Fixed or Moving Targets? Consistency of Desired number of children within Cohorts across Surveys in DHS and Predicting Fertility Changes

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1 INTRODUCTION

Data on fertility preferences[2] (e.g. desired number of children) were first collected in the 1940s in the US, and have since then been collected routinely in most demographic surveys. A primary objective for collecting data on fertility preferences was to help forecasting fertility changes (Westoff & Ryder, 1977; Kodzi, Johnson, & Casterline, 2010). However, there is no consensus on the utility of data on fertility preferences for projecting fertility changes. According to Goldstein, Lutz, & Testa (2003, p. 180)" initial hopes that reported family size ideals and intentions would lead to improved accuracy of fertility forecasts were soon disappointed." In contrast, Bongaarts considers "the trend in desired family size is the most critical determinant of future fertility" (Bongaarts, 2001, p. 278).

Skepticism about the utility of data on fertility preferences for forecasting fertility rests on two broad issues (Morgan, 2001). First, fertility preferences are typically assumed to be a "fixed target" (Hagewen & Morgan, 2005; Lee, 1980; Morgan, 2001; Yeatman, Sennott, & Culpepper, 2013). According to the fixed target model, individuals or couples formulate early in life a desired family size (D), and "pursue this relatively constant target throughout their reproductive life" (Lee, 1980). If individuals and couples were able to achieve their target perfectly, desired family size in youth could be used to predict completed fertility. However, the fixed target model has been seriously questioned. At the micro level, various factors may lead individuals or couples to revise their preferences over time (Lee, 1980; Yeatman, 2013). According to these critiques,

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[2] Throughout this paper, we use the term fertility preferences to reflect desired number of children or ideal family sized (these two terms are often used interchangeably).

fertility preferences are a moving target (Lee, 1980) that changes with age (over time), both at the individual and aggregate (cohort) level (Morgan, 2001). In other words, fertility preferences in youth may not be a good predictor of the desired number of children at later ages, let alone of completed family size.

A second reason for skepticism is that even if preferences were a fixed target, there may be a gap between preferences and fertility outcomes (Morgan, 2001). Existing cross-sectional data indicate a strong correlation between preferences and outcomes across countries (Bongaarts, 2001; Pritchett, 1994). Yet considerable gaps exist between preferences and period fertility. In low fertility countries, fertility tends to be lower than ideal family size (Bongaarts, 2001; Goldstein et al., 2003; Philipov, 2009), whereas fertility tends to be higher than ideal family size in countries with moderate to high fertility (Bongaarts, 2001). In summary, the link between preferences and fertility outcomes is far from perfect. Moreover, opposite views exist on the causal relationship between preferences and fertility (Hagewen & Morgan, 2005). For instance, in low fertility countries, Bongaarts (2001) considers that fertility preferences indicate fertility levels that could be reached if obstacles to preferences implementation were removed and if there were no tempo effects. In contrast, Goldstein et al. (2003) consider that (in some European countries) changes in fertility preferences may *follow* changes in fertility, and that the gap reflects a cultural lag. In developing countries, the positive gap between fertility outcomes and preferences is widely interpreted as reflecting unwanted fertility (Bongaarts, 2001); decline in fertility preferences precedes (and causes) decline in fertility. However, it has also been suggested that fertility decline may encourage changes in preferences (Rutstein, 1998).

Our objectives are threefold. The first objective is to evaluate, at the aggregate level, whether fertility preferences of cohorts are fixed targets or moving targets (Lee, 1980). If fertility preferences are a fixed target within cohorts (stable with age), they provide a potential basis for projecting fertility changes 10-15 years ahead. While strong arguments exist for the moving target model, to our knowledge no empirical test of the fixed vs. moving target model in a wide range of countries has been performed at the aggregate cohort level[3]. Growing evidence for a moving target model has been found

[3] For an analysis of changes in fertility preferences that can be used to evaluate the fixed vs. moving target model, see Rutstein (1998).

over the past years at the *micro level* (Kodzi et al., 2010; Yeatman et al., 2013); Yet, consistency of preferences at the individual level is not the main issue for the analysis of demographic changes and projections that rely on aggregate measures (Westoff, 1990).

The second objective is to document the relationships between changes in fertility and changes aggregate fertility preferences. In other words, we evaluate empirically if fertility changes mirror changes in fertility preferences. Most existing research on the links between aggregate fertility and fertility preferences uses cross-sectional data; we use date on changes in a wide range of countries to document the relationships over time. The third and more speculative objective of this paper is to discuss how aggregate changes in preferences can be incorporated in projections of fertility changes. This is very much an ongoing work.

2 DATA

Data on fertility preferences have been assembled from 198 Demographic and Health Surveys conducted in 52 countries since the mid-1980s[4]. All countries where at least two surveys are publicly available are used. Fertility preferences are measured using the desired number of children reported by the female respondents. The desired number of children is elicited using two questions (ICF International, 2011). The first question is asked to female respondents who have *living* children:

> (1) "If you could go back to the time you did not have any children and could choose exactly the number of children to have in your whole life, how many would that be?"

Women with no living children are asked the following question:

> (2) If you could choose exactly the number of children to have in your whole life, how many would that be?

While the phrasing of these questions has remained the same through DHS phase I (1984-1989) to VII (2013-2018), interviewers have been asked to probe for a numeric

[4] Data for the Pakistan 1990 and Nigeria 1990 surveys were dropped because more than 50% of non-numeric responses were recorded.

response since phase III (1992-1997). As a consequence, the percentage of non-numeric responses (e.g. "up to God" etc.) has decreased considerably since the early 1990s[5].

Data on desired number of children or ideal family size have been criticized on several grounds (Bongaarts, 2001; Lightbourne, 1987; Pritchett, 1994). As just mentioned, the percentage of non-numerica responses can be considerable in some contexts, which may be problematic when computing the mean desired number of children (see our approach below). Desired number of children may also underestimate desired fertility where mortality is high[6] or when gender preference is pronounced (Pritchett, 1994). These two factors may account for part of the differences between fertility preferences and actual fertility (Bongaarts, 2001). Finally, ex-post rationalization is also a frequent critique pointing to the fact that "women will tend to deny that their desired family size is smaller than their actual family size" (Pritchett, 1994, p.8). This is a case of moving target, in which reported preferences depend on fertility outcomes. Despite the critiques, this indicator is intuitive, and it provides a simple way to estimate ideal completed family size if fertility preferences are stable over time (fixed target), and possibly forecast fertility. The indicator is also widely available and has been collected in a consistent way over time and across countries.

In this paper, the *median* desired number of children is used as an aggregate measure of fertility preferences. This is preferred to the more common *mean* desired number of children on two grounds. First, the median is less affected than the mean by high values which may be unrealistic (e.g. 20 children). Secondly, the median allows us to deal with non-numeric responses in a more satisfactory way than the mean. The mean desired number of children is computed by excluding non-numeric responses; that is by assuming women with non-numeric responses have the same preferences as women with numeric responses). However, non-numeric responses may be more likely to be given by women with preferences for large families (Pritchett, 1994)[7]. In contrast, computing the median allows using non-numeric responses by considering them as "large" numbers (larger than the median). This facilitates comparisons across surveys with varying percentage of non-numeric responses.

[5] Among all the surveys used in this paper, the percentage of non-numeric responses decreased from more than 10% in the first two phases to less than 5% in phase VI.
[6] Desired number of children or ideal family size refers to the number of surviving children.
[7] Although this is not necessarily the case (Hayford & Agadjanian, 2013).

Fertility estimates come from the World Population Prospects of the United Nations Population Division (United Nations Population Division, 2013). Two indicators are used: the total fertility rate and the mean age at childbearing by 5-year periods. The UN fertility data are used for several reasons. First, they allow comparisons with fertility preferences over longer periods than published DHS fertility data. Secondly, published DHS fertility estimates are affected by data quality issues in some countries (Schoumaker, 2014). UN fertility estimates include corrections for data quality problems. Finally, these data are used for UN's population projections, and our results could be directly compared to the UN's projections. The way these data are used and compared to fertility preferences is explained in section 4.1.

3 FERTILITY PREFERENCES: FIXED OR MOVING TARGET?

Theoretical arguments and empirical evidence suggest that fertility preferences are, at the micro level (individuals or couples), moving targets. Life circumstances (e.g. divorce, unemployment, bad/good experience with childbearing and childrearing) may lead individuals and couples to reassess their preferences. Stated ideal family size may also be revised upward as a result of ex-post rationalization of unwanted births (Pritchett, 1994). In contrast, it has been argued that family planning programs may lead people to revise downward their fertility targets by spreading norms about small families, increasing contacts of people with contraceptive users (Bongaarts, 2011; Rutstein, 1998). Finally, preferences may also change because of the "poor reliability and validity of the construct" (Yeatman, 2013, 1716). All in all, the moving target model has strong theoretical justifications, and empirical research at the micro level supports this model (Kodzi et al., 2010; Yeatman et al., 2013).

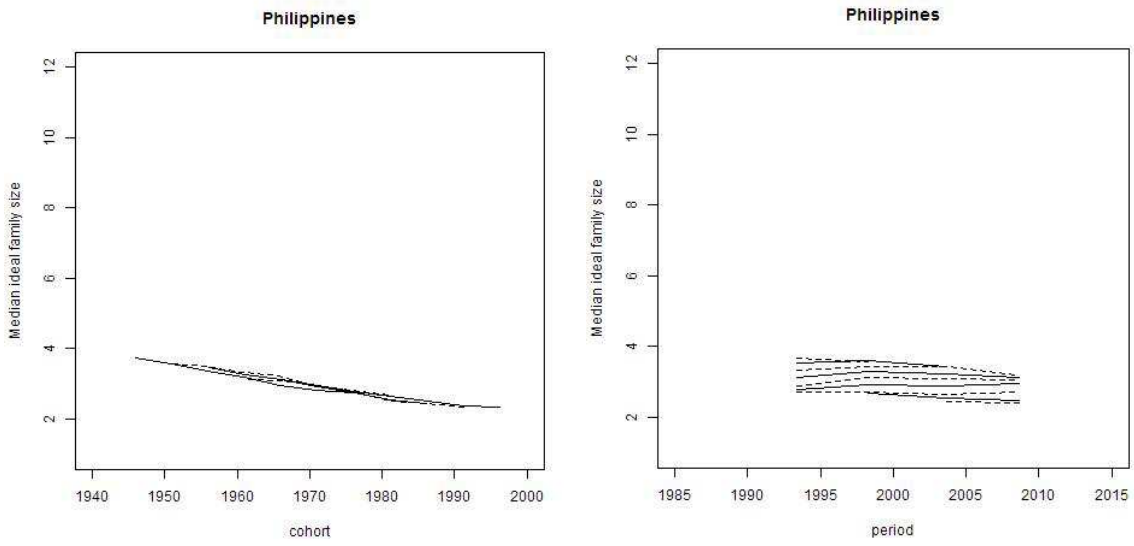
However, evidence regarding the fixed target vs. moving target model at the aggregate level is limited. A few scholars have highlighted that preferences were surprisingly stable within cohorts. In the US, Morgan (2001, p. 158) finds that "there is substantial evidence that mean intended parity is relatively stable and frequently provides good/useful estimates of mean completed parity". In Malawi, Yeatman et al. (2013) also found fertility preferences in DHS were fairly stable within birth cohorts over the period from 1992 to 2010. Most of the change in ideal family size over time was "due to the aging out of older women with high family size ideals and *not change* within cohort

(Yeatman et al., 2013, 1718)". In contrast, Rutstein (1998) provided evidence for the moving target model: using WFS and DHS data from 24 countries, he showed that there had been a *decline* within cohorts over time in desired numbers of children, and that the decline within cohorts accounted on average for half of the declines in mean desired number of children. All in all, evidence is limited and has led to mixed conclusions.

3.1 COMPARING PREFERENCES WITHIN COHORTS OVER TIME

Repeated cross-sections are used to test whether preferences are a fixed or a moving target. When several comparable surveys are available in a country, the same cohorts can be compared at several points in time. If preferences are a fixed target, the median desired number of children *for a given cohort* will remain constant from one survey to the other. According to this model, preferences may change *across* cohorts but do not change *within* cohorts. As a result, median desired number of children by cohort should be consistent across surveys. This is illustrated with data from the Philippines (Figure 1). The left-hand side figure shows the median desired number of children by birth cohort from successive surveys. Each line represents a different survey; these lines almost indistinguishable, illustrating the high consistency (stability) of median desired number of children over time. The right-hand side figure represents the same data using periods on the X-axis. Each line now represents fertility preferences at different points in time (surveys) for a birth cohort. These lines are almost horizontal, illustrating the fact that preferences are fairly stable over time within birth cohorts.

FIGURE 1 : MEDIAN DESIRED NUMBER OF CHILDREN BY COHORT AND PERIOD, PHILIPPINES.



The moving target model is illustrated below with three surveys from Guinea (Figure 2). The left-hand side figure shows that the median desired number of children decreases across cohorts, but fertility preferences are not consistent across surveys. Each new survey shows that preferences are, for the same birth cohort (same X value) higher than preferences in the previous survey. In other words, preferences increase over time (with age) within cohorts. This upward trend in desired number of children within cohorts is visible on the right-hand side figure. Targets may also move downward, or move upward and then downward, as illustrated by the case of Rwanda (Figure 3). In most cases however, targets move in the same direction over the entire period.

FIGURE 2 : MEDIAN DESIRED NUMBER OF CHILDREN BY COHORT AND PERIOD, GUINEA.

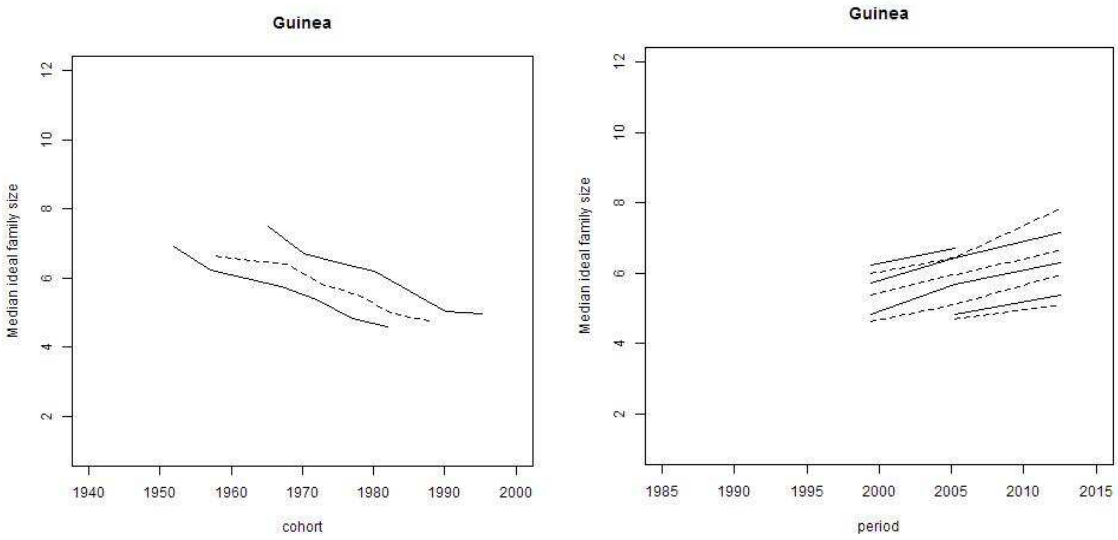
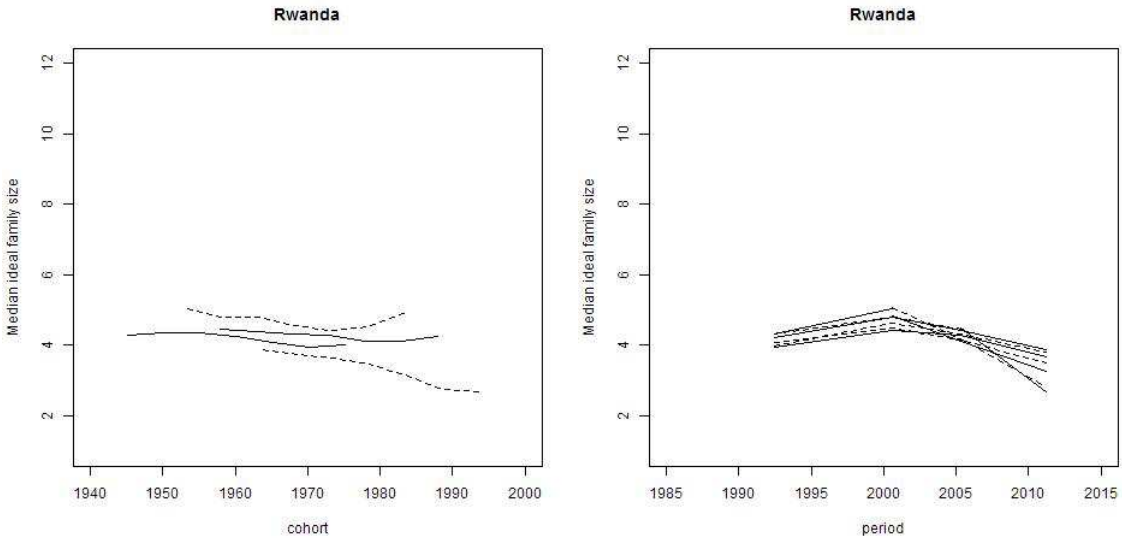


FIGURE 3 : MEDIAN DESIRED NUMBER OF CHILDREN BY COHORT AND PERIOD, RWANDA.



Increases of fertility preferences within cohorts may result from ex-post rationalization of unwanted births, but may also reflect genuine increases in fertility preferences with age. Decreases in fertility preferences within cohorts may result from the spread of preferences for low fertility, for instance through family planning programs (Bongaarts, 2011; Rutstein, 1998). Of course, part of these changes may also reflect data quality issues, and more specifically difference in sample implementation across surveys, but – except for a few surveys – this is not a major issue in DHS (Schoumaker, 2014).

3.2 CHANGES ACROSS COHORTS AND WITHIN COHORT

Fertility preferences by birth cohort and survey (as shown on Figure 1 to Figure 3) are computed in the 52 countries with at least two surveys (198 surveys in total). For each country, the data is used to evaluate if preferences are a fixed target (stable within cohorts) or a moving target. This is done with a linear decomposition method (Firebaugh, 1989). Preferences are modelled as a linear combination of age and cohort in the following way:

$$Preferences = b_1 + b_2.age + b_3.cohort \qquad \text{[Eq. 1]}$$

The dependent variable is the median desired number of children for a given cohort at a given time (age). The coefficient b_3 measures the change in preferences *across* cohorts, holding age constant. This corresponds to the (average) slope of the lines representing changes in desired number of children *across* cohort (left-hand side figures 1-3). The age effect is measured by b_2, which captures the change in preferences over time *within* cohorts. This corresponds to the (average) slope of the lines on the right-hand side figures 1-3. When preferences are stable (fixed target), b_2 will be close to 0; preferences that increase over time will be associated to a positive b_2; and decreasing preferences will be associated to a negative b_2. Finally, the intercept (b_1) measures the preferences when age and cohorts are equal to zero. The cohort variable was centered on 1970, and the age variable is centered on age 30, so that b_1 can be interpreted as the fertility preferences in year 2000 among women aged 30 (cohort 1970).

Equation 1 can be fitted in each of the 52 countries separately. However, in countries with only two surveys, the number of observations is limited, leading to possibly large standard errors. A random-coefficient model is used with the data of the 52 countries (198 surveys) pooled together. Countries are used as level-2 units (subscript j) and each

observation (for a cohort at a given date) as level-1 units. Each coefficient (b_1, b_2, b_3) is allowed to vary randomly across countries. Level-2 random terms (u_{1j}, u_{2j}, u_{3j}) are assumed to follow a multivariate normal distribution. The random-coefficient model is specified in the following way.

$$Preferences_{ij} = (b_1 + u_{1j}) + (b_2 + u_{2j}).age + (b_3 + u_{3j}).cohort + e_{ij} \qquad \text{[Eq. 2]}$$

b_1, b_2 and b_3 are now interpreted as the average coefficients for the pooled data set (52 countries); coefficients for specific countries (empirical Bayes estimates : b_{1j}, b_{2j}, b_{3j}) are estimated by adding the level-2 random terms (u_{1j}, u_{2j}, u_{3j}) to the regression coefficients (b_1, b_2, b_3). This model shows that, on average preferences strongly *decrease* across cohorts, and slightly increase within cohorts (Table 1). The cohort coefficient (b_3) indicates that for each new birth cohort, median fertility preferences decrease on average by 0.059 children (i.e. almost 1.8 children over a 30-year period). In contrast, the age coefficient (b_2) is slightly positive: the median desired number of children increases by 0.014 children per year within a cohort (around 0.4 children over a 30-year period). Changes in fertility preferences are thus largely driven by cohort replacement. In fact, changes *within* cohort tend to slow down changes in fertility preferences, as the age effect is positive[8].

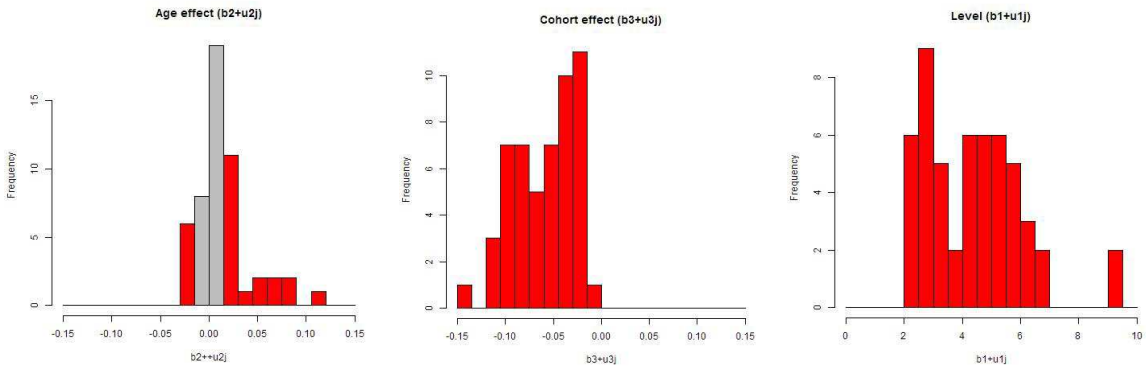
TABLE 1 : RANDOM-COEFFICIENT MODEL FOR THE LINEAR DECOMPOSITION OF AGE AND COHORT CHANGES IN FERTILITY PREFERNECES

Regression coefficients		Coefficient	Standard error
b_1	Intercept	4.373	0.232
b_2	Age	0.014	0.005
b_3	Cohort	-0.059	0.005
Standard deviations and correlations of random components			
sd(u_{1j})	Sd intercept	1.672	0.164
sd(u_{2j})	Sd Age	0.0307	0.0036
sd(u_{3j})	Sd Cohort	0.0322	0.0033
Corr(u_{1j}-u_{2j})	Corr(intercept-age)	0.595	0.105
Corr(u_{1j}-u_{3j})	Corr(intercept-cohort)	-0.763	0.061
Corr(u_{2j}-u_{3j})	Corr(age-cohort)	-0.462	0.122
sd(e_{ij})		0.307	

[8] This result is opposite to what Rutstein found in the late 1990s (Rutstein, 1998).

Coming back to our initial question, this model shows that, *on average*, fertility preferences are *moving targets* that (slightly) move upward with age. There is, however, considerable variation across countries. Adding and subtracting two standard deviations of u_{2j} (0.061) to b_2 (0.014) provides a quick estimate of the variation of b_2 across countries [-0.047; 0.075]. Preferences may move up or down (or remain stable) depending on the country (Figure 4). A more detailed view is obtained by computing the Bayesian empirical estimates (b2+u2j) for each country. In about half of the countries (27 out of 52), preferences change (upward or downward) within cohort by less than 0.015 children pear year (grey). These are interpreted as fairly stable preferences, corresponding to a fixed target model. In about a third of the countries (19), targets move up with age. In some of these countries (Niger, Nigeria, Guinea), the age effect is above 0.05. In the remaining six countries (Rwanda, Burundi, Namibia, Nepal, India, Morocco), targets move down with age by more than 0.015 children per year (Appendix table 1)[9]. All in all, *targets are fixed in some countries, and moving in others*. We come back to this issue.

FIGURE 4 : DISTRIBUTION OF COUNTRY-SPECIFIC COEFFICIENTS IN 52 COUNTRIES



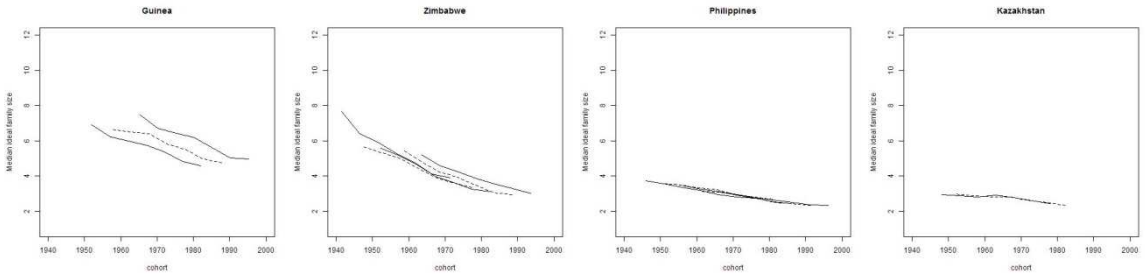
Changes in fertility preferences across cohorts (b_3) also vary considerably across countries, but - contrary to changes within cohorts - are *negative* in all the countries: fertility preferences decrease across cohorts in the 52 countries. Finally, levels of fertility preferences holding age and cohort constant (b_1) also varies considerably, from 2 children to almost 10 children.

[9] Interestingly, some of these countries have implemented strong family planning programs (e.g. Rwanda, Bongaarts, 2011) that may have contributed to decreasing fertility preferences with age.

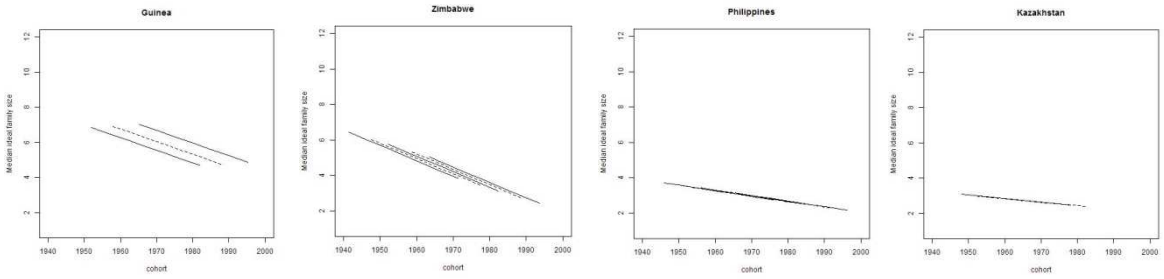
Of particular interests in Table 1 are the strong correlations between the random terms (u_{1j}, u_{2j}, u_{3j}). u_{2j} is correlated positively with u_{1j}, indicating that *when preferences are high, age effect tends to be positive.* In early stage of the fertility transition (or in pre-transitional settings), preferences are moving targets increasing with age; as preferences decrease, they also tend to become fixed or *decreasing* with age. u_{2j} is *negatively* correlated with u_{3j}, indicating that *when preferences strongly changes across cohorts, they also tend increase with age within cohorts.* In other words, *rapid changes across cohorts tend to be offset by increases within cohorts*. Finally, u_{3j} is *negatively* correlated with u_{1j}, indicating that *changes across cohorts are larger in early stages of the transition*. This correlation is expected, since absolute changes in preferences across cohorts must slow down when preferences are low. These results can be presented in a schematic way, using the preferences that are predicted with the regression model in countries with high preferences, intermediate preferences, and low preferences. Figure 5(a) shows the predicted values that facilitate the visualization of the broad patterns. Figure 5(b) shows the observed values for the same countries.

FIGURE 5 : PREDICTED AND OBSERVED FERTILITY PREFERENCES BY COHORT AND PERIOD IN 4 COUNTRIES

(a) observed



(a) predicted



While these results are observed at broadly the same periods in different countries, one can use them to represent how preferences change in the course of the fertility transition. The most interesting result for our purpose is that preferences tend to become fixed targets as they decrease. As a consequence, *changes across cohorts become good predictors of changes over time in fertility preferences*. Or said differently, looking at preferences among youth in a survey is a good predictor of fertility preferences among older women in the future. This is, of course, a simplification of the diversity of patterns of changes across countries, but it provides a fairly realistic representation of changes of fertility preferences over time.

4 CHANGES IN FERTILITY PREFERENCES AND IN FERTILITY

How are fertility preferences and fertility related? Existing research with cross-sectional data indicate strong correlations between mean ideal family size (among women 15-49) and period fertility across countries (Bongaarts, 2001). These data also show that observed fertility is higher than fertility preferences for countries in transition (TFR between 2 and 6), while the opposite tends to be observed in low fertility countries. Using data from Thailand, Bongaarts (2001) also illustrated this relationship between preferences and fertility over time.

Our data add several features to Bongaarts' description of changes of observed fertility and fertility preferences over time. First, the relationships between observed fertility and fertility preferences over time can be documented over relative long periods (e.g. 30 to 40 years) in a substantial number of countries. Secondly, our approach provides fertility preferences for periods that *extend beyond* observed fertility. When preferences are a fixed target, the median desired number of children among women ages 15-19 (17.5 years) is used to predict preferences for the whole cohort. If women in that cohort have their children on average at age 30, fertility of that cohort will occur on average 12.5 years ahead of the survey. Combining information on fertility preferences for the future and on the relationships between preferences and fertility may help predicting fertility changes.

We start by focusing only on countries where preferences can be considered as fixed targets, and discuss how these preferences can be used to predict fertility changes. We

next turn to the moving target situations. First, we describe the method for comparing observed fertility and preferences.

4.1 COMPARING OBSERVED FERTILITY AND PREFERENCES

Fertility estimates comes from the United Nations Population Division. The total fertility rate (TFR) is available by five-year periods since the 1950s until 2010. Changes in fertility are represented using central dates of periods (eg. 1972.5 for 1970-1975) on the X-axis, and TFRs on the Y-axis. Whereas TFRs are period indicators, preferences are cohort indicators. In order to represent them on the same X-axis, we add the estimated mean age at childbearing to the birth year of the cohort[10], in the same way as it is usually done for comparisons between period and cohort fertility.

In addition to the preferences by cohort and by survey (as on Figures 1-3), we also represent *predicted fertility preferences at ages 45-49* for each cohort. This is used both as a way for combining results from several surveys, and as a way for computing the desired number of children in the end of reproductive life when preferences are not fixed. For country j, the desired number of children (DNC) at age 45-49 (47.5) for a given cohort is obtained as follows[11].

$$DNC_j(47.5,\ cohort) = b_{1j} + b_{2j}.(47.5 - 30) + b_{3j}.(cohort - 1970) \qquad \text{[Eq. 1]}$$

When the desired number of children is a fixed target (b_{2j}=0), the equation simplifies and the predicted desired number of children simply reflects the preferences of the cohort (constant over time). When b_{2j} is close to zero, predicted preferences at age 45-49 will be very close to the observed fertility preferences. In contrast, when b_{2j} is positive (negative) the desired number of children at the end of the reproductive live will be higher (lower) than desired numbers of children reported at younger ages.

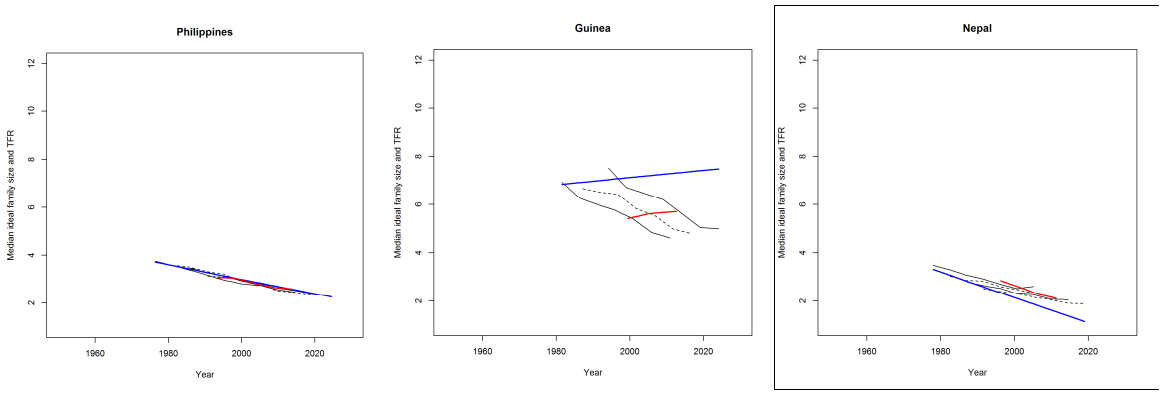
Figure 6 illustrates the predicted preferences at ages 45-49 (blue line) in three situations: fixed target (Philippines), target moving up (Guinea), and target moving down (Nepal). We also represent on these figures the median desired number of

[10] The mean age at childbearing is obtained from the United Nations data for 5-year periods. The mean age at childbearing is centered at mid-period (eg. 1972.5), and the corresponding birth cohort is obtained by removing the mean age at childbearing from the central date of the period (eg. 1972.5-29=1943.5). In this way, we estimate the mean age at childbearing by cohort. These data are interpolated to estimate the mean age at childbearing of the cohorts for which preferences are computed. The interpolated mean age at childbearing is then added to the birth date of the cohort to compare the cohort preferences and period fertility.

[11] This relies on the assumption that age and cohort effects are linear and constant over time. This is of course a simplification that will be discussed later. Age and cohorts were centered on 30 years and 1970.

children measured among all women in the successive surveys (red line). The black solid and dotted lines show preferences by cohorts in the various surveys. In the Philippines, where b_2 is very close to 0, these lines can almost not be distinguished. This figure clearly shows, however, that predicted preferences (blue line) cover a much longer period than observed preferences (all ages combined, red line) in successive surveys. In Guinea, predicted preferences at ages 45-49 increase, as do preferences among all women in successive surveys; the increase of preferences with age more than offsets the decrease of preferences across cohorts. The blue line is also much higher than the red line, indicating that the average desired number of children among all women underestimates preferences at ages 45-49 when preferences increase with age. The opposite is found in Nepal, where the age effect (b_2) is negative.

FIGURE 6 : COMPARISONS OF PREDICTED FERTILITY PREFERENCES AT 45-49, FERTILITY PREFERENCES FOR SUCCESIVE COHORTS FROM SEVERAL SURVEYS, AND AVERAGE PREFERENCES AMONG ALL WOMEN IN SUCCESISVE SURVEYS IN 3 COUNTRIES.

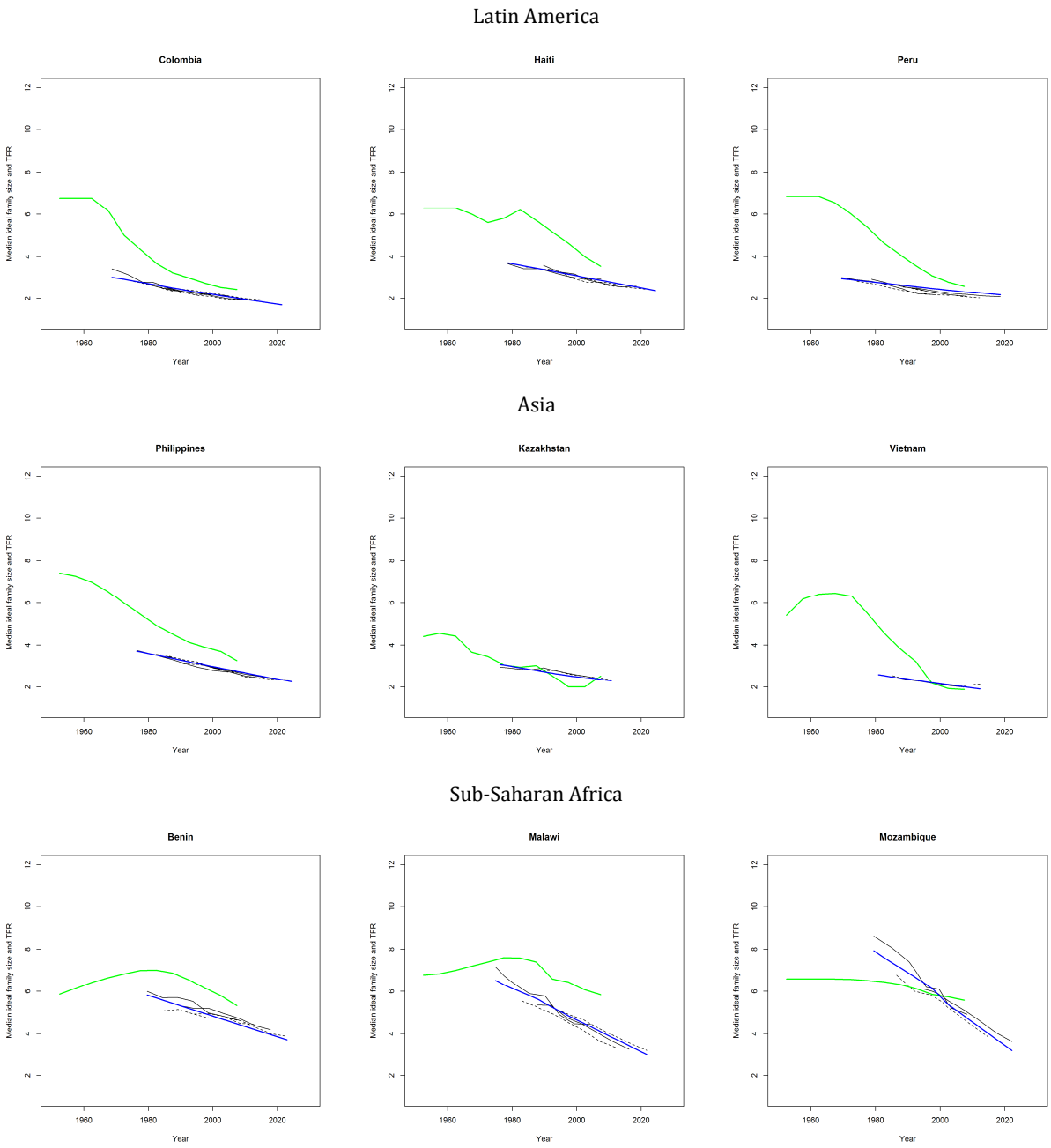


4.2 FERTILITY AND PREFERENCES IN CONTEXTS WITH FIXED PREFERENCES

Comparisons between preferences and fertility are first illustrated in selected countries where preferences are fairly stable (fixed target). Data for nine countries from Latin America, Asia and sub-Saharan Africa are shown on Figure 6 (results for all the countries are available in Appendix Figure 1). The green line represents the total fertility rate (UN estimates) from 1950-1955 (1952.5) to 2005-2010 (2007.5). As in the previous figures, the blue line represents the predicted median desired number of children for the women aged 45-49 (47.5 years), and the black solid and dotted lines represent preferences for cohorts in successive surveys. As expected in the fixed target model, the blue line (predicted preferences) is close to the preferences for cohorts in successive surveys

(black solid and dotted lines). In some cases (Philippines, Vietnam, Haiti), the lines can almost not be distinguished; in others (e.g. Malawi, Benin, Peru), they do not coincide perfectly but are yet quite close to each other.

FIGURE 7 : COMPARISONS OF PERIOD TOTAL FERTILITY AND COHORT FERTILITY PREFERENCES IN 9 COUNTRIES WITH PREFERENCES AS "FIXED TARGETS"



Legend : The green line represents the total fertility rate (UN estimates) from 1950-1955 (1952.5) to 2005-2010 (2007.5). The blue line represents the predicted median desired number of children for the women aged 45-49 (47.5 years) based on the regression model. The black solid and dotted lines represent preferences for cohorts in successive surveys.

These figures illustrate well the typical gaps between fertility outcomes and fertility preferences in the course of the fertility transition as described by Bongaarts (2001). During the transition, observed fertility is higher than the desired number of children (e.g. Philippines, Lesotho, Colombia); in contrast, in low fertility settings, fertility may

coincide with preferences (e.g. Vietnam) drop below preferences (e.g. Kazakhstan). In Colombia and Peru, fertility decline slows down as total fertility approaches preferences. The Mozambique case also illustrate the pre-transitional situation, where preferences exceed observed fertility; declining preferences cross the observed fertility curve at about 6 children, and a timid fertility decrease is observed.

FIGURE 8 : RELATIONSHIPS BETWEEN PREFERENCES AND OBSERVED FERTILITY OVER TIME IN 27 COUNTRIES WITH "FIXED TARGETS"

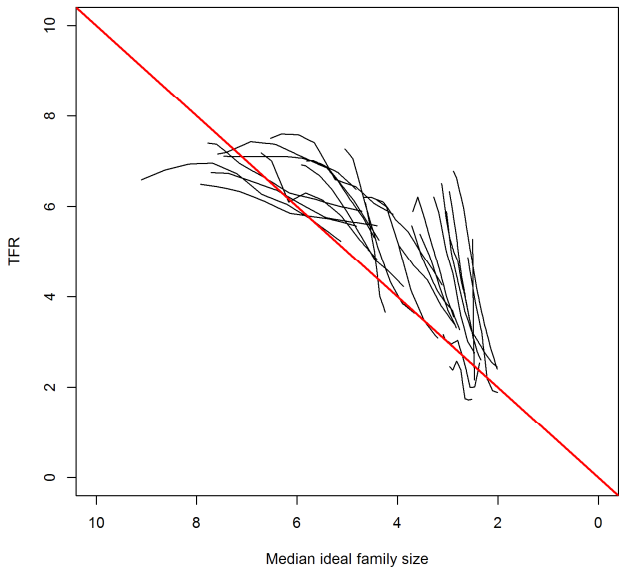


Figure 8 illustrates these relationships in the 27 countries where preferences are fixed. Each line represents the link between preferences (predicted preferences at 45-49) and fertility over time in a country12. The X-axis was inverted so that preferences decrease when moving to the right. These results broadly confirm existing evidence from cross-sectional data and aggregate longitudinal data. While there is considerable diversity across countries, there is also a clear structure in these data:

- When preferences are high (>6), the TFR is stable or declines slowly, and when preferences are very high (>7) the gap between TFR and preferences is negative.

[12] Countries with low preferences are concentrated in Latin America and Asia, while countries with high preferences are in sub-Saharan Africa. There is no guarantee that the relationships between preferences and fertility in Africa will follow the same path as in other regions.

- With declining preferences (desired number of children at 6 or below), the gaps becomes positive (observed fertility higher than preferences). Fertility then declines as preferences decline, but with a time lag.
- When the median desired number of children is between 3 and 6, fertility is virtually always greater than preferences (above the diagonal line); even when preferences are at 2 children, observed fertility rarely drops below preferences. In other words, in most situations of fertility transitions, the desired number of children appears as a lower bound for fertility. In most cases, observed fertility does not exceed preferences by more than 3 children, and differences tend to be smaller than 3 children.
- When preferences are low (a little above 2), fertility declines much more rapidly than preferences (steep slope) and fertility and preferences tend to converge. In some instances fertility falls below preferences.
- Except when preferences are very high (>7), slopes are always positive: if preferences decrease, fertility also decreases. Where preferences are high (>7 children), the slope is almost flat; Where preferences are low, the slope is much steeper.

4.2.1 USING PREFERENCES FOR PROJECTING FERTILITY CHANGES

Data on fertility preferences can potentially be used to help predict fertility changes because (1) the median desired number of children is available 10-15 years ahead of the survey time (with the fixed target model), and (2) there is a relationship between preferences and fertility.

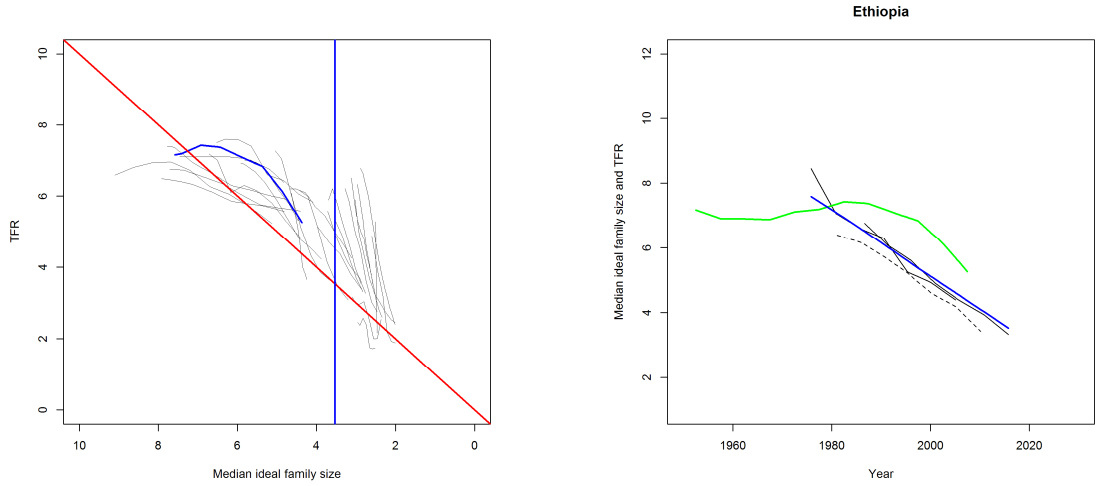
Data on preferences as used in this paper might be incorporated in complex models, such as those used in probabilistic projections with Bayesian methods (Alkema et al., 2011), but this is beyond the scope of this paper. Our objective at this stage is rather to illustrate, with a few examples, how data on trends in preferences and trends in fertility may help justifying assumptions about future fertility.

Let us start with the case of Ethiopia (Figure 9). The right-hand side figure shows the strong decline in fertility preferences, and the more recent decrease in fertility. The left-hand side figure shows the relationship between preferences and fertility (as on Figure 8), with the Ethiopian case highlighted in blue (grey lines represent these relationships

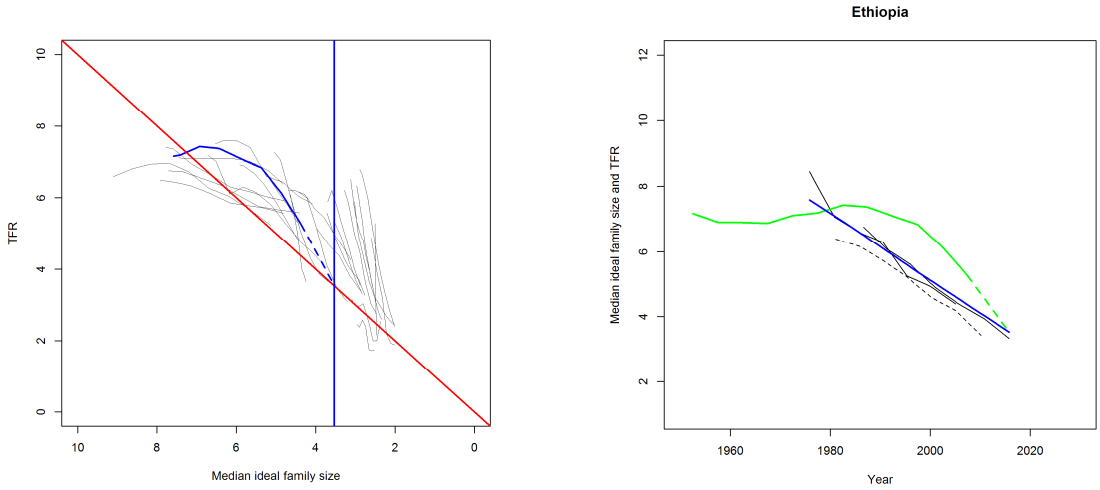
in the 27 countries with fixed preferences). The blue vertical line indicates the predicted median desired number of children at ages 45-49 (the target).

The question of predicting fertility changes can be viewed as "finding" the path(s) between the last observed point and the vertical line. Three options are discussed and illustrated here, but other options could of course be followed. In the first option (Figure 9), the intersection between the diagonal line and the blue vertical line is used to define the level of fertility; if we consider, as suggested by the data, that observed fertility does not drop below preferences during the transition, this intersection is the lower bound for the most distant time point available. It corresponds to the situations in which preferences are fully implemented. In the second option, the path to the vertical line is based on the experience of the other countries (other grey lines) for the same values of fertility preferences. The method used here consists in selecting the portion of the data that extends from the last point of the observed relationship between fertility and preferences in the selected country, and the vertical line corresponding to the target. A random-coefficient model (countries are level 2 units) is fitted using the data corresponding to that portion. The path for the country under study is then predicted from the random-coefficient model, and can be interpreted as the reflecting *the path to the target based on what was observed in other countries for a similar starting point*. This approach only uses the starting point in Ethiopia (the last point of the trajectory) and information from the other countries for the portion for which the projection is carried out (see results for the random-coefficient model for the Ethiopian case in Appendix Table 2 and Appendix Figure 1). A third approach consists in using a wider portion of the data to include the recent experience in the country (relationship between preferences and fertility) to predict the future level of fertility. In this third option, the portion starts on the X-axis (median desired number of children) 0.5 children before the last point. The same random-coefficient model is used as in the option 2, but the slope is now much closer to the observed slope for the country under study; this is very similar to an extrapolation of recent trends. The results indicate that, under the assumptions of these 3 options, fertility would decrease substantially in Ethiopia.

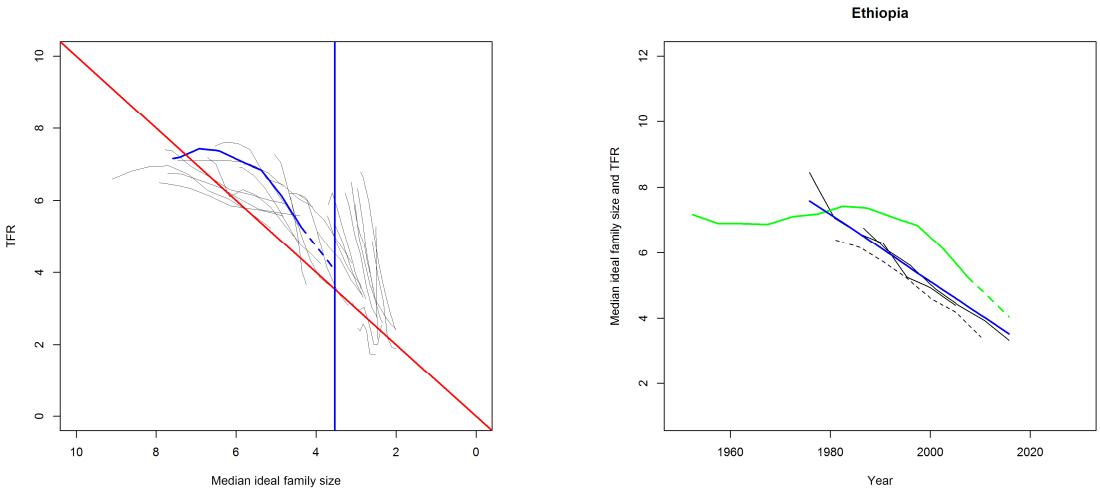
FIGURE 9 : PROJECTIONS OF FERTILITY USING INFORMATION OF FERTILITY PREFERENCES IN ETHIOPIA



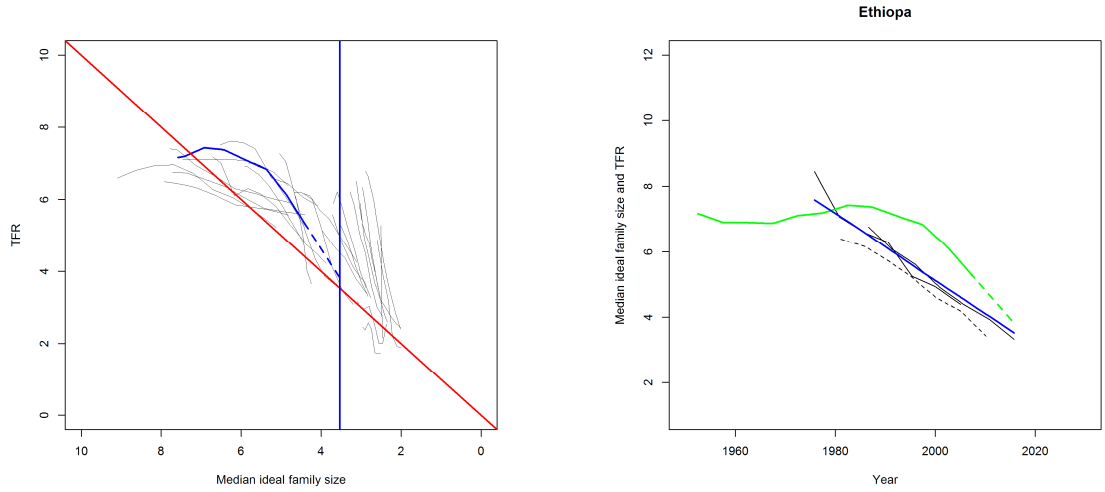
Option 1. Full implementation of preferences



Option 2. Relationship betweeb preferences and fertility based on other countries (window of preferences from A children to B)



Option 3. Relationship between preferences and fertility based on other countries and country under study (window of preferences from A-0.5 children to B).



Note : dotted blue and green lines represent predicted values.

Similar projections are illustrated in appendix for selected countries at various stages of transition and from different parts of the world (Cambodia, Zambia, Haiti, Uganda). These results are illustrative but indicate the method is potentially useful for devising realistic short-term projections of fertility.

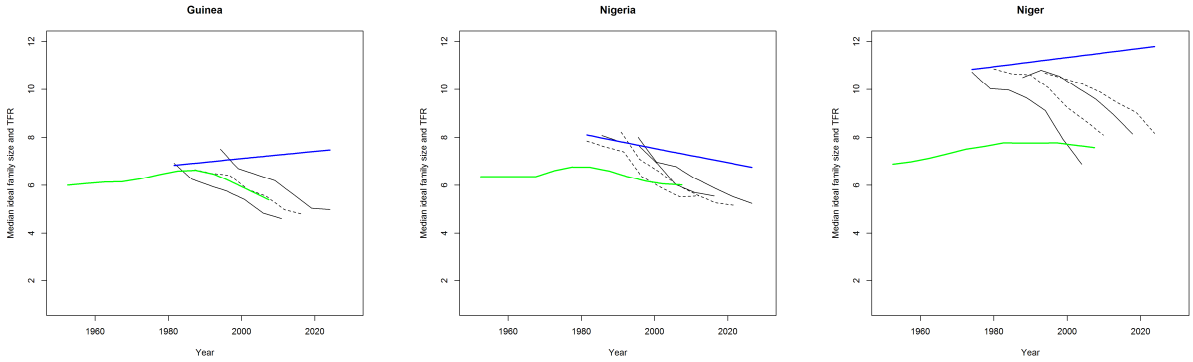
4.3 FERTILITY AND PREFERENCES IN CONTEXTS WITH CHANGING PREFERENCES

Preferences and observed fertility are now compared in countries where preferences are moving targets, that is where they increase or decrease with age within cohorts (Figure 10, see appendix figures 2 and 3 for the 25 countries). When preferences increase with age, predicted preferences at 45-49 are much higher than preferences at 15-19. This is illustrated with the cases of Guinea, Niger and Nigeria. They are, in these countries, also much higher than observed fertility. Countries where preferences decrease with age within cohorts show rapid decreases in predicted preferences at ages 45-49 (blue lines), as well as rapid decreases in fertility.

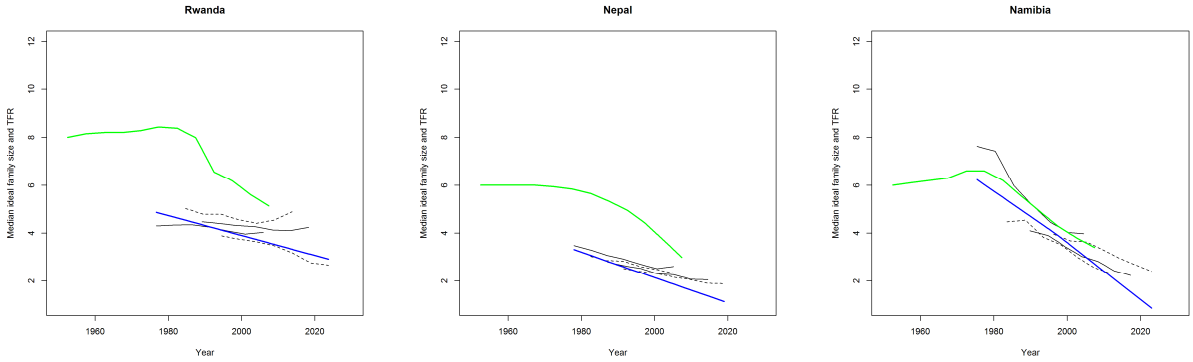
The same approach as followed for fixed target countries can be used here for projecting fertility for countries with moving preferences. However, predicted preferences at ages 45-49 rely on the assumption that preferences will continue changing (increasing/decreasing) with age as observed in the data. One could also consider that the target would become fixed, and compute predicted preferences under that assumption; this is not done here.

FIGURE 10 : COMPARISONS OF PERIOD TOTAL FERTILITY AND COHORT FERTILITY PREFERENCES IN 6 COUNTRIES WITH PREFERENCES AS "MOVING TARGETS"

Target moving up



Target moving down

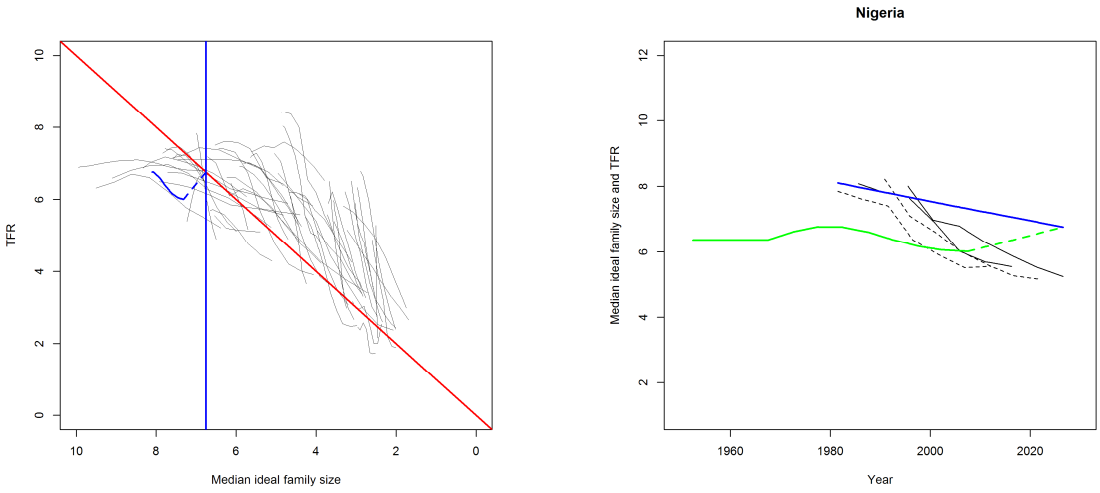


We illustrate projections using the same approach as for the fixed target situations for 2 countries. In Nigeria, the first two options (full implementation and paths in other countries) suggest that fertility will slightly increase; the third option, based on the recent trend between preferences and fertility in Nigeria, suggest a slight decrease. What these results show is that – based on the assumptions of the model - no strong fertility decline is expected in Nigeria by 2025. The second case is Rwanda, where preferences have been moving down with age. The three options suggest that fertility will continue declining until 2025, and could be below 3 children per women within 10 years. Again, these are illustrative results.

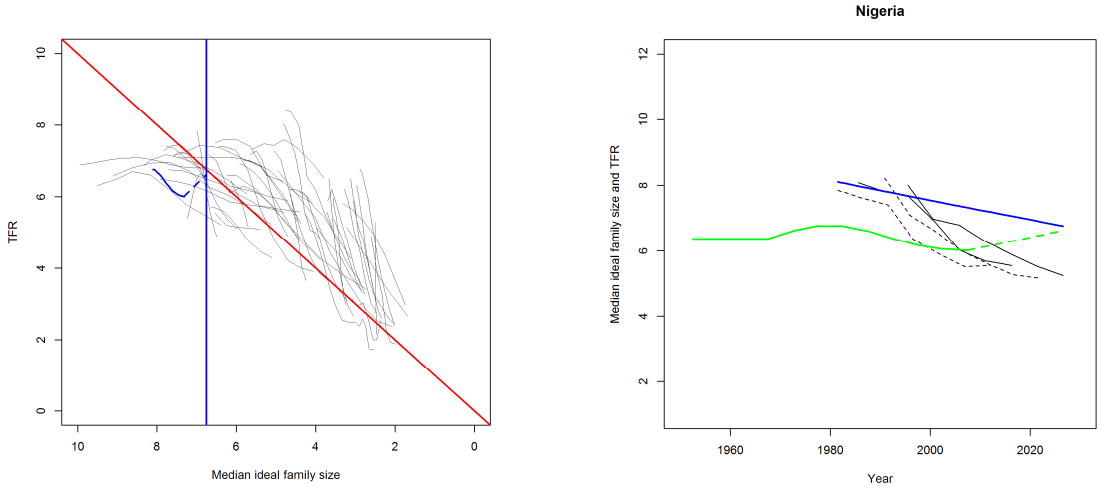
FIGURE 11 : PROJECTIONS OF FERTILITY USING INFORMATION OF FERTILITY PREFERENCES IN NIGERIA

Nigeria

Option 1. Full implementation of preferences



Option 2. Relationship between preferences and fertility based on other countries (window of preferences from A children to B)



Option 3. Relationship between preferences and fertility based on other countries and country under study (window of preferences from A-0.5 children to B).

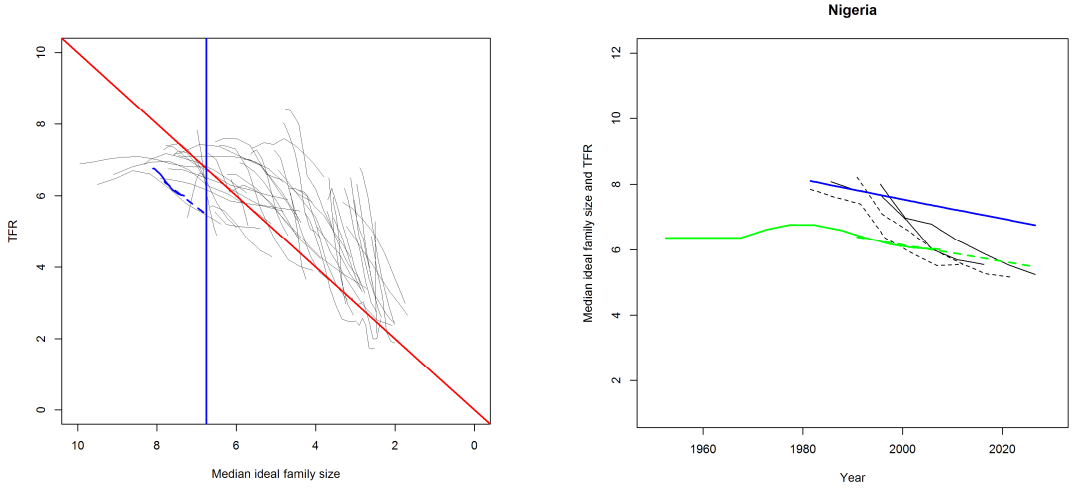
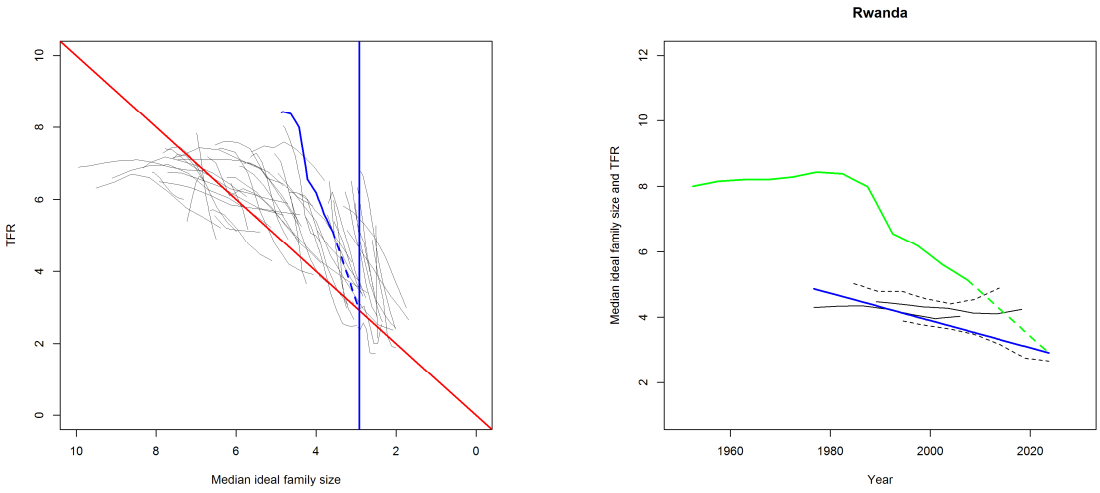


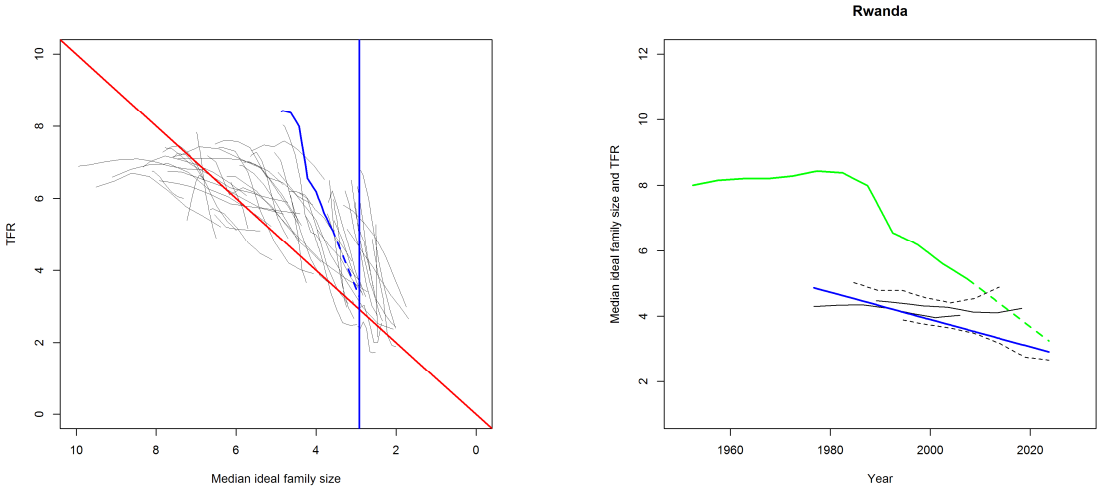
FIGURE 12 : PROJECTIONS OF FERTILITY USING INFORMATION OF FERTILITY PREFERENCES IN RWANDA

Rwanda

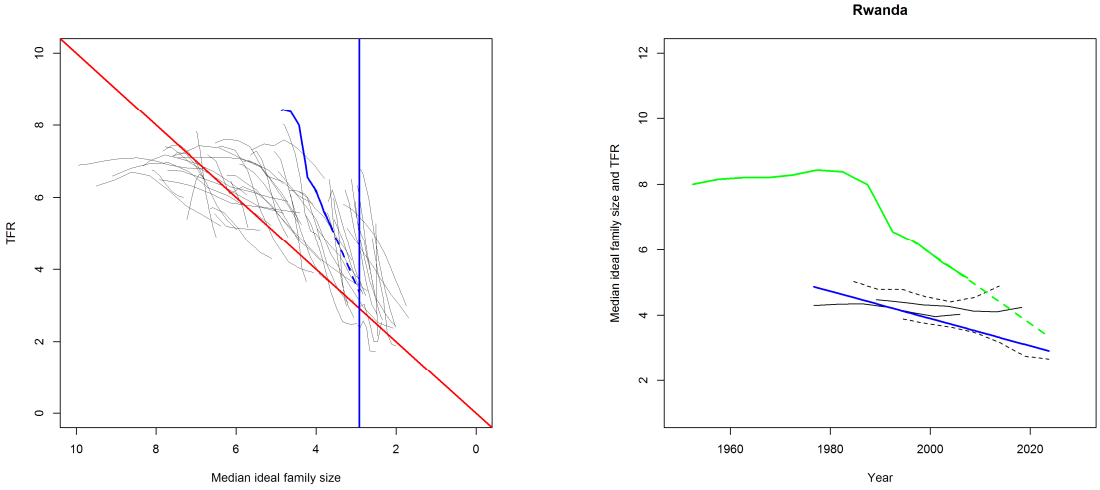
Option 1. Full implementation of preferences



Option 2. Relationship between preferences and fertility based on other countries (window of preferences from A children to B)



Option 3. Relationship between preferences and fertility based on other countries and country under study (window of preferences from A-0.5 children to B).



5 Discussion and Conclusion

Data on fertility preferences in successive DHS were used to evaluate if preferences (desired number of children) are stable within cohorts (fixed targets) or change with age (moving targets). Preferences are consistent with a fixed target model in roughly half of the 52 countries of this study, while targets move up in around a third of the countries and move down in the remaining six countries. Targets tend to become fixed as preferences decrease.

The fixed target model provides a basis for estimating fertility preferences in the future with some confidence. Fertility preferences can also be predicted in the future with a moving target approach, if we assume changes in preferences within cohorts are constant over time. In turn, trends in fertility preferences provide a reference for projecting the trajectory of fertility changes. Comparisons of trends in preferences and trends in period fertility were done in 52 countries, and were used to help predict fertility changes. The full implementation option (option 1) indicate how fertility would change if preferences were fully implemented, i.e. if fertility reached the desired number of children 10-15 years ahead of the survey. Empirical regularities between changes in preferences and changes in fertility in our data were also used to project fertility changes (options 2 and 3). The three approaches indicate that data on desired number of children are potentially useful for predicting fertility changes. For instance, our approach suggests no strong decline is expect in Nigeria in the next 10-15 years, while continuous declines are possible in countries as Ethiopia and Uganda. These results are replicable, and the assumptions on which they rely can be justified and modified.

Further research is necessary in several directions. First, the method needs to be applied in more countries to evaluate the plausibility of the results. Secondly, the relationships between changes in preferences and changes in fertility could be documented in a larger number of countries and over longer periods. This would provide a more solid empirical basis for projecting fertility using observations from other countries. Third, the empirical test of the fixed vs. moving target model relied on linear models. Taking account of non-linear relationships between preferences and age or cohorts would be more realistic in some contexts. Fourth, projecting fertility changes in countries with moving targets is more challenging than in fixed target settings; predicting preferences among women 45-49 could be improved or based on other assumptions than those used

in this paper. Fifth, other options for projecting fertility based on preferences could be devised. Currently three options were tested and provide useful results, but other approaches could certainly be tested. One of them would be to use the confidence intervals of the predicted slopes in the random-coefficient model of the relationship between preferences and fertility. Sixth, integrating additional information that could explain the gap between fertility and preferences, as in Bongaarts' (2001) framework (e.g. son preferences, child mortality, family planning programs) may help predicting fertility changes. Finally, our approach mainly relies on empirical regularities and does not address the causal relationships between changes in preferences and fertility changes.

The approach described in this paper is incomplete and speculative. We believe it provides some guidelines on how fertility preferences may be used in in preparing projections for fertility. Whether it would improve projections of fertility is difficult to evaluate and is beyond the scope of this paper. However, projected fertility with this approach could be easily compared with projections prepared by the United Nations Population Division, and would indicate whether different approaches lead to consistent results, or if the methods lead to very different outcomes.

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Appendix Table 1 – List of 52 countries and estimates of b1, b2 and b3 coefficients in each country

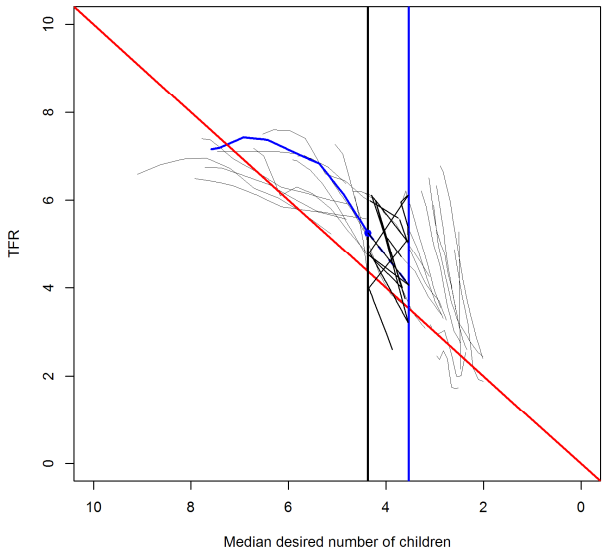
Cid	Country	b2j	b3j	b1j
AM	Armenia	0.0054	-0.0212	2.6042
BD	Bangladesh	-0.0079	-0.0170	2.4417
BF	Burkina Faso	0.0156	-0.0954	6.1135
BJ	Benin	-0.0061	-0.0400	4.9559
BO	Bolivia	0.0138	-0.0287	2.4614
BU	Burundi	-0.0275	-0.0225	4.5936
CD	DR Congo	0.0349	-0.0777	6.5333
CG	Congo Brazzaville	0.0186	-0.0738	5.5625
CI	Côte d'Ivoire	0.0741	-0.0901	5.3377
CM	Cameroon	0.0486	-0.1381	6.3306
CO	Colombia	0.0009	-0.0255	2.2562
DR	Dominican Republic	0.0182	-0.0326	2.9051
EG	Egypt	0.0240	-0.0324	2.9004
ET	Ethiopia	0.0103	-0.1094	4.9385
GA	Gabon	0.0273	-0.0862	5.1954
GH	Ghana	-0.0001	-0.0551	4.3077
GN	Guinea	0.0865	-0.0716	5.5898
GU	Guatemala	0.0051	-0.0525	3.4155
HN	Honduras	0.0036	-0.0381	3.0984
HT	Haiti	0.0027	-0.0301	3.0321
IA	India	-0.0223	-0.0209	2.5640
ID	Indonesia	0.0214	-0.0544	2.9170
JO	Jordan	-0.0150	-0.0320	4.2953
KE	Kenya	0.0164	-0.0423	3.8105
KH	Cambodia	0.0006	-0.0480	3.6146
KK	Kazakhstan	-0.0031	-0.0200	2.6368
LB	Liberia	0.0103	-0.1107	5.7980
LS	Lesotho	0.0043	-0.0555	3.2568
MA	Morocco	-0.0232	-0.0547	3.0222
MD	Madagascar	0.0068	-0.0744	4.9165
ML	Mali	0.0281	-0.1099	6.9987
MW	Malawi	0.0039	-0.0772	4.6467
MZ	Mozambique	-0.0039	-0.1027	5.8481
NC	Nicaragua	0.0063	-0.0331	2.6489
NG	Nigeria	0.0609	-0.0915	6.4801
NI	Niger	0.1147	-0.0956	9.3163
NM	Namibia	-0.0223	-0.0833	4.0083
NP	Nepal	-0.0206	-0.0278	2.6530
PE	Peru	0.0088	-0.0248	2.3251
PH	Philippines	0.0029	-0.0319	2.9666

PK	Pakistan	0.0115	-0.0328	4.2089
T still	Rwanda	-0.0171	-0.0232	4.1642
SL	Sierra Leone	0.0461	-0.0710	5.1006
SN	Senegal	0.0209	-0.0683	5.9983
TD	Chad	0.0815	-0.0883	9.3694
TG	Togo	0.0223	-0.0479	4.5131
TR	Turkey	0.0088	-0.0099	2.3251
TZ	Tanzania	-0.0051	-0.0913	5.3468
UG	Uganda	0.0068	-0.0769	5.3378
VN	Vietnam	-0.0014	-0.0182	2.2343
ZM	Zambia	0.0105	-0.1024	5.2767
ZW	Zimbabwe	0.0232	-0.0868	4.2154

Appendix Table 2 – random-coefficient model for the relationship between fertility preferences (independent variable) and total fertility (dependent variable), for values of desired number of children varying between 4.37 (starting point for Ethiopia) and 3.53 (target for Ethiopia).

Regression coefficients	Coefficient	Standard error
Intercept	5.68	0.31
Preferences	1.62	0.45
Standard deviations and correlations of random components		
Sd intercept	0.98	0.23
Sd preferences	1.37	0.34
Corr(intercept-preferences)	0.304	0.310
Level-1 units n=87		
Level-2 units n=11		

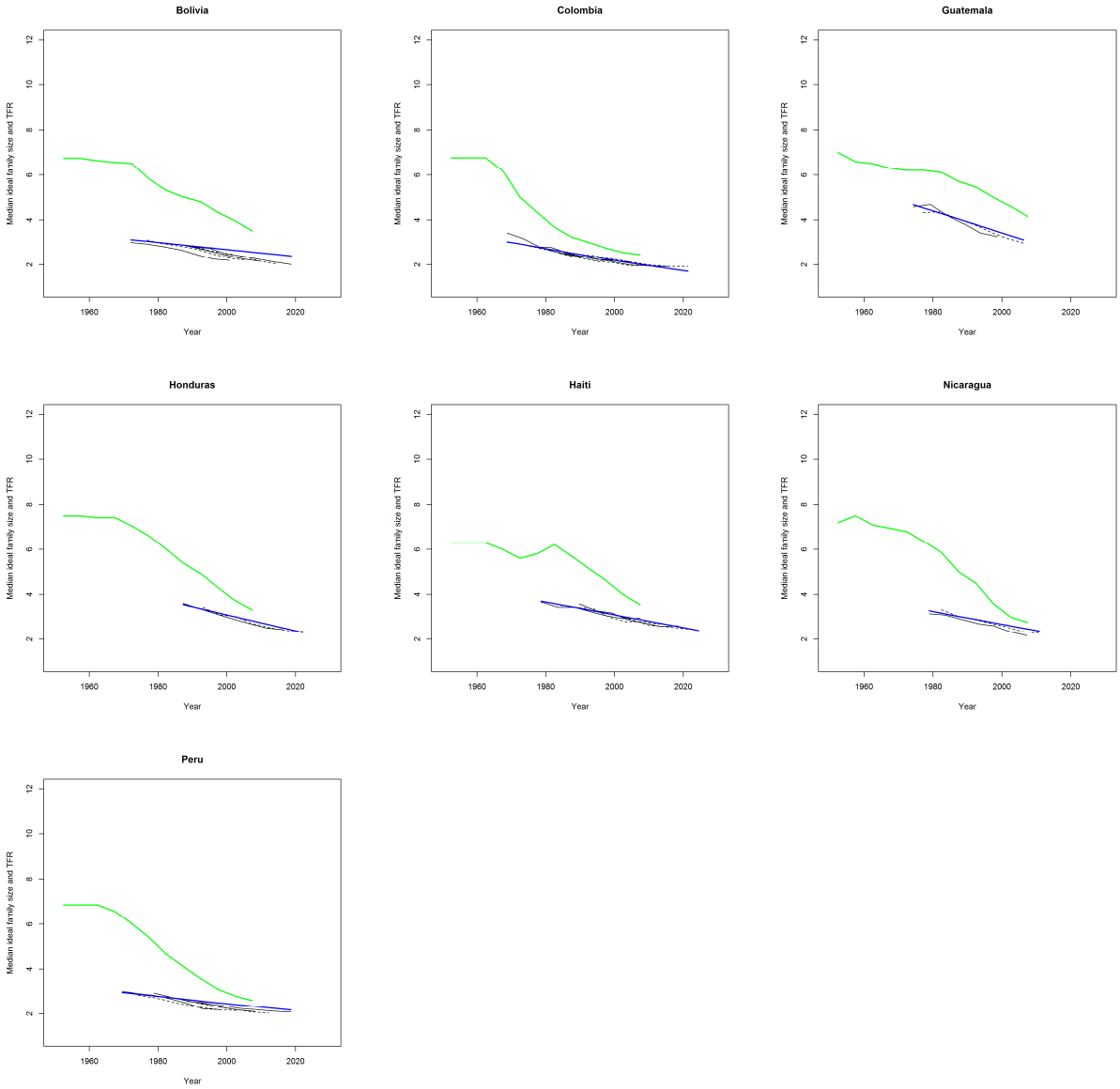
Appendix Figure 1 – Illustration of random-coefficient model for the relationship between fertility preferences (independent variable) and total fertility (dependent variable), for values of desired number of children varying between 4.37 (starting point for Ethiopia) and 3.53 (target for Ethiopia).



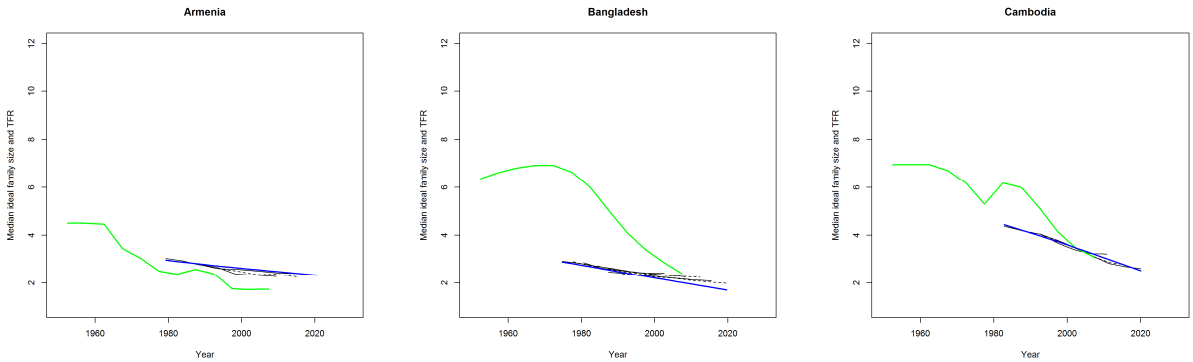
Legend: black lines between for fertility preferences between 3.53 and 4.37 represent predicted values from the random-coefficient model.

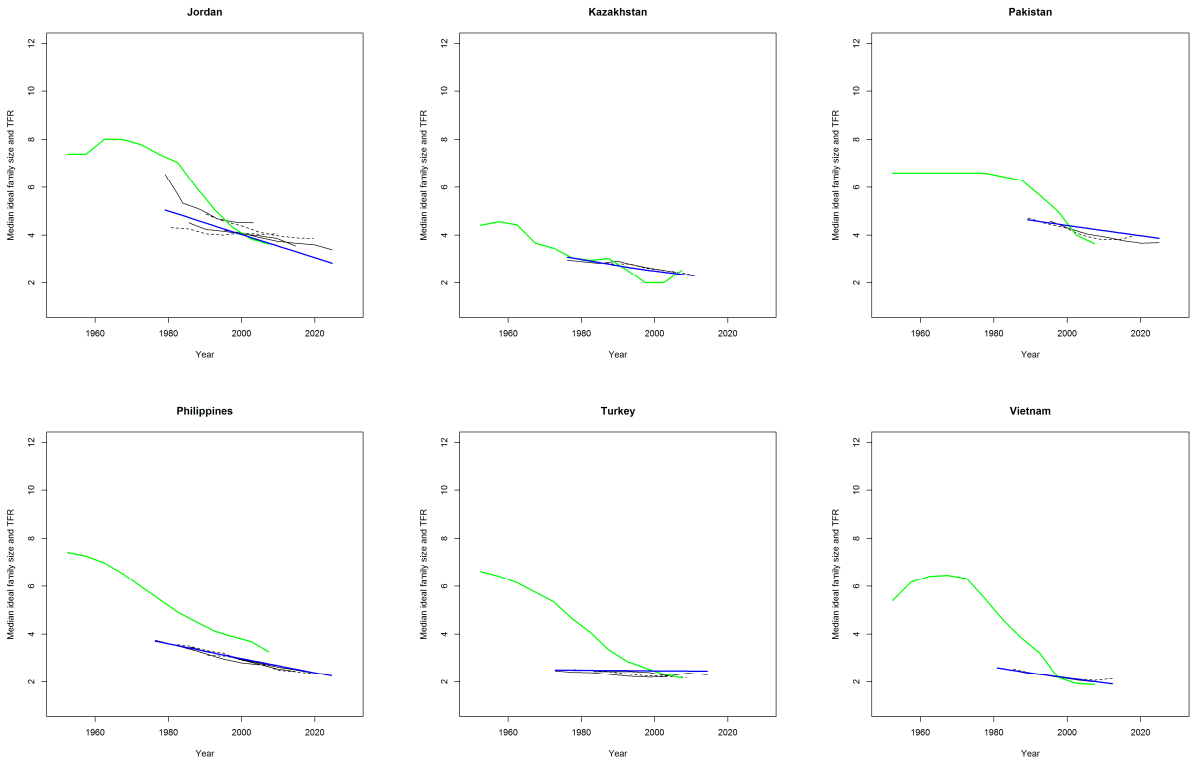
Appendix Figure 2. Comparisons of period total fertility and cohort fertility preferences in 27 countries with preferences as "fixed targets"

Latin America

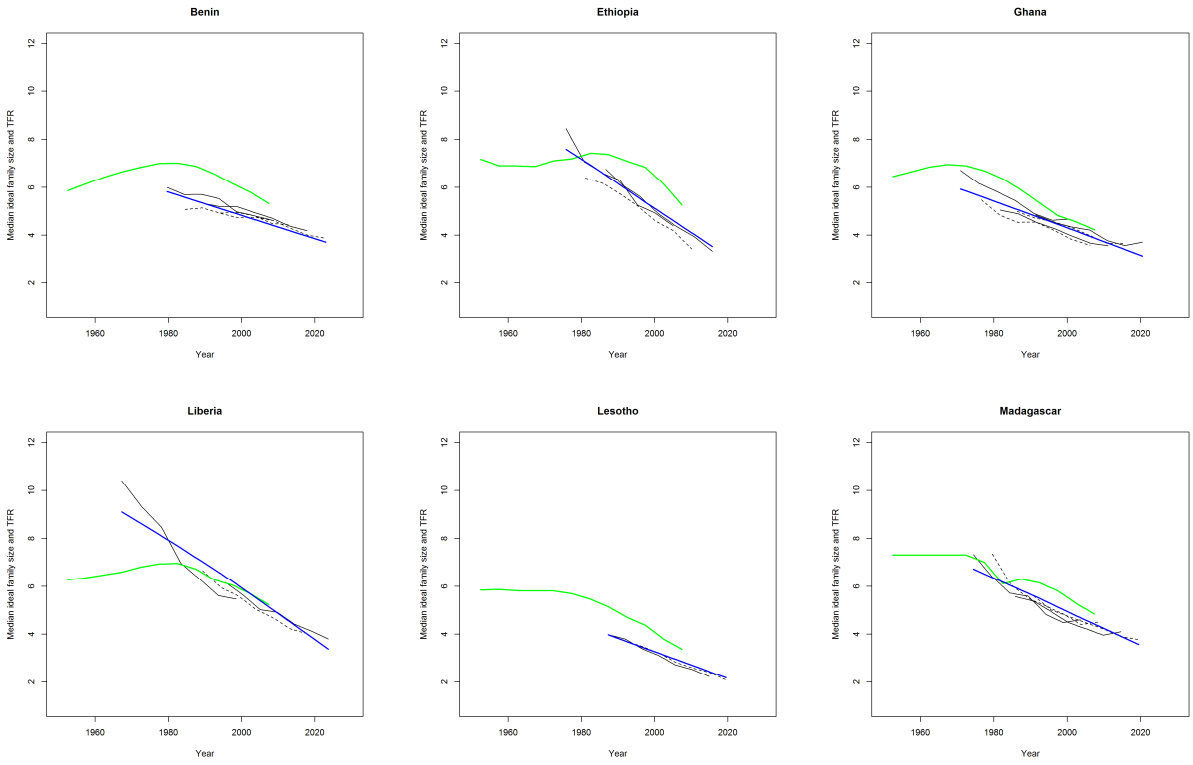


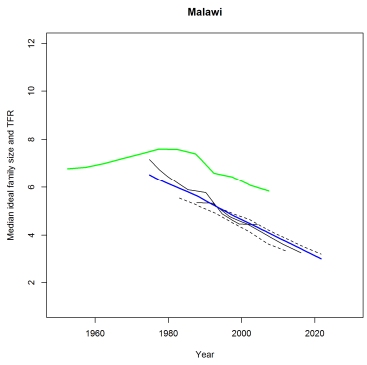
Asia & MENA

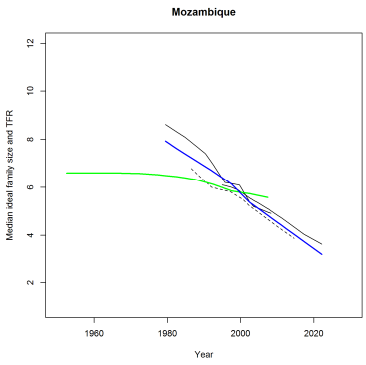


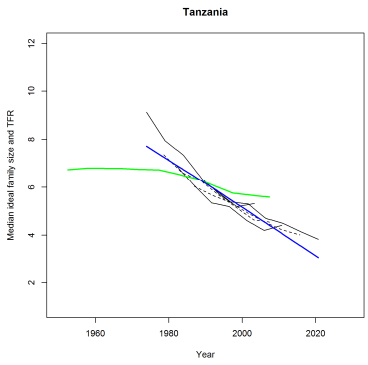


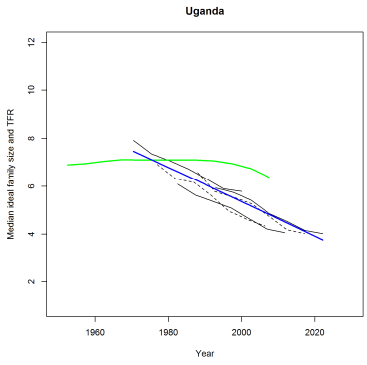
Sub-Saharan Africa




Malawi
Median ideal family size and TFR
Year

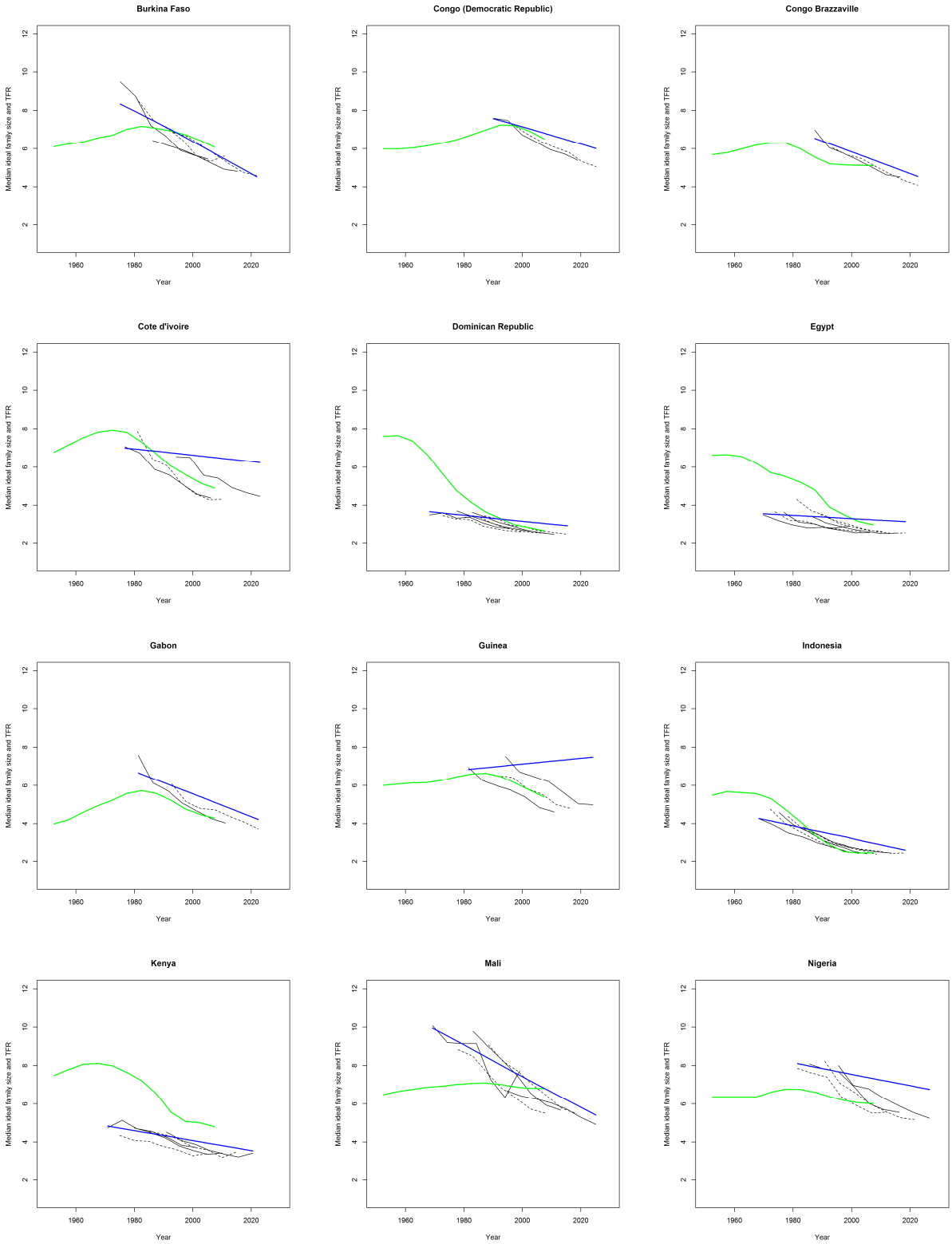

Mozambique
Median ideal family size and TFR
Year

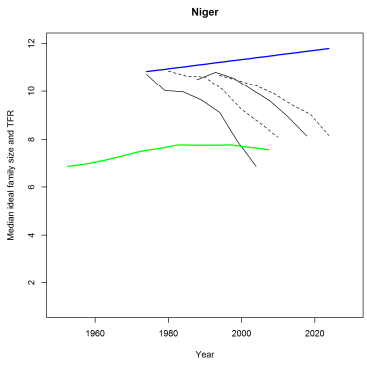

Tanzania
Median ideal family size and TFR
Year

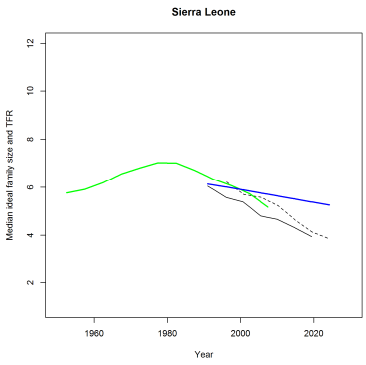

Uganda
Median ideal family size and TFR
Year

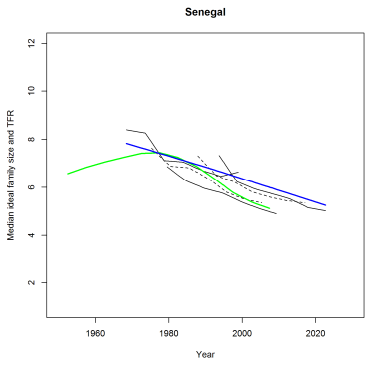

Zambia
Median ideal family size and TFR
Year

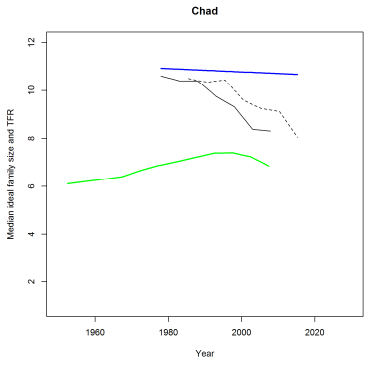
Appendix Figure 3. Comparisons of period total fertility and cohort fertility preferences in 19 countries with preferences as “targets moving up”.

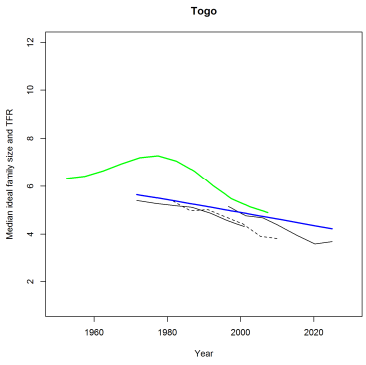


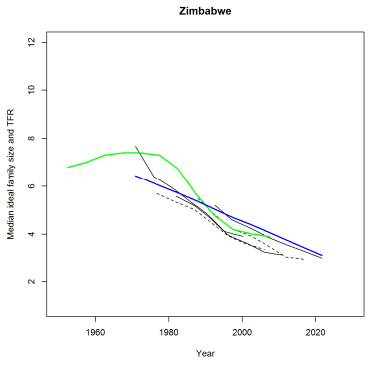

Niger
Median ideal family size and TFR
Year
2
4
6
8
10
12
1960
1980
2000
2020


Sierra Leone
Median ideal family size and TFR
Year
2
4
6
8
10
12
1960
1980
2000
2020

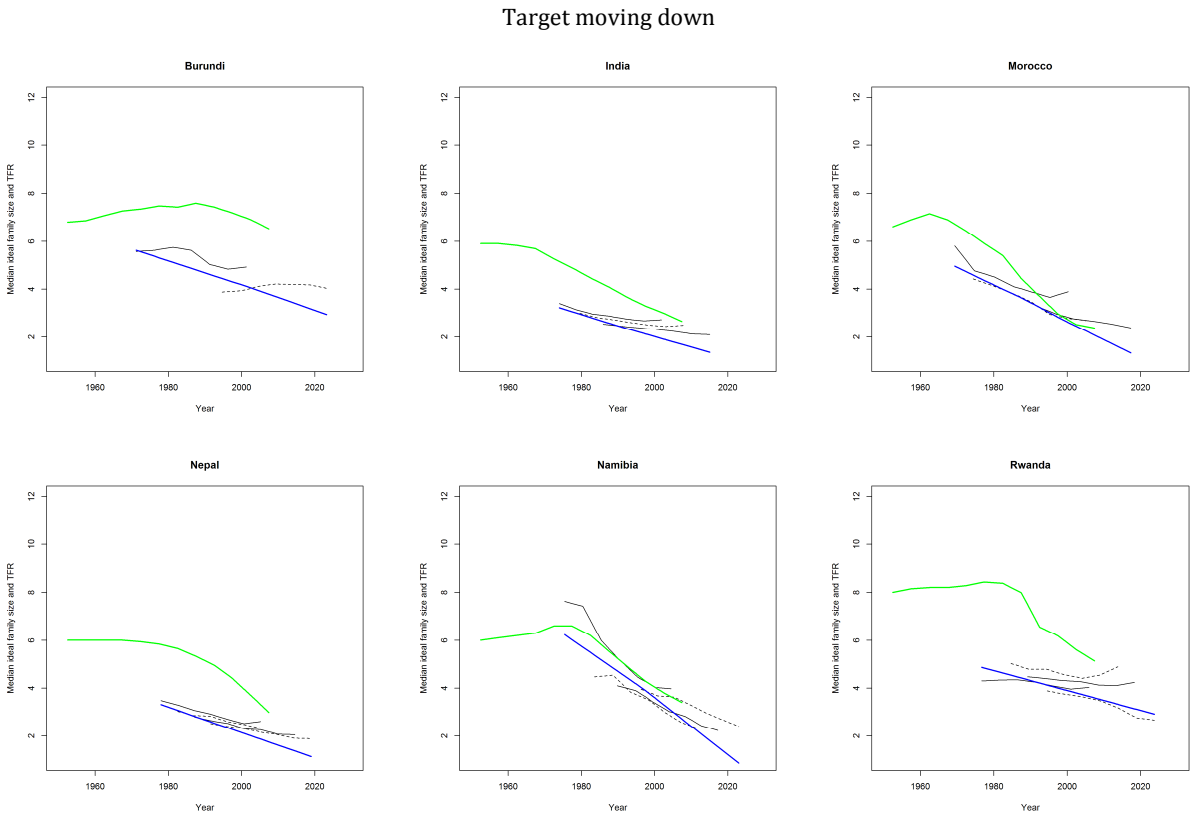

Senegal
Median ideal family size and TFR
Year
2
4
6
8
10
12
1960
1980
2000
2020


Chad
Median ideal family size and TFR
Year
2
4
6
8
10
12
1960
1980
2000
2020


Togo
Median ideal family size and TFR
Year
2
4
6
8
10
12
1960
1980
2000
2020


Zimbabwe
Median ideal family size and TFR
Year
2
4
6
8
10
12
1960
1980
2000
2020

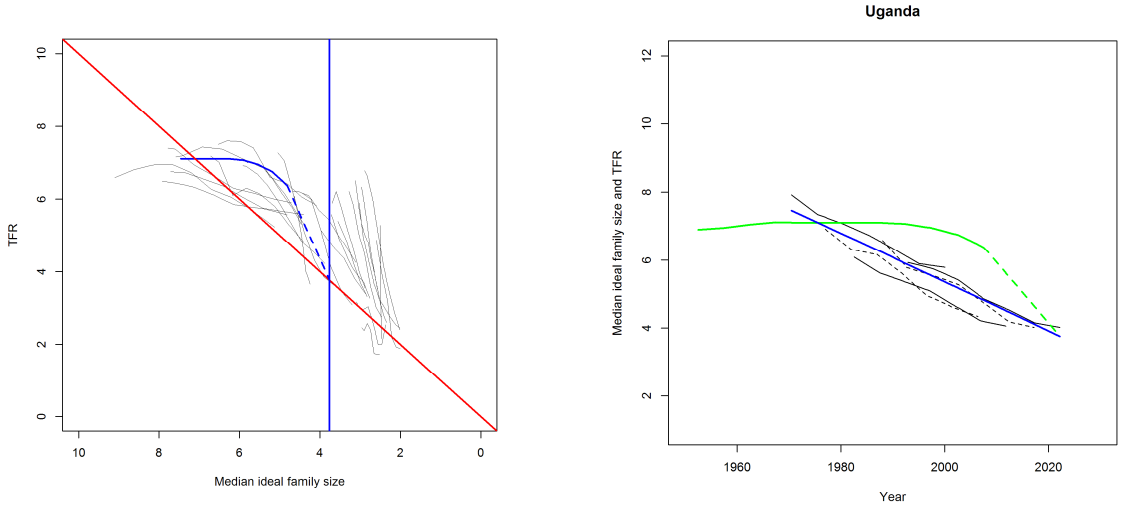
Appendix Figure 4. Comparisons of period total fertility and cohort fertility preferences in 6 countries with preferences as “targets moving down”.



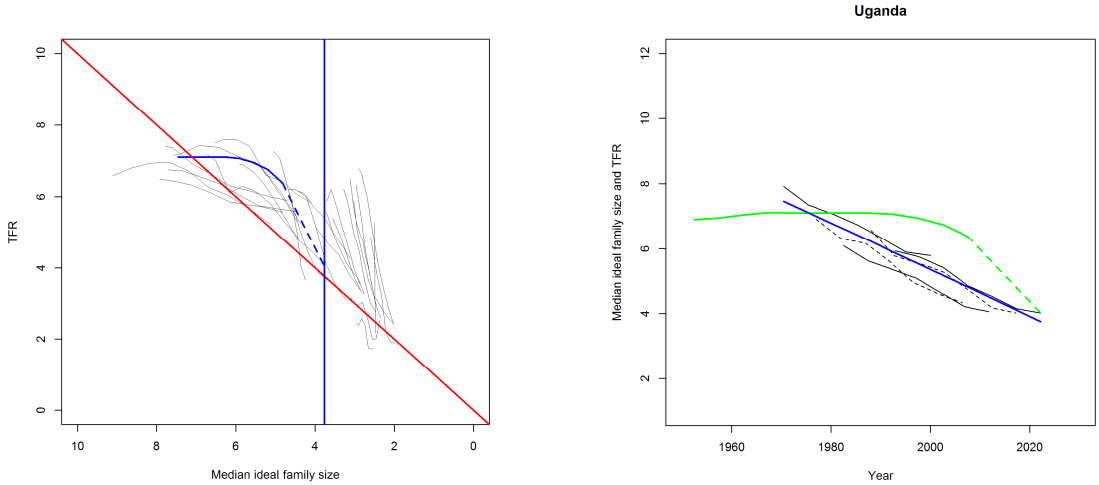
Appendix Figure 5. Projections of fertility using information of fertility preferences in 4 countries

Uganda

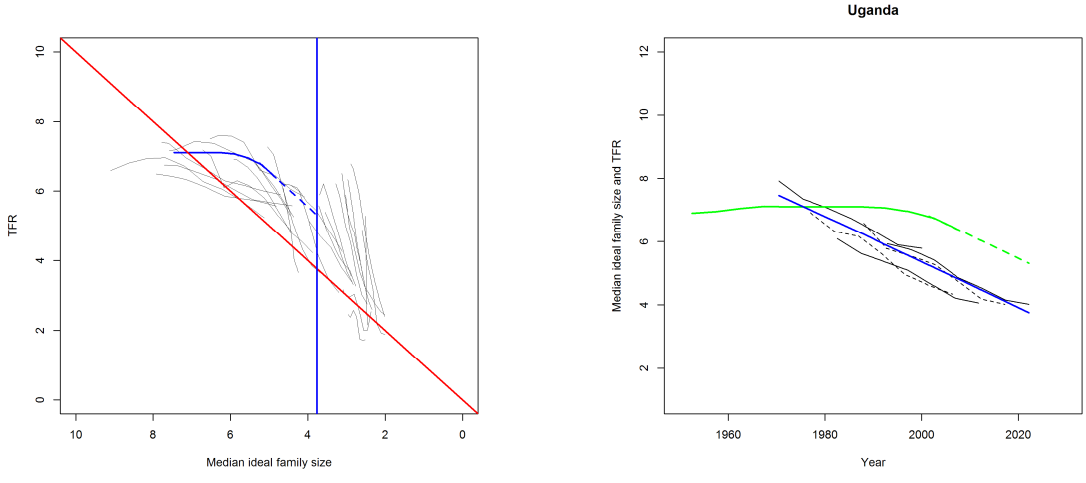
Option 1. Full implementation of preferences



Option 2. Relationship between preferences and fertility based on other countries (window of preferences from A children to B)

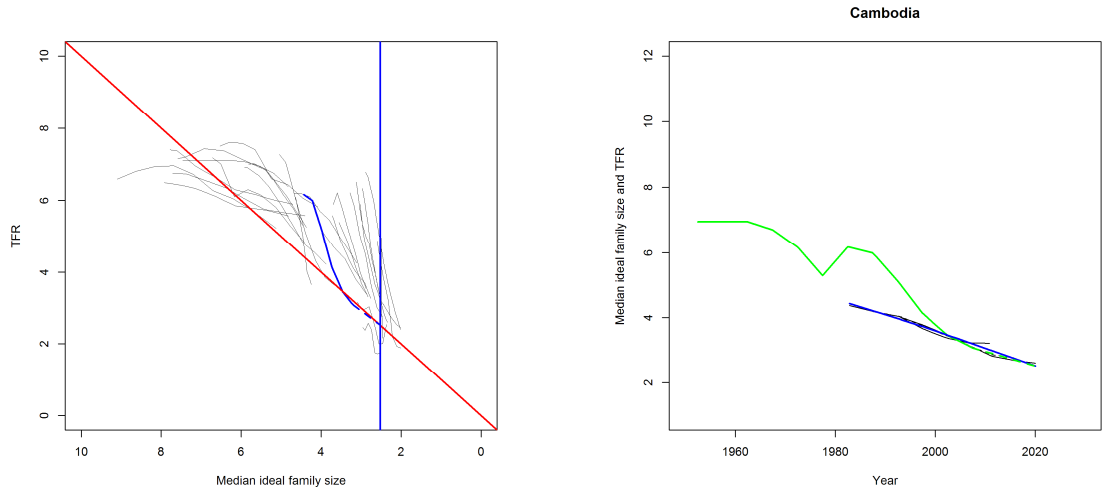


Option 3. Relationship between preferences and fertility based on other countries and country under study (window of preferences from A-0.5 children to B).

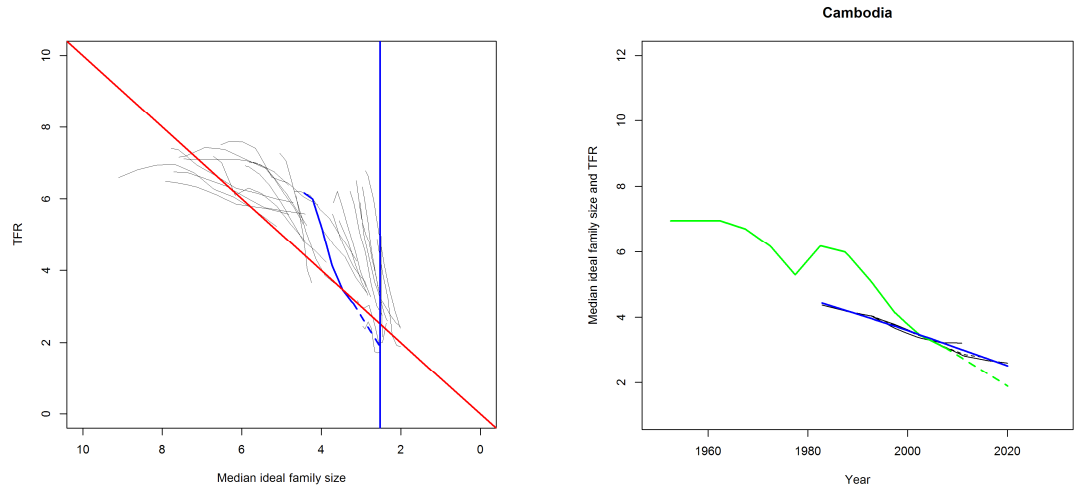


Cambodia

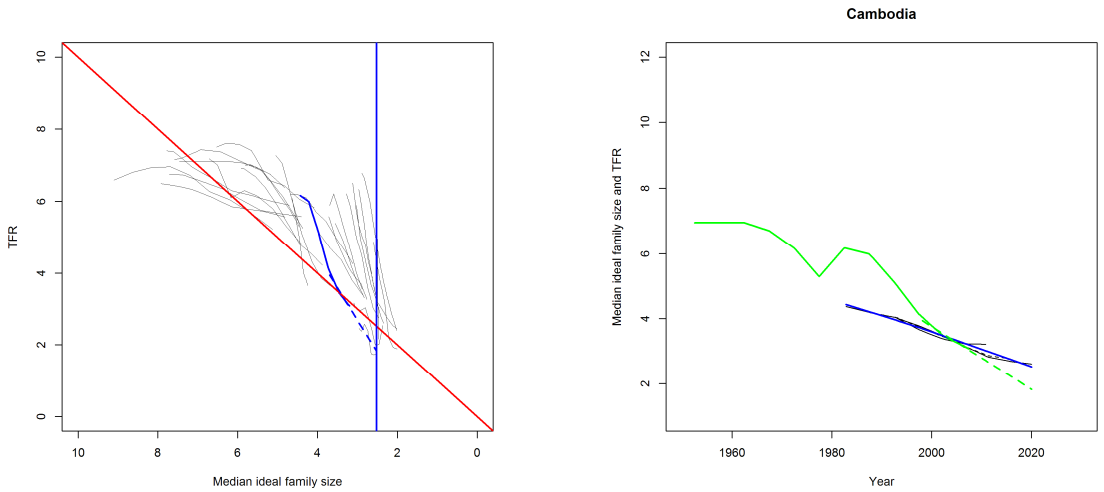
Option 1. Full implementation of preferences



Option 2. Relationship between preferences and fertility based on other countries (window of preferences from A children to B)

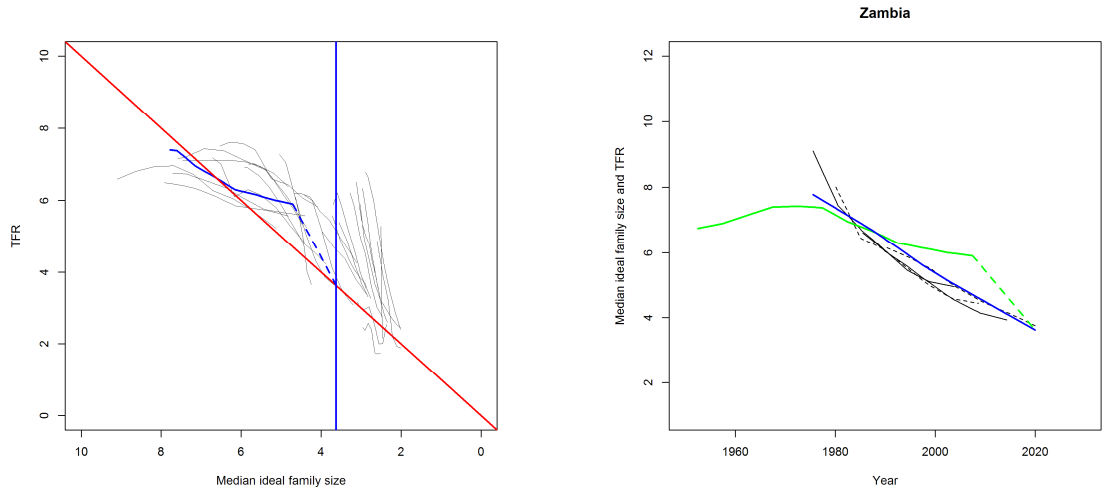


Option 3. Relationship between preferences and fertility based on other countries and country under study (window of preferences from A-0.5 children to B).

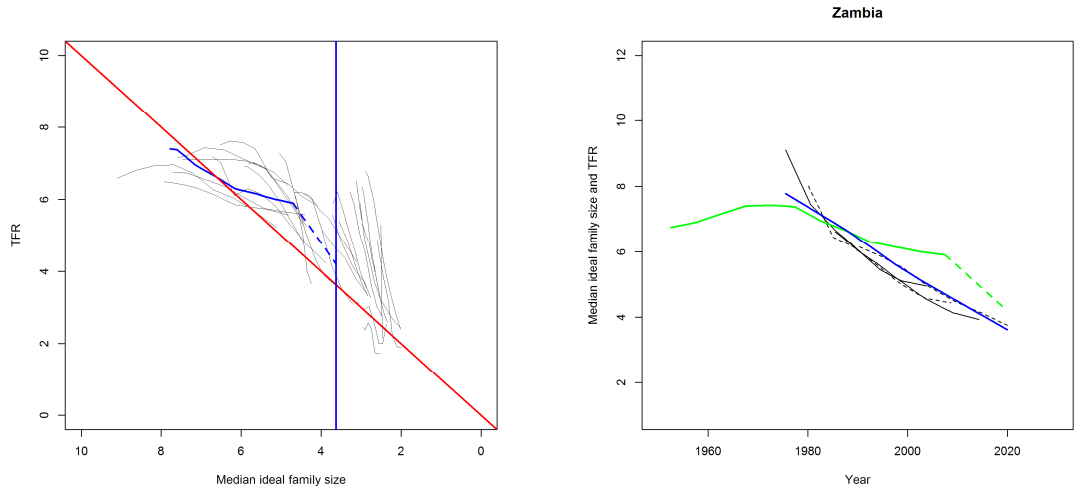


Zambia

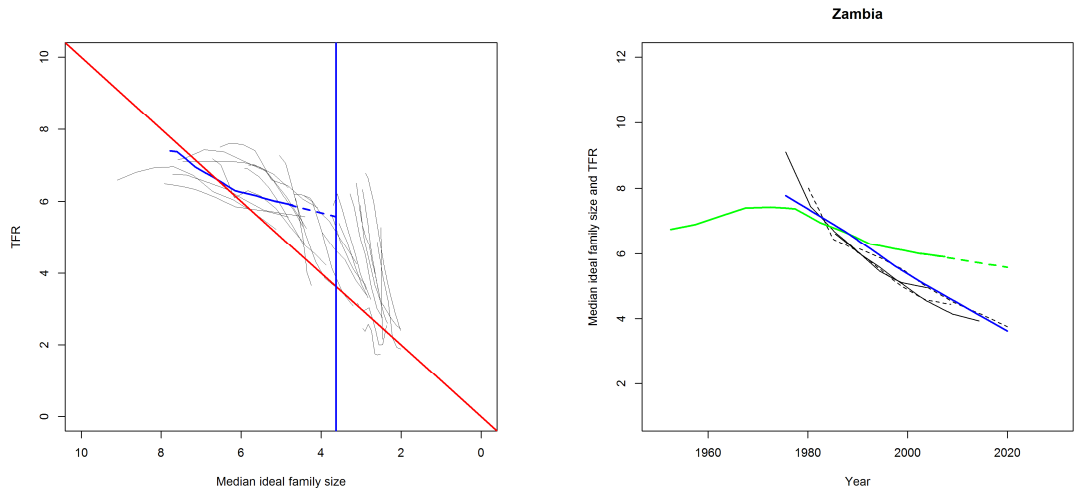
Option 1. Full implementation of preferences



Option 2. Relationship between preferences and fertility based on other countries (window of preferences from A children to B)

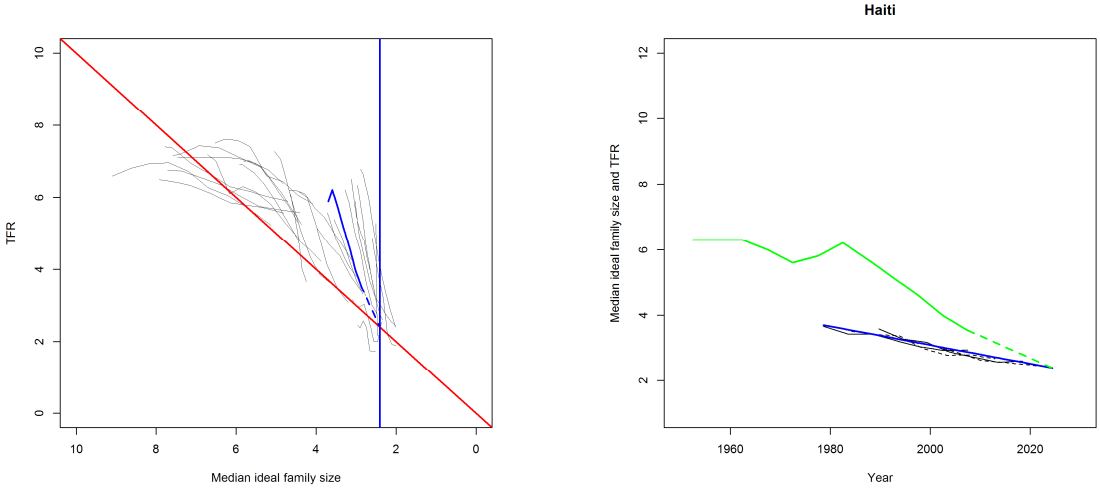


Option 3. Relationship between preferences and fertility based on other countries and country under study (window of preferences from A-0.5 children to B).

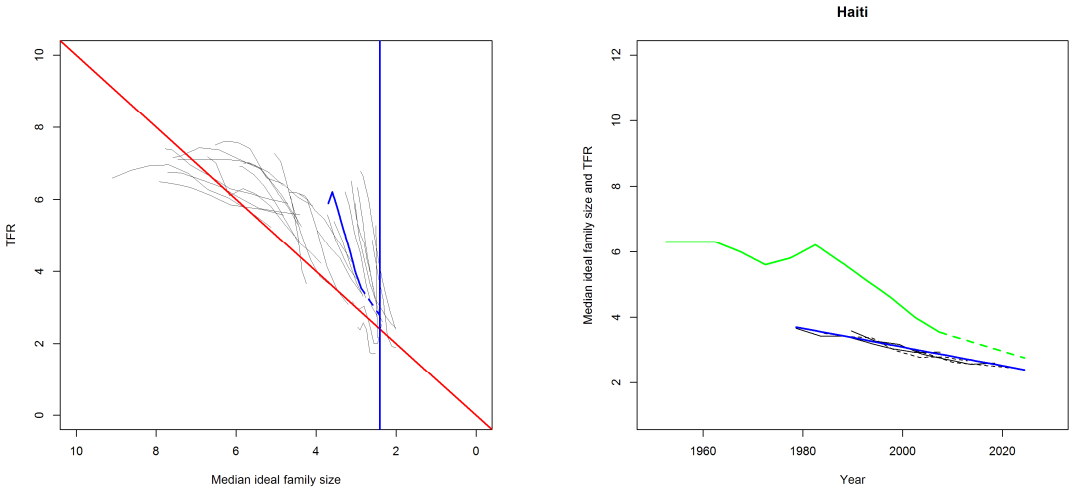


Haiti

Option 1. Full implementation of preferences



Option 2. Relationship between preferences and fertility based on other countries (window of preferences from A children to B)



Option 3. Relationship between preferences and fertility based on other countries and country under study (window of preferences from A-0.5 children to B).