the village fixed-effects (column (2) and column (3) in Table 5 suggests that the correlation between the village-specific propensity to conceive and placement of the FP clinic and Puskesmas is negative, and that the presence of Posyandu is associated with a higher propensity to conceive. With the inclusion of FP program variables interacted with education, the coefficients on education and its interaction with year become insignificant as shown in column (5) of Table 5. The FP clinic variable interacted with education is still negative and significant at the 5% level, while Posyandu interacted with education and Puskesmas interacted with education are not significant. Hence, the effects of these two health institutions seem to reinforce the differential effect of FP clinic on educational groups.

one child less than the optimal number of children is relatively bigger than that from having one child more.

The theory is developed by considering only the final two periods of a woman's reproductive life. Although Heckman and Willis (1975) pointed out that the implications of the model cannot be generalized to other birth intervals, the model provides us with an insight regarding the cost of contraception and birth spacing. That is, the theory shows that an increase in efficiency of contraception increases marginal benefit of using contraceptives this period, but, at the same time, it decreases the marginal benefit through an increase of benefit from using contraceptives in the next period. Further, the model shows that the total effect of introducing modern methods of birth control depends on the relative magnitude of the utility loss from having too few children and that from having too many children.

When a Cobb-Douglas form of utility function is assumed, the finding can be understood that couples were putting relatively more weights on child good than on other consumption goods in the 1970s, and that they were putting relatively more weights on consumption goods other than children in the 1990s. Given the fertility decline in Indonesia over the sample period, this interpretation can be reached by the existing static models of fertility. One of them is a model of quantity and quality tradeoff in child good where the consumption good is one factor in producing the quality of a child. Another model involves an increase in labor market opportunity of women and the shape of home production function. Therefore, investigating more implications of the model will help us understand the connection between the static and dynamic models of fertility.

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Appendix A. Missing Steps in Equation (17) and (18)

Consider the decision in the first period. Applying the implicit function theorem to the first order condition in equation (15), the comparative dynamics regarding the effect of an increase in the contraceptive efficiency on the optimal level of contraception effort in the first period becomes

$$\begin{aligned}\frac{\partial e_1}{\partial a} &= -\frac{\frac{\partial(ap\Delta V(\tilde{}b_2))}{\partial a}}{-f''(e_1)}\\ &= -\frac{p\Delta V(\tilde{}b_2) + ap\frac{\partial \Delta V(\tilde{}b_2)}{\partial a}}{-f''(e_1)}\\ &= \frac{-p(2-p)[V(N_t^*) - V(N_t - 1)] + pp(1-2ae_2^*)[V(N_t^*) - V(N_t^*+1)] + pf(e_2^*)}{f''(e_1)}\end{aligned}$$

Recall that the second order condition for an interior solution of e_1 is $f''(e_1) > 0$ and that the necessary condition for a couple to make a positive level of contraception efforts in the first period is

$$\Delta V(\tilde{}b_2) = -(2-p)[V(N_t^*) - V(N_t - 1)] + p_2^*[V(N_t^*) - V(N_t^*+1)] + f(e_2^*) > 0.$$

$$\Leftrightarrow \left\{\frac{p_2^*}{(2-p)} + \frac{f(e_2^*)}{(2-p)[V(N_t^*) - V(N_t^*+1)]}\right\} > \frac{[V(N_t^*) - V(N_t - 1)]}{[V(N_t^*) - V(N_t^*+1)]}$$

Given that these conditions hold,

$$\begin{aligned}\frac{\partial e_1}{\partial a} &> 0 \quad \text{if} \quad V(N_t^*) - V(N_t^* - 1) > pae_2^*[V(N_t^*) - V(N_t^*+1)]\\ \frac{\partial e_1}{\partial a} &< 0 \quad \text{if} \quad V(N_t^*) - V(N_t^* - 1) < pae_2^*[V(N_t^*) - V(N_t^*+1)].\end{aligned}$$

Suppose that there exists an interior solution for e_1^* in the first period ($0 < e_1^* < 1/a$). Then, an increase in the effectiveness of contraception will increase the optimal level of contraception in the first period if the utility loss from having too few children is greater than a certain proportion of that from having too many children, otherwise the reverse holds.

Table 5: Effect of Family Planning Program on Second Birth Hazard (Appendix B)

	(1)	(2)	(3)	(4)	(5)
	Logit	Logit	FE Logit	Logit	FE Logit
	Coef.	Coef.	Coef.	Coef.	Coef.
age at 1st birth	-0.0443	-0.0431	-0.0494	-0.0436	-0.0502
	(3.60)	(3.51)	(3.34)	(3.54)	(3.39)
duration	0.3418	0.3467	0.5296	0.3521	0.5359
	(8.19)	(8.27)	(11.66)	(8.37)	(11.75)
duration^2	-0.0341	-0.0343	-0.0428	-0.0348	-0.0433
	(8.33)	(8.35)	(9.83)	(8.44)	(9.91)
year	-0.0444	-0.0432	-0.0641	0.0560	0.1012
	(6.67)	(1.12)	(1.51)	(0.91)	(1.48)
Primary education	-0.0946	-0.0728	-0.2564	0.2146	-0.0205
	(0.98)	(0.75)	(2.27)	(1.25)	(0.10)
husband's schooling	0.0097	0.0109	-0.0032	0.0107	-0.0044
	(1.09)	(1.21)	(0.28)	(1.19)	(0.39)
FP clinic		-0.1405	0.0521	-3.3124	-0.1555
		(1.71)	(0.41)	(1.92)	(0.07)
FP clinic*year				0.0387	0.0039
				(1.87)	(0.16)
FP clinic*Primary edu				-0.3430	-0.5947
				(1.60)	(2.37)
Posya		-0.0755	-0.1562	6.9425	6.1657
		(0.77)	(1.23)	(2.99)	(2.24)
Posya*year				-0.0843	-0.0756
				(3.05)	(2.31)
Posya*Primary edu				0.2516	0.1965
				(1.20)	(0.82)
nPusk		-0.0388	-0.0060	0.1685	0.8002
		(1.53)	(0.12)	(0.37)	(1.41)
nPusk*year				-0.0022	-0.0092
				(0.41)	(1.40)
nPusk*Primary edu				-0.0903	-0.0007
				(1.58)	(0.01)
FP province		-0.1117	0.6251	-0.1092	0.5549
		(0.18)	(0.60)	(0.17)	(0.53)
FP nation		2.0443	2.3256	-6.3824	-11.0899
		(0.49)	(0.52)	(1.12)	(1.78)
1st baby female	-0.0970	-0.0937	-0.0997	-0.1029	-0.1017
	(1.58)	(1.52)	(1.42)	(1.66)	(1.44)
age at 1st marriage	0.0401	0.0414	0.0394	0.0439	0.0417
	(3.27)	(3.38)	(2.69)	(3.56)	(2.84)
Muslim	-0.1582	-0.1183	-0.1471	-0.1412	-0.1761
	(1.59)	(1.12)	(0.74)	(1.33)	(0.88)
living w/ own parents	-0.0359	-0.0479	0.0444	-0.0484	0.0390
	(0.51)	(0.68)	(0.51)	(0.68)	(0.44)
living w/ parents-in-law	0.2079	0.1907	0.1875	0.1917	0.1846
	(2.55)	(2.33)	(1.94)	(2.33)	(1.90)
Constant	2.3500	2.0454		-4.9141	
	(4.26)	(0.79)		(1.16)	
no. of observations	6,004	6,004	5,991	6,004	5,991
no. of groups			267		267

Notes: 1) The t-statistics are in parentheses.