Factors Associated with Contraceptive Discontinuation in Bali, Indonesia: A Multilevel Discrete-time Competing Risks Hazard Model

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Abstract

As contraceptive use increases, studies on contraceptive discontinuation have become increasingly important. This paper uses contraceptive calendar data collected in the 1991 and 1994 Indonesia Demographic and Health Surveys. It aims to study the factors associated with contraceptive discontinuation by reason in Bali, an Indonesian province successfully implementing family planning program. The cumulative probability of discontinuation at the first 12 months of the initiation of use in 1986-1991 was 19.3%, increased to 24.9% in 1989-94. Side effects and health concerns are the most common reasons to discontinue. With a multilevel discrete-time competing risks hazard model, the study found that contraceptive method chosen and duration of use are strongly associated with contraceptive discontinuation. Socio-economic and demographic factors are also important in this matter. Unobserved heterogeneity at woman level significantly affects contraceptive discontinuation.
Acknowledgement

I would like to thank the Asian MetaCentre for Population and Sustainable Development Analysis for giving me an opportunity to reach wider readers of the research findings. This piece of research work was carried out and submitted as a part of my PhD dissertation entitled “Contraceptive Use Dynamics in Indonesia with the Special Focus on Bali: Measurements and Determinants” conducted under the supervisions of Prof. Ian Diamond and Dr. John W. McDonald, University of Southampton, United Kingdom.

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As usual, the remaining errors in interpretation and opinions belong to the author.
Introduction

Family planning program through promoting the use of contraceptive use have played an important role in reducing fertility in many countries. In the early stage of an implementation of the program, its focus is to motivate couples to adopt contraceptive use. Therefore, contraceptive prevalence has been used as an indicator to evaluate the implementation of family planning program. However, as contraceptive use increases and becomes strongly established in societies, it is recognized that its success cannot be adequately measured by an increase in the contraceptive prevalence. The focus should be shifted to encourage couples to maintain the use (Kost, 1993). The use can be maintained by giving couples counselling when problems appear and providing them with a range of contraceptive options to suit their needs (Curtis and Hammerslough, 1995; Curtis and Blanc, 1997).

In other words, the focus on quality of care has become more important than simply on contraceptive prevalence, with contraceptive continuation as one of the outcomes of the quality of care (Blanc, Curtis, and Croft, 1999). Therefore, studies on contraceptive discontinuation have become increasingly more relevant. The increasing availability of contraceptive history data, such as collected through the Demographic and Health Survey (DHS) program since the late 1980s, has provided opportunities to study contraceptive discontinuation in more depth, across time and even across countries (Ali and Cleland, 1995, Curtis and Hammerslough, 1995; Curtis and Blanc, 1997). These studies on contraceptive discontinuation were based on the DHS data and have been considered as population-based studies with a representative sample of women. Previous studies were commonly carried out based on clinical-trial information in which observations and coverage were limited.

Studies utilizing the DHS data are not only useful to examine overall discontinuation but also to examine various reasons for discontinuation. For example, Moreno and Goldman (1991) estimated contraceptive failure rates for 15 developing countries based on 1986-1989 Demographic and Health Survey (DHS) data. The further study by Moreno (1993) ascertained the importance of place of residence and education as correlates of contraceptive failure across populations with varying levels of fertility and contraceptive use. Another comparative study on contraceptive discontinuation (Ali and Cleland 1995) in six developing countries examines cause-specific contraceptive discontinuation. Not only are contraceptive failure studied but also other reasons for discontinuation such as desire to get pregnant, health concern and other reasons is studied. This study also used DHS data from the same period as Moreno and Goldman did. A subsequent study investigated the determinants of contraceptive discontinuation (Ali and Cleland, 1999).

The availability of the DHS data has enriched the knowledge and enhanced the method of analysis in this matter. Curtis and Blanc (1997) use a multi-level model in examining determinants of contraceptive use dynamics in developing countries namely Bangladesh, Colombia, Egypt, Indonesia, Peru and Zimbabwe applied to the DHS data collected between 1991 and 1994.
Studies especially focused on Indonesia have been carried out by Samosir (1994) and Fathonah (1996). Using a multi-nominal statistical analysis, Samosir focuses on factors associated with contraceptive switching in Indonesia using the 1991 DHS. Fathonah applies a life table technique to estimate various rates of contraceptive discontinuation for Indonesian as whole, including the differentiation by urban-rural residence and educational level, using 1994 DHS. Yet, very few had applied the advanced technique as in Curtis and Blanc (1997).

This paper is a continuation and modification of Curtis and Blanc's work by focusing on the Bali province of Indonesia. It examines the determinants of contraceptive discontinuation using both the 1991 and 1994 DHS data, employing the multi-level discrete time competing risks hazard model. A multiple-decrement life table technique is also utilized to estimate the discontinuation rates.

Bali is selected because of both substantial and practical reasons. On the substantial grounds, Bali has achieved below replacement level since the beginning of the 1990’s with contraceptive prevalence rates more than 70%, and hence attention should have focused more on quality care (including contraceptive continuation). Furthermore, Indonesia is a very heterogeneous society and attention to a particular region within Indonesia has become a more relevant approach to study Indonesia. In particular, the government of Indonesia has been implementing regional autonomy since 2001.

As in other event history analyses, the length of time before the occurrence of an event is very important in Curtis and Blanc’s study. Duration of use of contraceptive has been utilized as the length of time and they use three months as the segment to calculate the discontinuation. This paper goes for a deeper study by using one month as the segment to calculate the discontinuation. However, because Indonesia is a very large country, the approach of using one month as the segment has resulted in the explosion of the number of observations. Therefore, for a practical reason, the analysis is then limited to Bali, so that the data set becomes manageable.
Data

The data analysed in this study are taken from the 1991 and 1994 Indonesia Demographic and Health Surveys. The samples are nationally representative and are designed to produce estimates at the national and provincial levels. The surveys cover all 27 provinces in Indonesia, including Bali – the focus of this study.

The questionnaires were adapted from the DHS Model ‘A’ core questionnaire, which was designed for countries with high contraceptive prevalence, approximately 40%. This model has a section, which is aimed to collect monthly information from ever-married women aged 15-49 years on contraceptive use history, pregnancy history and other information related to them for a five-year period before the survey date. The information collected using this method is called calendar data. More detailed explanation about it is presented in Appendix 1. The calendar data is the main source of information for this study. The calendar data enable us to identify precisely the timing of discontinuation in relation to one another by taking into account the duration of use.

The unit of analysis of this study is based on segments of contraceptive use. These segments have to be extracted from the calendar data, in particular from the period of 3-62 months before the survey. The three months immediately prior to the survey month are excluded from the analysis to allow for possibilities of underreporting of first trimester pregnancies at the time of the survey. The underreporting could bias estimates of failure rates. After extraction, the segments are linked to the reason of discontinuation and also background variables. A detailed discussion on the process of extraction is referred to Appendix 2.

The extracted segments of use consist of full duration, right-censored and left-censored segments. In this analysis, the left-censored segments are excluded. Based on Allison (1984), Curtis and Hammerslough (1995), this exclusion does not bias the estimates. All segments of sterilization are excluded from the analysis because the chance of a woman discontinuing sterilization is extremely low.

The number of eligible segments of use for the analysis is 466 from the 1991 calendar data and 562 from the 1994 data. These segments come from 366 and 433 non-sterilized ever-married women for the respective data sets. This indicates that many women may contribute more than one segment of use in the sample. Table 1 shows the distribution of women by the number of segments of use they contributed, which ranges from one to four segments of use. Those who have contributed more than one segment of use during the five years observed accounts for 22% in the 1991 and 23% in the 1994. About seventeen percent of women have experienced two segments of contraceptive use in both data sets. Successive segments within each women mean they will not be independent. Such hierarchical data leads to an inappropriate use of ordinary method of analysis discussed in the next section.
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Number</td>
<td>%</td>
</tr>
<tr>
<td>1</td>
<td>286</td>
<td>78.1</td>
</tr>
<tr>
<td>2</td>
<td>63</td>
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<tr>
<td>3</td>
<td>14</td>
<td>3.8</td>
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<tr>
<td>4</td>
<td>3</td>
<td>0.8</td>
</tr>
<tr>
<td>Total</td>
<td>366</td>
<td>100.0</td>
</tr>
</tbody>
</table>


Table 1: Distribution of Women by the Number of Segments of Use:
Statistical Modeling

Multiple-decrement life table is used to estimate the overall rate of discontinuation by reasons for discontinuation without being controlled by other variables. Controlling the estimates with other variables makes the sample size too small to produce reliable estimates. We use a discrete-time competing risk hazards model that allow for controlling the effects of some other factors on reasons for discontinuation. This model is essentially the multinomial logit model in which the contraceptive status is recorded for certain intervals of time. In this analysis, each segment of use is recorded into monthly intervals of use. There are two reasons for choosing the discrete-time approach. Firstly, the duration of each interval is designed and recorded to the nearest whole month, therefore, time is not measured exactly. As argued by Yamaguchi (1991), it may be more natural to assume a model that reflects a discrete time measurement. Secondly, because duration of use is measured in months, the data are likely to contain a large number of ties. Events are tied when two or more individuals experience an event at the same time (Yamaguchi 1991). Our data show that many users in each month of use have the same length of duration of contraceptive use.

In competing risk hazards model, censored cases (still using) can be treated as the reference category, and the risks of each type of discontinuation relative to the risk of still using a method can be estimated simultaneously. The duration of use at each month is included as a covariate in the model and, after a series of testing of dependency of duration of use in the model, the natural logarithm of duration of use is used in this analysis.

In event history data such as a contraception history, the situation is often complicated further by the fact that an event of interest can occur more than once to an individual during a particular period of observation. This results in a hierarchical structure with repeated observations at the first level. Therefore, the individual becomes the second level. Individual characteristics are likely to affect woman’s contraceptive behaviour and the outcomes of segments of use contributed by the same woman are likely to be correlated. In addition, women who live in the same cluster are likely to be more alike than women who live in different clusters. Standard hazard model assumes that observations are independent, an assumption that does not hold in such clustered hierarchical data. The failure of the independence assumption means that estimates of standard errors obtained from standard hazard models are likely to be biased downwards, which in turn may result in effects appearing to be statistically significant when, in fact, they are not.

To address this problem, finally a multilevel discrete-time competing risks hazards model is used for the analysis. This model is an extension of the multinomial hazards model, where intercepts are allowed to vary randomly across clusters. The random-effects multinomial model is a special case of the non-linear multilevel model for discrete-response data proposed by Goldstein (1991). By including a random effect in the model, one can control both for unobserved heterogeneity and for possible correlation between duration of use for women who contribute multiple spells of use. This point is important because there are likely to be omitted or even unmeasurable factors that affect a woman’s contraceptive behaviour.
For instance, fecundability varies across women, and the risk of experiencing an unintended pregnancy during use of a contraceptive method (a contraceptive failure) would be expected to vary because of difference in fecundability. One may expect women who experience difficulty with use to discontinue early, contributing a series of short segments, while others who have fewer problems and, therefore, manage to continue use for longer periods often contribute only one long segment of use.

The model can be expressed as the log odds of experiencing a particular reason, \( r \), for discontinuation relative to continuing of the use of contraception at time \( t \) for the \( i \)th segment for the \( j \)th woman with covariates \( X_{rtij} \).

\[
\log \left( \frac{\lambda_{rtij}}{\lambda_{srtij}} \right) = \beta_{r0} + \beta_{r1} \text{ln}(Z_{rtij}) + \beta_{r2} X_{rtij} + u_{rj}, \quad r = 1, \ldots, 4
\]  

(1)

where \( \text{ln}(Z_{rtij}) \) is a natural logarithm of duration of use for the \( i \)th segment for the \( j \)th woman at time \( t \) for a reason of discontinuation \( r \). Duration of use broken down into monthly intervals and it has values from 1 to 60. \( u_{rj} \) is the random effect associated with the \( j \)th woman for type of discontinuation \( r \). The values of \( u_{rj} \) are assumed to be distributed normally with mean 0 and variance \( \sigma_{r}^2 \). Two random effects \( u_{rj} \) and \( u_{qj} \) can be correlated with covariance \( \sigma_{rq} \). The model can be regarded as consisting of a fixed part and a random part, where \( \beta_{0r}, \beta_{1r}, \) and \( \beta_{2r} \) are the parameters in the fixed part of the model and \( \sigma_{r}^2 \) and \( \sigma_{rq} \) are parameters in the random part.

The following equations give the probabilities of discontinuing use of contraception due to a particular reason for discontinuation \( r \) at time \( t \) for a use interval \( i \) with a set of background characteristics \( X_{rtij} \) in the random-effects hazards model:

\[
\hat{\lambda}_{rtij} = \frac{\exp(\beta_{r0} + \beta_{r1} \text{ln}(Z_{rtij}) + \beta_{r2} X_{rtij} + u_{rj})}{1 + \sum_{k=1}^{4} \exp(\beta_{k0} + \beta_{k1} \text{ln}(Z_{rtij}) + \beta_{k2} X_{rtij} + u_{rj})}, \quad r = 1, \ldots, 4
\]  

(2a)

and

\[
\hat{\lambda}_{srtij} = \frac{1}{1 + \sum_{k=1}^{4} \exp(\beta_{k0} + \beta_{k1} \text{ln}(Z_{rtij}) + \beta_{k2} X_{rtij} + u_{rj})}
\]  

(2b)

The cumulative probability of discontinuation due to reason \( r \) is calculated using equation 2b.

In order to test significance of the random effect, the random parameter significance test has to be modified because \( \sigma = 0 \) is on the boundary of parameter space. Rather than as a chi-square random variable with one degree of freedom, Maller and Zhou (1996) have suggested that, in large sample, the test statistic is approximately distributed as a random variable with an equal probability (50-50) mixture of a chi-square and a point mass at zero. The 95th percentile of the distribution of such a random variable is given by

\[
\frac{1}{2} + \frac{1}{2} p(X_i^2 \leq c_{0.95}) = 0.95
\]
or

\[ p \left( X_1^2 \leq c_{0.95} \right) = 0.90 \]

This critical value for the 0.05 significance level now becomes 2.71 rather 3.84 as in the standard case. This critical value is used in the present study to calculate significance levels of the random parameters.
Variables Used in the Analysis

The dependent variable is reasons for discontinuation, which is divided into four groups: failure (become pregnant while a woman is using a contraceptive method), desire to get pregnant, side effects and health concerns, and other reasons for discontinuation. Table 2 shows the frequency distribution of the number of segments of contraceptive use according to the reasons reported for discontinuation. It shows that of the total segments, 33.0% discontinue for a range of reasons during 1986-1991 and became 40.6% during 1989-1994. Ten percent, the highest percentage, of segments in 1986-91 discontinued because of the desire to get pregnant. Thirteen percent, the highest percentage, of segments in 1989-94 discontinued because of side effect and health concerns. The smallest percentage is for those discontinued because of failure, 4.3% of the segments in 1986-91 and 6.9% in 1989-94.

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Number</td>
<td>%</td>
</tr>
<tr>
<td>Still using</td>
<td>312</td>
<td>67.0</td>
</tr>
<tr>
<td>Failure</td>
<td>20</td>
<td>4.3</td>
</tr>
<tr>
<td>To get pregnant</td>
<td>47</td>
<td>10.1</td>
</tr>
<tr>
<td>Side effects and health concerns</td>
<td>42</td>
<td>9.0</td>
</tr>
<tr>
<td>Other Reasons*</td>
<td>45</td>
<td>9.7</td>
</tr>
<tr>
<td>Total</td>
<td>466</td>
<td>100.0</td>
</tr>
</tbody>
</table>

Noted: * Other reasons consist of partner disapproved, availability, want more effective method, inconvenient to use, infrequent sex, cost, separated/widowed, fatalistic, IUD expelled, don’t know and others.

Table 2: Distribution of the Number of Segments of Contraceptive Use According to the Reasons Reported for Discontinuation: Bali, 1986-1991 and 1989-1994

In a hazard model, a variable measuring duration is an important independent variable. In this study duration of use is measured as monthly duration and transformed into a logarithmic form. Each segment of contraceptive use is coded according to the method of contraception used during that segment. The methods are grouped as follow: pills, IUDs, injectables, and less effective methods. Less effective methods, as the reference group, consist of traditional methods such as periodical abstinence, withdrawal and herbs, some modern methods like condom and intravag. These less effective methods are combined into one group because of small numbers of segments of use.

Each segment of use is also assigned a code that corresponds to the woman’s contraceptive status in the month immediately prior to the use. This variable was grouped into three categories: no method, birth or termination, and used any method of contraception. The last category is the reference group. This variable is intended to measure the effect of previous experience with contraception on the rate of discontinuation.

Socioeconomic background variables included in the model are place of
residence, the women’s and husband’s educational level. Place of residence represents the place where the respondents lived at the time of the survey, and represents whether they lived in urban or rural areas. Ideally, this should be measured at the beginning of the segment, not at the time of the survey. Because there is no information on residence at the start of the segment, we assume that there is no change of residence from the start of the segment to the time of the survey.

Level of wife’s and husband’s education is also measured at the time of the survey and we assume that there is no change in the level of education from the start of the segment to the time of the survey. These variables were grouped as follows: no schooling, some primary, completed primary and completed some secondary.

The demographic variables are age, number of living children, contraceptive intention, and past contraceptive use experience. The age at the start of use was grouped into three categories, less than 25 years old, between 25 and 29, and above 30 years. The number of living children refers to the number of children the woman had at the start of the segment of use. It consists of three groups: childless women and women with one child combined in one group, women who had two or three children, and those with more than four children as the reference group.

Contraceptive intention is included in the model as a proxy for the strength of women’s motivation to avoid pregnancy. This variable is based on the woman’s report of the wantedness of the next birth after the segment of use, that is, whether the birth was wanted at that time, wanted later, or not wanted at all. The information on the date that the segment of use began was utilised to identify the birth following the segment of use. If that birth was classified as wanted then or wanted later, the contraceptive intent for that segment was classified as a ‘spacer’. If the birth was reported as not wanted at all, the intention for that segment of use was classified as ‘limiter’. If there is no birth following the segment of use, the variable is based on the woman’s current fertility preference. Women with uncertain fertility intentions were included in the category of spacers. Spacers are reference group.

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1 As we have information on the date of the first month of each segment of use (CMCSTART) and the woman’s date of birth as century month codes. The age at the start of use was calculated as the CMCSTART minus the date of birth and it was then divided by twelve to calculate age in years.
Results

Multiple decrement life table analysis

Using multiple decrement life table analysis, we calculate contraceptive discontinuation by its reasons. Figure 1 presents cumulative probability of contraceptive discontinuation for the first 24 months since initiation of use for each reason during the two periods of observation. If we take a closer look at the first 12 months since initiation of use, the cumulative probability of discontinuation in 1986-1991 was 19.3%, increasing to 24.9% in 1989-94. We can also see from this figure that there is a change in composition of reasons for discontinuation from the first period to the second one. In 1986-91 reasons for discontinuation at the 12th month after initiation of use consisted of 7.7% discontinuation due to side effect and health concerns, 5.5% due to other reasons, 4.4% due to desire to get pregnant, and 1.5% failure. In 1989-94 the reasons for discontinuation at the 12th month after initiation of use had changed in its composition in which side effect and health concerns (9.1%) remained the most common reasons, followed by other reasons (6.8%), failure (4.8%) and desire to get pregnant (4.2%). Probability of discontinuation due to failure is higher than that of desire to get pregnant in 1989-94, but lower in 1986-91. Furthermore, the rank order of the reasons for discontinuation remains the same in second 12 month of use in 1989-94 but changes in 1986-91.

![Figure 1: Cumulative Probability of Contraceptive Discontinuation by Reason Bali, 1986-91 and 1989-94](image-url)
Duration of use and method of contraception

Figure 2 presents estimated hazard function\(^2\) for each reason for discontinuation as duration of use increases, controlling for socio-economic and demographic factors. This figure is derived from the parameter estimates presented in Tables 3 and 4. As shown in these tables, duration of use has a significant effect on discontinuation although the effect is not seen in each reason for discontinuation. The effect of duration of use is significant on discontinuation due to desire to get pregnant, side effects and health concerns, and also other reasons in 1986-91. Furthermore, the effect is significant on two reasons for discontinuation only, namely desire to get pregnant and other reasons in 1989-94. Duration of use does not have any significant effect on discontinuation due to failure in both periods.

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\(^2\) Estimates of the hazard functions by duration are calculated from the multilevel model. At this stage, the random effects at the woman level are held at their mean value of zero.
### Table 3: Parameter Estimates and Standard Errors (SE) from the Multilevel Discrete-Time Competing Risks Hazard Models for Contraceptive Discontinuation

Controlling for Other Variables: Bali, 1986-1991

<table>
<thead>
<tr>
<th>Variable</th>
<th>Failure</th>
<th>Desire to get pregnant</th>
<th>Side Effects and Health Concerns</th>
<th>Other Reasons</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>ESTIMATE</td>
<td>S. E</td>
<td>ESTIMATE</td>
<td>S. E</td>
</tr>
<tr>
<td>Intercept</td>
<td>-6.028</td>
<td>1.658</td>
<td>-4.529</td>
<td>1.005</td>
</tr>
<tr>
<td>Log(duration)</td>
<td>0.525</td>
<td>0.285</td>
<td>0.481***</td>
<td>0.182</td>
</tr>
<tr>
<td>Method</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><em>Pill</em></td>
<td>0.424</td>
<td>1.182</td>
<td>-1.280**</td>
<td>0.622</td>
</tr>
<tr>
<td><em>IUD</em></td>
<td>-0.312</td>
<td>1.078</td>
<td>-1.586****</td>
<td>0.471</td>
</tr>
<tr>
<td>Injectable</td>
<td>0.581</td>
<td>1.123</td>
<td>-0.372</td>
<td>0.482</td>
</tr>
<tr>
<td>Place of residence</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><em>Urban</em></td>
<td>-0.128</td>
<td>0.569</td>
<td>0.373</td>
<td>0.357</td>
</tr>
<tr>
<td>Women's education (base=secondary plus)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><em>No schooling</em></td>
<td>0.403</td>
<td>0.979</td>
<td>-0.158</td>
<td>0.611</td>
</tr>
<tr>
<td><em>Some Primary</em></td>
<td>0.315</td>
<td>0.891</td>
<td>-0.488</td>
<td>0.567</td>
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<tr>
<td><em>Primary</em></td>
<td>0.111</td>
<td>0.767</td>
<td>-0.172</td>
<td>0.440</td>
</tr>
<tr>
<td>Husband's education (base=secondary plus)</td>
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<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><em>No schooling</em></td>
<td>-0.778</td>
<td>1.196</td>
<td>0.437</td>
<td>0.787</td>
</tr>
<tr>
<td><em>Some Primary</em></td>
<td>-0.473</td>
<td>0.719</td>
<td>-0.005</td>
<td>0.552</td>
</tr>
<tr>
<td><em>Primary</em></td>
<td>-0.987</td>
<td>0.745</td>
<td>0.345</td>
<td>0.446</td>
</tr>
<tr>
<td>Status in the month immediately before use (base= any method)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><em>No method</em></td>
<td>-0.483</td>
<td>0.691</td>
<td>-1.091***</td>
<td>0.399</td>
</tr>
<tr>
<td><em>Birth</em></td>
<td>-0.285</td>
<td>1.071</td>
<td>-0.983</td>
<td>0.613</td>
</tr>
<tr>
<td>Age the start of use (base=&lt;30)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>&lt; 25</td>
<td>0.701</td>
<td>0.813</td>
<td>0.702</td>
<td>0.623</td>
</tr>
<tr>
<td>25 – 29</td>
<td>0.066</td>
<td>0.812</td>
<td>0.769</td>
<td>0.607</td>
</tr>
<tr>
<td>Contraceptive intention at the start of use (base=spacers)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><em>Limiters</em></td>
<td>-1.478**</td>
<td>0.604</td>
<td>-1.706****</td>
<td>0.463</td>
</tr>
<tr>
<td>Number of living children at the start of use (base=&gt;4)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>0-1</td>
<td>-1.100</td>
<td>1.092</td>
<td>0.078</td>
<td>0.826</td>
</tr>
<tr>
<td>2-3</td>
<td>-0.542</td>
<td>0.892</td>
<td>-0.386</td>
<td>0.746</td>
</tr>
<tr>
<td>Random effect</td>
<td>0.911</td>
<td>0.931</td>
<td>0.000</td>
<td>0.000</td>
</tr>
</tbody>
</table>

Note: **** p< 0.001  *** p< 0.01  ** p< 0.05
Figures 2 shows two types of hazard functions, negative and positive ones. As duration of use increases, the risk of discontinuation use of contraception due to side effects and health concerns decreases, and so does for discontinuation due to other reasons. On the other hand, the effect of duration of use on the risk of discontinuation due to desire to get pregnant is positive. The positive effect of duration of use on the discontinuation due to desire to become pregnant is as expected but only significant in 1989-94. An interesting result is that the risk of discontinuation due to desire to get pregnant after one year of use is higher in 1989-94 than that in 1986-91. These findings could have led to an increase of fertility rate during these periods. Another interesting thing from Figure 2 is that the risk of failure within 24 months of the initiation of use in
1989-94 is higher than in the previous period. The finding in use failure is consistent with the result from the multiple decrement life table analysis.

The negative effect of duration of use on discontinuation due to side effects and health concerns is also expected. The longer a woman manages to use a method of contraception successfully, the more experience she becomes and the less likely she is to discontinue due to side effects and health concerns. We found that the risk of discontinuation due to these reasons sharply declines from a relatively high risk at the beginning of the initiation of use in 1986-91. On the other hand, in 1989-1994 the negative effect of duration of use to discontinuation due to these reasons is not significant although the negative pattern is still seen in Figure 2. The figure reveals that the risk of discontinuation due to side effects and health concerns in the very early use of contraception decreases from 1986-91 to 1989-94. However, this figure also reveals that after three months on initiation of use the risk of discontinuation due to side effects and health concerns is higher in 1989-94 than that in 1986-91. Significantly negative effect of duration of use is also observed on the risk of discontinuation due to other reasons. In the two time periods, the risk of discontinuation due to other reasons remains the same.

Methods of contraception vary in their convenience, effectiveness and availability and in the side effects. Consequently, discontinuation rates for a particular reason vary across methods. Being controlled for socio-economic and demographic factors, the method of contraception is significant for some, but not all reasons for discontinuation. Method is not significantly associated with both contraceptive failure and experiencing side effects and health concerns in 1986-1991. However, method is significantly associated with these reasons in 1989-1994. Relative to less effective methods, as expected, users of the IUDs and injectables tend to have significantly lower risk of failure. The risk of failure of the pills is not significantly different from that of less effective methods. Furthermore, the pill users are more likely to discontinue due to side effects and health concerns than the less effective methods’ users (Table 4).

Discontinuation because of desire to become pregnant is significantly associated with method of contraception in both periods. The IUD users are the least likely to discontinue use because of desire to become pregnant. This is expected as the IUDs are regarded as a long-term method, an alternative to sterilization, whereas other methods are more likely to be used as temporary contraception among couples who planned to have another child. Pill users are significantly lower to discontinue due to desire to become pregnant than less effective methods’ users in 1986-91, but not significant in 1989-94. The injectables users are significantly lower to do so than less effective methods’ users in 1989-94. These results imply that users who want to have another baby tend to use less effective methods.

Method of contraception is also associated with discontinuation due to other reasons. In both periods, the IUD and injectable users have significantly lower probabilities than less effective methods’ users in discontinuation due to other reasons. The pill users also tend to have lower probability than less effective methods to discontinue due to other reasons in 1989-94.
Socio-economic and demographic variables

The socio-economic variables, woman and husband’s educational level and place of residence, have no significant association with all types of reasons for discontinuation in 1986-91. The lack of significant differential in discontinuation of contraceptive use among users from different backgrounds on educational attainment, and also between users who live in urban and rural areas is consistent with those seen in other studies (Ali and Cleland, 1996; Zhang, Tsui and Suchindran, 1999). However, this is not the case in 1989-94 in which women’s education and place of residence have significant effects on contraceptive discontinuation due to failure. It is interesting to find out that users with no education and those with some primary education are less likely to discontinue due to contraceptive failure than those with secondary education and higher. The higher risk of failure among educated users might be because the more educated women are more fecund.

Place of residence is statistically significant at p < 0.001 for discontinuation due to failure in the 1989-1994. Women who lived in urban areas were less likely to experience contraceptive failure than those who lived in rural areas. This means that urban women were doing better in using contraception than rural women, because urban women might have better access to the information on how each method works or how to use the method correctly.

Discontinuation may be related to the past experience on contraceptive use. Therefore, to examine the impact of past experiences on the risk of any type of discontinuation, the status in the month immediately before segment of use of contraception is included in the model. It is categorized into three groups: whether a woman just had a baby or a termination, had no method of contraception, and had used any method of contraception. The results show that this variable has a significant effect; implying that the preceding experience is important in determining discontinuation of contraceptive use for particular reasons. In 1986-91, those having previous experiences with contraceptive use are significantly more likely to discontinue due to desire to get pregnant than those with no previous experiences. However, in 1989-94, the past experience does not significantly affect the risk of discontinuation due to desire to become pregnant but it affects discontinuation due to experiencing side effects and health concerns (p < 0.05). Relative to those who previously used another method, users who had just delivered a baby or experienced pregnancy termination in the month immediately before the use are less likely to discontinue due to experiencing side effects and health concerns.

Contraceptive intention is associated with the risk of contraceptive failure in 1986-1991 but not in 1989-1994. Women who are using contraception to limit future births were less likely to experience contraceptive failure. This probably reflects the role of motivation to avoid pregnancy on the quality of contraceptive use. Contraceptive intention is also strongly negatively associated with other risks of discontinuation. The risk of experiencing side effects and health concerns is lower for those who are using contraception for limiting future births than those who are using contraception for spacing with p < 0.05 in 1986-91. As expected, discontinuation due to desire to become pregnant is likely lower for limiters than spacers with p < 0.001 in 1986-91 and p < 0.05 in 1989-94. In the latter period limiters are also more likely to discontinue for other reasons than spacers.
The number of living children is only significantly associated at $p < 0.1$ with the risk of experiencing side effects and health concerns, and other reasons. This case is only observed in 1986-1991. Women with no children or with one child are less likely to experience side effects and health concerns than other women are. Women with more than four children are more likely to discontinue due to other reasons.

There is no evidence of a significant effect of woman’s age at the start of use on contraceptive failure and on discontinuation due to desire to get pregnant. However, woman’s age at the start of use significantly ($p < 0.1$) affects the risk of discontinuation due to side effects and health concerns in 1986-1991 and discontinuation due to other reasons.

**Random effects**

DHS surveys are carried out based on a three-stage sampling design. Household is the focus of the surveys but the first stage-sampling unit is often a well-defined geographical unit, generally known as a cluster. A cluster in Indonesia DHS surveys is a primary sampling unit or an enumeration area. Therefore, the population is divided into clusters that are randomly selected. In the following stage, households are randomly selected within each cluster and all women of reproductive age are interviewed. This clustered structure is expected to be related to the individual behaviour in that people living close together are likely to share similar norms and values. After considering the woman level, the next model is to extend the model to a three level model where clusters are considered as higher than woman level.

We have tested the cluster effect in a series of model estimations, and we found out that all random parameters of the cluster levels are not statistically significant in both 1991 and 1994 data. In analysing contraceptive discontinuation in Brazil, Leite (1998) also finds that all random effects at cluster level are not significant. Therefore, the cluster level is excluded from the analysis. In other words, this study is limited to two levels: segments of contraceptive use as level 1 nested within women as level 2. The random effect is limited to women as the level-2 effect.

Covariates capturing the characteristics of an individual prior to an event of interest should be added into the model to take into account of the possible dependencies between observations on the same individual. Steele, Diamond and Wang (1996) mention an example of such variables, e.g. the number of previous uses of contraception or the number of previous failures. Steele (1996) uses both variables in the analysis of contraceptive discontinuation in China. (Curtis and Blanc 1997) include the status in the month immediately before use of contraception is considered in the model, e.g. whether an individual was using any method, just had a birth or a termination, or was not using any method. In this study, the contraceptive use status in the month immediately is used as one of the independent variables.

When we utilized duration of use as the only independent variable in the model, results are not presented here, the parameter estimate of random effect of contraceptive failure is significant at the 0.05 level of significance in 1986-91 and at the 0.001 in 1989-94. The significant parameter estimate of random effect is also revealed in discontinuation due to side effects and health concerns in the 1986-1991 and due to other reasons in 1989-1994. The parameter estimates of random effect for
discontinuation due to desire to become pregnant in the two periods of observation are zero.

The magnitude of parameter of random effect changes when method of use is included in the model. The inclusion of method of use in the model reduces the extra variation in the risk of discontinuation due to side effects and health concerns, and also contraceptive failure in both periods. The random parameter estimate of 3.69 is high for contraceptive failure. However, the inclusion of the method of use in the model increases the extravariation in the risk of other reasons from 1.162 to 1.577. The level of significance of the random effect of other reasons increases from 0.05 to 0.01 in 1989-94.

In spite of the large number of variables included in the model the random effects of discontinuation due to contraceptive failure and other reasons are still significant at the 0.05 level of significance in 1989-1994 (Table 4). However, the significant random effect for side effects and health concerns is no longer observed in both periods. Previous contraceptive experience explained the changes in significance of the random effects of side effects and health concerns discontinuation. This variable explained the correlation among segments of use of contraceptive within woman.

The significance of the random effect of contraceptive failure and other reasons suggests that there remain some unobserved variables that increased or decreased a woman's susceptibility to the risk of discontinuing use of contraception related to those reasons. To examine the extent to which the variation across women affects the rates of discontinuation due to contraceptive failure, and other reasons, the 12-month and 24-month duration for each one of these two reasons are calculated for different values of random effect at woman level. The value of random effect considered by Curtis et al. (1993) are $-2\sigma, -\sigma, 0, +\sigma, and +2\sigma$ which correspond to the mean value of $u_{ij} (0)$ and to one and two standard deviations on either side of the mean. Hence, 68% of women has the probability that a use episode with a certain set of characteristics for type of discontinuation $r$ lie between the probabilities corresponding to $u_{ij} = -\sigma$ and $u_{ij} = +\sigma$, and 95% of women has the probabilities corresponding to $u_{ij} = -2\sigma$ and $u_{ij} = +2\sigma$ for 95% of women. Negative values of random effect ($-2\sigma$ and $-\sigma$) would correspond to women who had below-average risk of discontinuation due to type of reasons $r$ on the unobserved factors; positive values ($2\sigma$ and $\sigma$) would correspond to women with above-average risk.

Table 5 presents estimated probabilities of discontinuation due to contraceptive failure and other reasons within one-year and two-year after initiation of use for segment with average characteristics in 1989-94, for different values of the random effect $u_{ij}$. These probabilities are calculated by fixing all variables in the model at their mean values and setting the random effects associated with the other two types of discontinuation at 0 because they are not significant.
Table 5: Estimated 12-month and 24-month Cumulative Probabilities (in Percentage) of Contraceptive Failure and Other Reasons for Discontinuation for Different Values of the Woman-level Random Effect:
Bali, 1989-94

<table>
<thead>
<tr>
<th>Reason for Discontinuation</th>
<th>Duration</th>
<th>Woman-level Random Effect ($u_i$)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>$-2\sigma_r$</td>
</tr>
<tr>
<td>Failure</td>
<td>12-month</td>
<td>0.2</td>
</tr>
<tr>
<td></td>
<td>24-month</td>
<td>0.3</td>
</tr>
<tr>
<td>Other Reasons</td>
<td>12-month</td>
<td>0.6</td>
</tr>
<tr>
<td></td>
<td>24-month</td>
<td>0.9</td>
</tr>
</tbody>
</table>

As can be seen from Table 5, the probability of contraceptive failure within one year of initiation of use at the mean value was low, but these probabilities varied greatly from 0.2 at two standard deviations below the mean to 31.1 at two standard deviations above the mean because of the unobserved variables that affect the experience of contraceptive failure. The probability of failure within two years of initiating use ranged from 0.3 to 45.5. These two ranges overlap. Therefore, although the probability of failure within one year was lower than that observed within two years, users associated with one standard deviation above the mean would experience higher rate of failure (10.1) than users associated with the mean of random effect (5.2). In other words, though in general women who had used contraceptive within one year tended to have a lower probability of failure than a women who had use contraceptive within two years, a woman of one-year duration but of higher risk (e.g., at one standard deviation above the mean) had a higher probability of failure than a woman of two-year duration but with lower risk (e.g., at one standard deviation below the mean.)

Similarly the random effect at woman level had a strong effect on the cumulative probabilities of discontinuing due to other reasons. Women associated with one standard deviation above the mean may have their risk of discontinuation due to other reason increased by 158% in relation to those women associated with an average random effect in the case of discontinuation within one year of initiating use. The increase of 143% was observed for discontinuation due to other reasons within two years after adoption.

The significant extra variation on contraceptive failure is also found in China (Steele, 1996). She mentions that unobserved biological factors might be a possible explanation. Some women may have an inherently higher chance of conceiving and, therefore, have a higher risk of failure, regardless of which method they are using. Another possible factor that may explain at least part of the unobserved heterogeneity is the frequency of coitus. The opinion of the husbands in relation to male dependent methods could also explain part of the unobserved variation for discontinuation due to other reasons. Further possibilities are variables relating to the availability and quality of family planning services.

Wang and Diamond (1995) suggest that much of the IUD failure rate can be attributed to the low quality of IUDs used in China. It is possible that Bali, where the predominant users were the IUD users, might have a similar case to China. IUD quality
and poor insertion techniques might have led to an increase in failure, side effects and health concerns, and expulsion risk.
Conclusion

A multilevel discrete time competing risks hazard model is used to study factors associated with contraceptive discontinuation in Bali, Indonesia in 1986-91 and 1989-94. We use a discrete time hazard model to treat duration of use as a discrete interval, which is rounded to the nearest month. Whereas, a competing risks approach allows one to distinguish between the risk factors associated with each reason for discontinuation, i.e. contraceptive failure, desire to become pregnant, side effects and health concerns, and other reasons. A multilevel model allows omitted covariates at the woman level and also correlation between segments of use for the same woman.

Duration of use and contraceptive method chosen are strongly associated with the risk of discontinuation although not always in each reason for discontinuation in both data sets. Duration of use is positively associated with discontinuation because of desire to become pregnant, but negatively associated with discontinuation because of other reasons in both periods. Duration of use is negatively associated with side effects and health concerns in 1986-91 only. Users of modern methods had consistently lower rates of discontinuation than users of less effective methods. Overall, these results suggest that method choice and duration of use played an important role in contraceptive discontinuation behaviour.

A series of socio-economic and demographic factors are associated with reasons for discontinuation. However, contraceptive intention tends to have strong relationship with each reason for discontinuation. Over time women who used contraception for limiting future births are more likely to discontinue contraceptive use due to desire to become pregnant or due to experience side effects and health concerns than those who used contraception for spacing. Spacers in 1986-91 are more likely to experience a contraceptive failure than limiters. Spacers are more likely to discontinue due to other reasons than limiters in 1989-94.

The effects of socio-economic variables were important, however, in the case of contraceptive failure and side effects and health concerns although not for all periods. The risk of contraceptive failure for those who lived in urban areas in 1989-1994 is lower than that of rural areas. The risk of contraceptive failure was also higher in the latter period in rural areas. This may indicate the importance of how to improve users' knowledge about using a contraceptive method correctly.

Even after controlling for a range of covariates, substantial unobserved heterogeneity remains for contraceptive failure in 1989-1994. This can probably be a result of the absence of variables indicating fecundability. In conjunction with an increase in contraceptive failure for two periods of observation, the risk of contraceptive failure is higher for the more educated users; and it increases over time. As in Bongaarts and Potter (1983), health and nutritional status are some of the proximate determinants of fertility. The more educated users can have better health and nutritional status. Therefore, they can be more fecund and they, in turn, can have a larger risk of contraceptive failure.

The random effect at woman level has also a strong effect on the risk of discontinuation due to other reasons. A possible factor that may explain at least part of the unobserved heterogeneity is the frequency of coitus along with fecundability. The
opinion of the husbands in relation to male dependent methods can also explain part of the unobserved variation for discontinuation due to other reasons.
Reference


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Appendices

Appendix 1: Calendar Data

The calendar approach collects retrospective monthly contraceptive histories and pregnancy histories for the five years preceding the surveys. It is implemented routinely in DHS surveys in countries that have reached contraceptive prevalence above 40%. The calendar has been used in 24 DHS surveys (Curtis, 1997). Indonesia is one of them and the 1991 survey is the first to administer the calendar questionnaire.

The calendar questionnaire consists of a matrix of rows and columns. Each row represents a particular month with the last row usually representing January of the fifth calendar year before the survey. These are January 1986 and 1989 for the surveys conducted in 1991 and 1994, respectively. The columns are used to record different types of information for each month. In the 1991 DHS survey there were six columns included in the calendar but this was reduced to four in the 1994 survey.

The first two columns are most relevant for the analysis of contraceptive use dynamics. The first column is assigned for identifying and marking the calendar months in which the respondent gave birth, she was pregnant, she had stillbirth/abortion/miscarriage, she used a contraceptive method and she did not use any method. Every box (month) of this column contains only one code – a code for pregnancy, live birth, stillbirth/miscarriage/abortion, non use and use of a particular method. Codes for use of contraception are different for different methods, and there are at least ten methods used by the users; (1) Pill, (2) IUD, (3) Injection, (4) Norplant, (5) Intravag, (6) Condom, (7) Female sterilisation, (8) Male sterilization, (9) Periodical Abstinence, (10) Withdrawal and (11) other methods (Central Bureau of Statistics et.al., 1992 and 1995).

Information was entered into the calendar at different stages of the interview. Immediately after completing the birth history, each reported live birth was entered into the month of birth in the calendar and the duration of its pregnancy into the eight preceding months or into the preceding months up to last month if the pregnancy occurred before that date. Thereafter, any non-live births that occurred in the remaining months were probed. These are then entered in the calendar along with the number of months of pregnancy preceding each non-live birth (Curtis, 1997). This column is completed in the contraceptive section of the questionnaire when interviewers probe for all periods of contraceptive use and non-use using the live and non-live births already recorded as reference points, such as name of children, dates of birth, and period of pregnancy. The use of reference points aids the respondent’s recall and helps reconcile the timing of contraceptive use with reproductive events.

The second column records the reason for discontinuation of each episode of contraceptive use of each method. This information was coded in the row (month) corresponding to the last month of continuous use of each contraceptive. Based on this information, episodes of contraceptive use can be identified and linked to the reasons for discontinuation. Other columns are used to record respectively information on postpartum amenorrhoea, postpartum abstinence, breastfeeding histories and marriage histories. Both postpartum amenorrhoea and postpartum abstinence were not collected in
the 1994 survey.
Appendix 2: Calendar Data Extraction

Extraction of segments of use and non-use utilises the CAL2SPSS programme, which is one of the computer software programs called DYNPAK designed to accompany the DHS Model Further Analysis Plan: Contraceptive Use Dynamics (Curtis and Hammerslough 1995). This programme has been employed by Fathonah (1996) and Curtis and Blanc (1997) to analyse the 1994 IDHS. This programme will only process the rectangular data file supplied by the DHS. So that the name of the rectangular file inputed to the programme must be the same as the DHS named. For example, the 1994 Indonesia’s rectangular data file named IDIR31RT.DAT.

This programme will produce a new data file with a name based on the name of the rectangular file. This file will be called, for instance, IDIR31CL.DAT. The output contains each record representing a segment of contraceptive use or a segment of nonuse. A segment of use is defined as an uninterrupted period of use of an individual contraceptive method, while a segment of nonuse is an uninterrupted period in which the woman is not pregnant and is not using a contraceptive method.

The information included on each record are the woman’s ID information (CASEID), the woman’s sample weight (WEIGHT), the method use in that segment (including no method) called METHOD, the reason for discontinuing use (not applicable for segments of nonuse) called WHYDISC, the woman’s reproductive status in the month immediately following discontinuation of the segment (NEXTMON), the duration of the segment (DUR), the woman’s reproductive status in the month immediately before initiation of the segment (PREVMON), the number of births the woman had following the segment (BIRTHS1), and the date of the first month of the segment as a century month code (CMCSTART).

The calendar data covered a 69-month period prior to the survey. We use a 60-month period before the survey. The last three months immediately before the survey are excluded. This is conventional practice to enable women who get pregnant to recognize that they are pregnant and hence to reduce bias in estimated failure rates due to unidentified failures. Therefore, the period covered by the data on segments of use is 3-62 months before the survey date of each woman. In addition, the programme also ignores left-truncated observations, i.e., observations that start before this 60-month period and continue into it. The excluded segments might come from women who were sterilized before the observation period, women who had no contraceptive use due to their husbands being sterilised, women who were divorced/widowed before the 62th month prior to the survey, and truncated segments of use.

The calendar questionnaire consists of a matrix of rows and columns. Each row represents a particular month with the last row usually representing January of the fifth calendar year before the survey. These are January 1986 and 1989 for the surveys conducted in 1991 and 1994, respectively. The columns are used to record different types of information for each month. In the 1991 DHS survey there were six columns included in the calendar but this was reduced to four in the 1994 survey.

The first two columns are most relevant for the analysis of contraceptive use dynamics. The first column is used to record histories of pregnancy and contraceptive use. Information was entered into the first column of the calendar at different stages of

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3 Every box (month) of this column contains only one code – a code for pregnancy, live birth, stillbirth/miscarriage-abortion, non use and use of a particular method. Codes for use of contraception are different for different methods, and there are at least ten
the interview. Immediately after completing the birth history, each reported live birth was entered into the month of birth in the calendar and the duration of its pregnancy into the eight preceding months or into the preceding months up to last month if the pregnancy occurred before that date. Thereafter, any non-live births that occurred in the remaining months were probed. These are then entered in the calendar along with the number of months of pregnancy preceding each non-live birth (Curtis, 1997). This column is completed in the contraceptive section of the questionnaire when interviewers probe for all periods of contraceptive use and non-use using the live and non-live births already recorded as reference points, such as name of children, dates of birth, and period of pregnancy. The use of reference points aids the respondent’s recall and helps reconcile the timing of contraceptive use with reproductive events.

The second column records the reason for discontinuation of each episode of contraceptive use of each method whenever it occurs. This information was coded in the row (month) corresponding to the last month of continuous use of each contraceptive. Based on this information, episodes of contraceptive use can be identified and linked to the reasons for discontinuation. Other columns are used to record respectively information on postpartum amenorrhea, postpartum abstinence, breastfeeding histories and marriage histories. Both postpartum amenorrhea and postpartum abstinence were not collected in the 1994 survey.

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