Estimating abortion rates from contraceptive failure rates via risk compensation: a mathematical model

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ABSTRACT

In this paper, we propose a set of hypotheses for deriving the abortion rate as a function of the intercourse interval in weeks, the number of weeks since the start of first intercourse, the number of weeks of pregnancy, the number of weeks of breastfeeding, and the contraceptive failure rate. We also propose risk compensation as feedback: the intercourse interval is proportional to the $m^{th}$ power of the contraceptive failure rate. We show that for different values of $m$, the abortion rate may become smaller, bigger, or remain the same compared to the case when no contraceptives are used. Thus, one way to settle the RH Bill debate is to determine the correct value of $m$ derived from accurate data on the reproductive health parameters of a large sample of the female population. If this data is not available, it is better not to take risk in approving the bill, because there is a possibility of increasing our national abortion rate through the promotion of contraceptives. Instead, it may be better to use alternative methods to manage our population and reduce our abortion rate to zero by promoting chastity before marriage, late marriages, and breastfeeding—and accepting each child conceived as a gift and not as a burden.

1 Introduction

The Reproductive Health Bill is currently being proposed in the Philippine Congress as House Bill 4244[1] and in the Philippine Senate as Senate Bill 2378[2]. The pro-RH Bill groups claim that making condoms more accessible and affordable will lessen the number of abortions, which may be as high as 85% according to a Guttmacher Report[3], a figure which was quoted by Cong. Lagman[4]. On the other hand, Anti-RH Bill groups claim that the abortions will in fact increase—a view shared by the the Catholic Bishops Conference of the Philippines, saying that many scientific analysts themselves wonder why prevalent contraceptive use sometimes raises the abortion rate[5].

Unfortunately, high quality data on contraception—and especially on induced abortion—are difficult to obtain[6, 7], so that the results are only valid to the sampled group. Also, the interpretation of data is dependent on the theoretical framework used. For example, the observed simultaneous rise of contraceptive prevalence and abortion rate in some countries at certain decades can be interpreted in two ways. One interpretation is that more contraceptives results to more abortions, so the government should not promote contraception. Another interpretation is that the contraception prevalence rate has not yet
reached the critical threshold of 80% before the abortion rate falls as fertility rate approaches the replacement level of two births per woman, which is the interpretation of Marston and Cleland[8] using the inverted U-shaped framework of Bongaarts[9]. Thus, without an accurate data set and a common framework for interpreting the data, the debate on the RH bill will never be resolved.

In this paper, we propose a theoretical framework for estimating the number of abortions a woman will have depending on the failure rate of the contraceptive she uses. We wish to determine whether the availability of more effective contraceptives will decrease or increase the number of abortions.

We shall divide the paper into six sections. Section 1 is Introduction. In Section 2, we shall review the literature on the relationship between contraception and abortion by discussing determinants for fertility and abortion rates, the importance of intercourse frequency as determinant, the hypothesis of risk compensation, and the systems thinking framework. In Section 3, we shall compute the average number of weeks before pregnancy occurs, given the intercourse frequency and the contraceptive failure rate. We shall also discuss the effective contraceptive failure rate if more than one contraceptive is being used. In Section 4, we shall derive the abortion rate as a function of intercourse interval in weeks, the number of weeks from first intercourse, the number of children, the number of weeks spent on breastfeeding, and the contraceptive failure rate. In Section 5, we shall discuss risk compensation and determine whether more effective contraceptives would lessen or increase the number of abortions. Section 6 is Conclusions.

2 Conceptual Framework

2.1 Determinants of fertility and abortion rates

In 1978, Bongaarts[10] pioneered in the construction of mathematical frameworks for the analysis of fertility rates of populations by reducing them to 8 determinants:

1. Proportion of married among females
2. Contraceptive use and effectiveness
3. Prevalence of induced abortion
4. Duration of postpartum infecundability
5. Fecundability (or intercourse frequency)
6. Spontaneous intrauterine mortality
7. Prevalence of permanent sterility
8. Duration of fertile period

In 1982, he dropped duration of fertile period as determinant, reducing the number of determinants to 7[11]. In 2000, Bongaarts and Westoff[12] further reduced the number of determinants to three: the desired number and spacing of births, the prevalence and effectiveness of contraceptive practice to implement these preferences, and the probability of undergoing an abortion to avoid unintended births when contraceptives fail or are not used.

In this paper, instead of looking at fertility rates, we shall instead look at abortion rates. We shall use the following determinants to the abortion rate:

1. Frequency of intercourse
2. Weeks elapsed since first intercourse
3. Weeks of pregnancy
4. Weeks of breastfeeding
5. Contraceptive failure probability

We dropped the duration of the fertile period as a determinant, because we assumed it to be constant: the woman is fertile 1 week out of 4 weeks[13]. We shall assume that the intercourse is on any random day in this 4-week fertility cycle, so that the probability of getting pregnant is always constant at $1/4 = 25\%$. We shall also assume that the woman always uses the same type of contraceptive during intercourse. Note that we make no distinction between induced abortions and spontaneous intrauterine mortality, because our only interest is the total maximum number of abortions a woman can have which is the primary parameter that we shall relate to contraceptive failure rate.

2.2 Intercourse Frequency

Of his 8 determinants of fertility rates, Bongaarts considered the frequency of intercourse as not a very
important determinant of fertility rate. He proposed the use of mean waiting time to conception instead:

*The level of the total fecundity rate is influenced by coital frequency, but it is easily demonstrated that coital frequency is not a very important determinant of fertility differences among populations. Because reliable coital frequency data exist for very few countries, it is difficult to analyze this relationship by comparing individual populations. It is possible, however, to estimate a plausible range of values for the total fecundity rate by relying on observations of the mean waiting time to conception, which is determined by coital frequency.*[10]

Unlike Bongaarts, our interest is not in the national fertility and abortion rates, but simply on the abortion rate per woman. To translate the latter to the former requires more sophisticated statistical tools, such as distribution functions for the reproductive health parameters—fertility cycles, contraceptive use, intercourse intervals, etc. We shall leave this discussion for a future work. For now, it suffices that we propose the following claim: *the frequency of intercourse is a very important determinant that allows us to compute how long it will take for the woman to get pregnant and the total maximum abortions that a woman shall have in her lifetime.*

### 2.3 Contraception

The purpose of contraceptives is to prevent pregnancy. The American Pregnancy Association provides a list of contraceptives and their failure rates[14]. But in this list, the probability of getting pregnant within the year without contraceptives is 85% and not 25% which we assumed based on the woman fertility of 1 week in a 4-week fertility cycle. One possible explanation for this discrepancy is that a woman’s desire for intercourse is higher in her fertile days than in her infertile days, so the distribution is skewed towards fertile days. Another possible explanation is that the probabilities listed in the table are averaged for a year of regular use and not for each intercourse. Thus, even if the uncontracepted failure rate is only 25% per intercourse, and the woman has intercourse once a week, then she will most likely get pregnant in 4 weeks. This is already counted in the literature as one pregnancy equivalent to 100% contraceptive failure rate. In a future work, we shall develop a more detailed derivation of these average contraceptive failure rates using different types of distribution functions for the intercourse interval s.

### 2.4 Risk Compensation

Another reason why we believe that the frequency of intercourse is an important determinant is because of risk compensation. According to de Irala and Alfonso[15]:

*This [risk compensation] hypothesis suggests that the introduction of new technological approaches to prevention could reduce the perception of risk and thus worsen the compliance with other basic preventive behaviours. In the end, higher risk taking could offset the protective benefits theoretically associated with the new approach.*

Risk compensation may explain why the increasing use of seatbelts do not lessen car accidents. According to Adams[16, 17], “protecting car occupants from the consequences of bad driving encourages bad driving.” Richens, Imrie, and Copas[18] applied this seatbelt hypothesis to condoms, which they refer to as the *seatbelts for sex*, because they lessen the risk of pregnancy:

*Increased condom use could reflect decisions of individuals to switch from inherently safer strategies of partner selection or fewer partners to the riskier strategy of developing or maintaining higher rates of partner change plus reliance on condoms. . . . A vigorous condom-promotion policy could increase rather than decrease unprotected sexual exposure, if it has the unintended effect of encouraging greater sexual activity.*

In 2009, Pope Benedict XVI became the center of controversy when he made the following remark regarding HIV epidemic in Africa:
A tragedy that cannot be overcome by money alone, that cannot be overcome through the distribution of condoms, which even aggravates the problems[19, 20]

The Pope was supported by Green who in turn whipped another controversy. According to Green:

One reason is “risk compensation.” That is, when people think they’re made safe by using condoms at least some of the time, they actually engage in riskier sex. Another factor is that people seldom use condoms in steady relationships because doing so would imply a lack of trust. (And if condom use rates go up, it’s possible we are seeing an increase of casual or commercial sex.) However, it’s those ongoing relationships that drive Africa’s worst epidemics. . . These ongoing multiple concurrent sex partnerships resemble a giant, invisible web of relationships through which HIV/AIDS spreads. [21]

In this paper, we shall limit ourselves to the analysis of the relation of abortion rates to contraceptive failure probabilities for one woman, with risk compensation taken into account; the mode of HIV/AIDS transmission through multiple concurrent sex partners is beyond the scope of the present research.

2.5 Contraception-Abortion System

Senge[22] proposes systems thinking as a framework for understanding how the interrelationships between components determine the behaviour of the whole system:

Systems thinking is a discipline for seeing wholes. It is a framework for seeing interrelationships rather than things, for seeing patterns of change rather than static “snapshots.” It is a set of general principles…. It is also a set of specific tools and techniques, originating in two threads: “feedback” concepts of cybernetics and in “servomechanism” engineering theory dating back to the nineteenth century…. And systems thinking is a sensibility—for the subtle interconnectedness that gives living systems their unique character.

In this paper, we propose an contraception-abortion system described in Fig. 1. There are three main determinants for the abortion rate: contraceptive effectiveness, intercourse frequency, and other determinants. These other determinants are the number of weeks elapsed from first intercourse, the number of weeks of pregnancy, and the number of weeks of breastfeeding. We introduce risk compensation as a feedback mechanism: the intercourse interval is proportional to the $m^{th}$ power of the contraceptive failure rate. We want to determine how the resulting abortion rate will vary as a function of the contraceptive failure rate. Will the availability of more effective contraceptives reduce the abortion rate as expected? Will the abortion rate remain constant? Or will the abortion rate actually increase?

![Figure 1: Contraception-abortion system with risk compensation](image-url)
3 Pregnancy Waiting Period

3.1 Without Contraceptives

We know that 1 in 4 weeks, a woman is fertile. Thus, 1 in 4 intercourse of the woman would result to a pregnancy if done on any 4 random days in the 4-week fertility cycle. If \( s \) is the intercourse interval in weeks, then the average pregnancy waiting period \( T_p \) in weeks is

\[
T_p = 4s. \tag{1}
\]

In physics, the inverse of period is frequency. Hence, the frequency \( f_p \) corresponding to the pregnancy waiting period \( T_p \) is

\[
f_p = \frac{1}{T_p} = \frac{1}{4s}. \tag{2}
\]

We shall refer to \( f_p \) pregnancy frequency.

**Example 1.** Suppose a woman has intercourse once every two weeks, so that \( s = 2 \) weeks. If both she and her partner does not use contraceptives, the woman will most likely become pregnant within \( T_p = 4 \times 2 = 8 \) weeks, which is about 2 months.

3.2 With Contraceptives

If a contraceptive has a success probability \( c \), where \( 0 \leq c \leq 1 \), then its failure probability is \( 1 - c \). A contraceptive failure means a pregnancy may occur. So we propose the following hypothesis:

**Hypothesis 1.** Contraceptives reduce the effective pregnancy frequency \( f_{pc} \) in such a way that the pregnancy frequency \( f_p \) is multiplied by the contraceptive failure probability \( 1 - c \).

That is,

\[
f_{pc} = (1 - c)f_p = \frac{1 - c}{4s}, \tag{3}
\]

so that its corresponding pregnancy waiting period is

\[
T_{pc} = \frac{1}{f_{pc}} = \frac{4s}{1 - c}. \tag{4}
\]

Let us take some limiting cases. If the contraceptive success rate is perfect at \( c = 1 \), then the pregnancy waiting period is \( 4s/(1 - c) \to \infty \), regardless of the value of intercourse interval \( s \) in weeks. On the other hand, if the contraceptive success rate is \( c = 0 \), then the pregnancy waiting period is the same as that if no contraceptives are used: \( T_{pc} = T_p = 4s \). These limits look reasonable, so we are confident that our hypothesis is reasonably valid.

**Example 2.** Suppose a woman has intercourse once every two weeks, so that \( s = 2 \) weeks. If her partner always uses a condom with 90% success rate, then \( c = 0.9 \), and the woman will most likely become pregnant within \( T_{pc} = (4 \times 2)/(1 - 0.9) = 80 \) weeks, which is equivalent to \( 80/(52.1775) = 1.533 \) years. Note that we used the definition of the mean solar year in the Gregorian calendar as 365.2425 days, which corresponds to 52.1775 weeks.

3.3 With Multiple Contraceptives

During intercourse, it is possible that the woman and her partner uses several contraceptives with different contraceptive failure rates. What is the effective contraceptive failure rate? Let us propose the following hypothesis:

**Hypothesis 2.** The effective contraceptive failure rate is equal to the product of the contraceptive failure rates of the individual contraceptives used by the couple at the same time.

That is, if \( c_e \) is the effective contraceptive success probability and \( c_1, c_2, \ldots, c_n \) are the contraceptive success probabilities of the individual contraceptives used, then the effective contraception failure rate is

\[
1 - c_e = (1 - c_1)(1 - c_2)\cdots(1 - c_n). \tag{5}
\]

Thus, we may generalize the frequency \( f_{pc} \) in Eq. (3) to

\[
f_{pce} = (1 - c_e)f_p, \tag{6}
\]
so that the effective pregnancy waiting period $T_{pce}$ is

$$T_{pce} = \frac{1}{f_{pce}} = \frac{4s}{1 - c_e}. \quad (7)$$

**Example 3.** A couple uses two contraceptives with failure rates $1 - c_1 = 0.20$ and $1 - c_2 = 0.10$. The effective contraceptive failure probability is $0.2 \times 0.10 = 0.02$. If the couple has intercourse once every 2 weeks, then $s = 2$ weeks. Thus, the effective pregnancy waiting period is $4 \times 2/0.02 = 400$ weeks, which is equivalent to $400/(52.1775) = 7.666$ years.

### 4 Fertility and Abortion Rates

#### 4.1 Womb Year

Normal pregnancy duration is about 40 weeks. This defines a natural unit of measurement, which we shall refer to as the *womb year*. We chose the phrase *womb year* over *pregnancy year* because the latter is already a well-used term, which means the year when the woman is pregnant. On the other hand, *womb year* is a new phrase, so we still have the freedom to give it a technical definition.

#### 4.2 Number of Possible Abortions

Let $40n_s$ be the number of weeks from the woman’s first intercourse, where $n_s$ is the corresponding number of womb years. If $T_{pce}$ is the effective pregnancy waiting period in weeks, then the number of pregnancies that the woman may have (which she may abort) is

$$N_p = \frac{40n_s}{T_{pce}} = \frac{10n_s}{s}(1 - c_e), \quad (8)$$

where $s$ is the intercourse interval in weeks and $1 - c_e$ is the contraceptive failure probability.

**Example 4.** Suppose that a woman has been sexually active for $40n_s = 800$ weeks or $800/52.1775 = 15.322$ years, so that $n_s = 800/40 = 20$ womb years. Suppose that during this period, she has intercourse once every $s = 2$ weeks, while using contraceptives with effective failure probability of $1 - c_e = 0.05$. Therefore, the maximum number of pregnancies that she may have (which she may abort) is $N_p = (10/2)(20)(0.05) = 5$ pregnancies.

#### 4.3 Abortions Averted due to Pregnancy and Breastfeeding

Let $40n_p$ be the cumulative number of weeks that a woman is pregnant and let $40n_b$ be the cumulative number of weeks of continuous breastfeeding after birth, where $n_p$ and $n_b$ are the number of womb years for pregnancy and breastfeeding. Since pregnancy and breastfeeding are the periods when the woman is naturally infertile, then the number of abortions that were averted during the pregnancy and breastfeeding periods is

$$N'_a = \frac{40(n_p + n_b)}{T_{pce}} = \frac{10}{s} (n_p + n_b)(1 - c_e). \quad (9)$$

where $s$ is the intercourse interval in weeks and $1 - c_e$ is the contraceptive failure rate.

**Example 5.** Suppose that a woman is pregnant for a total of $40n_p = 120$ weeks, so that $n_p = 120/40 = 3$ womb years, which may correspond to a total of 3 children. Suppose that she breastfed each of her child for $40n_b = 30$ weeks, so that $n_b = 3(30/40) = 2.25$ womb years. Suppose that during this period of pregnancy and breastfeeding, she has intercourse once every $s = 2$ weeks using contraceptives with effective failure rate of $1 - c_e = 0.10$. Therefore, the woman averted $N'_a = (10/2)(3 + 2.25)(0.10) = 2.625$ abortions.

#### 4.4 Abortion Rate

Since we assumed that the woman is infertile during $40(n_p + n_b)$ weeks of pregnancy and breastfeeding, then the remaining years weeks left in her $40n_s$ sexually active weeks is $40n_s - 40(n_p + n_b)$. During this period, if the woman has intercourse once every $s$
weeks, then the number of abortions that she will have is

\[ N_a = \frac{1}{T_{pce}} 40(n_s - n_p - n_b) \]
\[ = \frac{10}{s} (n_s - n_p - n_b)(1 - c_e). \]  \hspace{1cm} (10)

where \( 1 - c_e \) is the contraceptive failure probability. Note that

\[ n_s \geq n_p + n_b, \]  \hspace{1cm} (11)

so that the abortion rate \( N_a \geq 0 \).

From Eq. (10), we see that the abortion rate \( N_a \), which is the number of abortions per woman, may be lowered in three ways:

1. Lower the number of womb years \( n_s \) of sexual activity by postponing the first intercourse up to adult years through late marriage and chastity before marriage
2. Increase the number of children by increasing the number of womb years \( n_p \) for pregnancy
3. Increase the number of womb years \( n_b \) spent on breastfeeding

The number of abortions may also be lowered by changing the values of the intercourse interval \( s \) and the contraceptive failure rate \( 1 - c_e \), but because these values may be related to each other through risk compensation, we shall postpone the discussion of these methods in the next section.

**Example 6.** Suppose that a woman is sexually active for 40 weeks, which is about \( 520/52 \times 1775 = 9.966 \approx 10 \) solar years. This gives \( n_s = 520/40 = 13 \) womb years. During this time, she had 3 children and she breastfed each of them for 25 weeks. This means that \( n_p = 3 \) and \( n_b = 3 \times 25/40 = 1.875 \). Suppose that the woman has intercourse once every \( s = 5 \) weeks using a contraceptive with failure rate of \( 1 - c_e = 0.10 \). Thus, during this 10-year period, the woman shall have about \( N_a = (10/5)(13 - 3 - 1.875)(0.10) = 1.625 \) abortions.

### 5 Risk Compensation

Women who know that contraceptives offer less risk to pregnancy would tend to take riskier behaviours by engaging in intercourse more frequently. This hypothesis is called risk compensation. In mathematical terms, we propose the following hypothesis:

**Hypothesis 3.** The intercourse interval is related to the contraceptive failure rate by a power law.

That is, we propose that a woman’s intercourse interval \( s \) is proportional to the \( m^{th} \) power of the contraceptive failure rate \( 1 - c_e \):

\[ s = k(1 - c_e)^m, \]  \hspace{1cm} (12)

where \( k \) is a constant. Substituting Eq. (12) to Eq. (10), we obtain

\[ N_a = \frac{10}{k} \frac{(n_s - n_p - n_b)}{(1 - c_e)^{m-1}}. \]  \hspace{1cm} (13)

Equation (13) is the equation for abortion rate with risk compensation.

To determine the parameter \( k \), we define the following boundary condition: as the contraceptive failure rate \( 1 - c_e \to 1 \), the intercourse interval \( s \to s_0 \), where \( s_0 \) is the intercourse interval if the woman is not using contraceptives. Hence, Eq. (12) becomes

\[ s_0 = k, \]  \hspace{1cm} (14)

so that Eqs. (12)

\[ s = s_0(1 - c_e)^m, \]  \hspace{1cm} (15)

which is the the equation for the intercourse interval \( s \) in terms of the uncontracepted intercourse interval \( s_0 \), and the contraceptive failure rate \( 1 - c_e \).

Using the result in Eq. (14), the abortion rate in Eq. (13) becomes

\[ N_a = \frac{10}{s_0} \frac{(n_s - n_p - n_b)}{(1 - c_e)^{m-1}}. \]  \hspace{1cm} (16)

Setting \( 1 - c_e = 1 \), we get

\[ N_a = N_{a0} \equiv \frac{10}{s_0} (n_s - n_p - n_b), \]  \hspace{1cm} (17)
which is the abortion rate if no contraceptives are used. This allows us to rewrite Eq. (16) as

\[ N_a = \frac{N_{a0}}{(1 - c_e)^{m-1}}, \]  

(18)

which is a simpler equation to analyze compared to the abortion rate expression in Eq. (13).

Let us summarize the two equations for the intercourse interval \( s \) and the abortion rate \( N_a \):

\[ s = s_0(1 - c_e)^{m}, \]  

(19a)

\[ N_a = \frac{N_{a0}}{(1 - c_e)^{m-1}}. \]  

(19b)

Fig. 2 shows the graph of the relative intercourse interval \( s/s_0 \) and the relative abortion rate \( N_a/N_{a0} \) as functions of the risk compensation parameter \( m \) for a particular value of the contraceptive failure rate \( 1 - c_e \). Notice that if the intercourse interval is small, then the number of abortions is large; if the intercourse interval is large, then the number of abortions is small. This relationship becomes more obvious if we get the product of the abortion rate \( N_a \) and the intercourse interval \( s \):

\[ N_a s = N_{a0}s_0(1 - c_e), \]  

(20)

so that

\[ \frac{N_a}{N_{a0}} = \frac{s_0}{s}(1 - c_e). \]  

(21)

That is, the abortion rate \( N_a \) is inversely proportional to the intercourse interval \( s \) (see Fig. 3). This theorem is true regardless of the value of the risk compensation parameter \( m \).

Table 2 provides an alternative summary of the behaviour of the intercourse interval \( s \) and the abortion rate \( N_a \) with respect to their uncontracepted counterparts \( s_0 \) and \( N_{a0} \) for different values of \( m \):

- For \( m < 0 \), contraceptives make the intercourse interval \( s \) longer and the abortion rate \( N_a \) smaller. This may be for case of contraceptives that alter the woman’s physiology or chemistry, making her less desirous of intercourse.

- For \( m = 0 \), contraceptives do not change the woman’s intercourse interval \( s \), yet the abortion rate \( N_a \) becomes smaller. This may be for the case of women who do not care whether they use contraceptives or not during intercourse.

- For \( 0 < m < 1 \), contraceptives make the woman’s intercourse interval smaller, yet the abortion rate \( N_a \) becomes smaller. This maybe for the case of women who knows that contraceptives provide lesser risk to pregnancy, so in response, she lessens her intercourse interval. Yet, this form of risk compensation does not result to increase in abortions; the abortions actually become lower.

- For \( m = 1 \), contraceptives make the woman’s intercourse interval \( s \) smaller and the abortion rate \( N_a \) constant. This is the classic case of risk compensation: the abortion rate is constant regardless of contraceptive failure rate.
Figure 3: The relative abortion rate $N_a/N_{a0}$ is inversely proportional to the relative intercourse interval $s/s_0$ for a given contraceptive failure rate $1 - c_e$, regardless of the value of the risk compensation parameter $m$.

- For $m > 1$, contraceptives make the woman’s intercourse interval $s$ smaller and the abortion rate $N_a$ larger. This is an extreme case of risk compensation: contraceptives actually increase the number of abortions. The smaller the contraceptive failure rate, the more abortions a woman will have.

Tables 2 provides the ratio $s/s_0$ of intercourse interval $s$ with contraceptives and the intercourse interval $s_0$ without contraceptives for different values of the contraceptive failure rate $1 - c_e$ and the risk compensation parameter $m$. Table 5, on the other hand, provides a similar ratio $N_a/N_{a0}$ of the number of abortions with contraceptives and the number of abortions $N_{a0}$ without contraceptives.

Example 7. For the risk compensation parameter $m = 0.5$ and contraceptive failure rate $1 - c_e = 0.05$, the intercourse interval ratio $s/s_0$ and the abortion rate ratio $N_a/N_{a0}$ are both equal to 0.22. This means that the woman has intercourse about $100/22 = 4.5 \approx 4$ times more frequent than when she does not use contraceptives, yet the number of her abortions would lower to about $1/4$ of what she would have if she does not use contraceptives.

Example 8. For the risk compensation index $m = 2$ and contraceptive failure probability $1 - c_e = 0.20$, the intercourse interval ratio is $s/s_0 = 0.04$ and the abortion rate ratio $N_a/N_{a0} = 5$. This means that the woman has intercourse 20 times more frequent than when she does not use contraceptives, and the number of her abortions would increase to 5 times of what she would have if she does not use contraceptives.

Table 1: The intercourse interval $s$ and the abortion rate $N_a$ with contraceptives in comparison to those without contraceptives denoted by the subscript 0

<table>
<thead>
<tr>
<th>Risk Compensation Parameter $m$</th>
<th>Intercourse Interval in Weeks $s$</th>
<th>Number of Abortions $N_a$</th>
</tr>
</thead>
<tbody>
<tr>
<td>$m &lt; 0$</td>
<td>$s &gt; s_0$</td>
<td>$N_a &lt; N_{a0}$</td>
</tr>
<tr>
<td>$m = 0$</td>
<td>$s = s_0$</td>
<td>$N_a &lt; N_{a0}$</td>
</tr>
<tr>
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<td>$s &lt; s_0$</td>
<td>$N_a &lt; N_{a0}$</td>
</tr>
<tr>
<td>$m = 1$</td>
<td>$s &lt; s_0$</td>
<td>$N_a = N_{a0}$</td>
</tr>
<tr>
<td>$m &gt; 1$</td>
<td>$s &lt; s_0$</td>
<td>$N_a &gt; N_{a0}$</td>
</tr>
</tbody>
</table>
Table 2: The ratio $s/s_0$ of the intercourse interval with and without contraceptives for different values of the contraceptive failure probability $1-c_e$ and risk compensation parameter $m$

<table>
<thead>
<tr>
<th>$1-c_e$</th>
<th>$m=-1$</th>
<th>$m=0$</th>
<th>$m=0.5$</th>
<th>$m=1$</th>
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</tr>
</thead>
<tbody>
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<td>0.00</td>
<td>$\infty$</td>
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<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
</tr>
<tr>
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Table 3: The ratio $N_a/N_a0$ of the number of abortions with and without contraceptives for different values of the contraceptive failure probability $1-c_e$ and risk compensation parameter $m$

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6 Conclusions

In this paper, we showed that because a woman is fertile 1 in 4 weeks, then 1 in 4 intercourse generally leads to pregnancy. From this we showed that the waiting time interval for pregnancy is 4 times the intercourse interval in weeks. This defines a pregnancy waiting period whose inverse is the pregnancy waiting frequency. We made the hypothesis that the product of the pregnancy waiting period and the contraceptive failure probability is the effective pregnancy waiting frequency, which lengthens the effective pregnancy waiting period. For the case of multiple contraceptives, we assumed that the effective failure probability of their combination is just the product of the individual failure probabilities.

We defined 40 weeks as a natural unit of duration and called it the womb year. We showed that the abortion rate $N_a$ or the number of abortions per woman is the product of three quantities: 1) the ratio of 10 and the intercourse interval $s$; 2) the difference of the number of womb years for sexual activity (measured from the first intercourse) $n_s$ with the sum of the womb years for pregnancy $n_p$ and breastfeeding $n_b$; and 3) the contraceptive failure rate $1-c_e$.

From this equation, we deduced three methods for lowering that abortion rate: 1) lessen the number of womb years $n_s$ for sexual activity by late marriage; 2) increase the number of children $n_p$, and 3) prolong the womb years $n_b$ for breastfeeding.

We showed that the lowering the abortion rate may not necessarily be lowered by the availability of more
effective contraceptives, because of the possibility of risk compensation. To understand this phenomenon, we modelled the intercourse interval $s$ as proportional to the $m^{th}$ power of the contraceptive failure probability $1 - c_e$. We showed that for $m < 0$, contraceptives make the intercourse interval $s$ longer and the abortion rate $N_a$ smaller. For $m = 0$, contraceptives do not change the intercourse interval $s$; the abortion rate $N_a$ becomes smaller. For $0 < m < 1$, contraceptives make the intercourse interval smaller, though the abortion rate $N_a$ still becomes smaller. For $m = 1$, contraceptives make the intercourse interval $s$ smaller and the abortion rate $N_a$ constant. For $m > 1$, contraceptives make the intercourse interval $s$ smaller and the abortion rate $N_a$ larger. But regardless of the value of the risk compensation parameter $m$, the number of abortions $N_a$ can always be lowered by increasing the intercourse interval $s$, because $N_a$ is inversely proportional to $s$. This means long periods of abstinence from intercourse.

The results in this paper shows that the use of contraceptives is related to abortion rate, but whether the abortion rate becomes smaller, remains the same, or becomes bigger depends on the parameter $m$. So this paper does not settle the debate regarding the RH Bill. But both sides can use the equations here as framework for research projects to determine the exact value of the parameter $m$. This can be done by interviewing each woman regarding her reproductive history: how frequent is her intercourse before and after using a particular contraceptive, how many children she has, how many weeks she breastfeed each child, and how many children she aborted. If possible, each woman interviewed should keep a logbook, noting down all the pertinent dates and times, including her monthly periods, and physiological changes such as her body weight. This data is very difficult to obtain, but only an exceptionally accurate data coupled with careful statistical methods can settle the RH Bill debate.

In the absence of such data, it is better to be cautious and not legislate through the RH bill the use of contraceptives to lower the abortion rate. It is better to advocate other methods such as promoting breastfeeding, chastity before marriage, and late marriages—which the government and the Catholic Church is already doing. If the woman becomes pregnant, then the woman should be encouraged to accept the child as a gift and not as a burden to be aborted, and carry the child in her womb until his birth; the government can assist here to reduce the maternal mortality rate through excellent hospitals and midwives. In this way, we can manage our population growth and at the same time reduce the number of abortions to zero without the use of contraceptives.

References


