Stalls in Fertility Transitions in Sub-Saharan Africa:

Real or Spurious?

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STALLS IN FERTILITY TRANSITIONS IN SUB-SAHARAN AFRICA: REAL OR SPURIOUS?[1]

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1. Introduction

Since the early 2000s, situations of fertility stalls or reversals of fertility declines have been described and analyzed in several African countries. Kenya and Ghana were the first countries to be identified as experiencing a stall in fertility decline. Bongaarts' early study (2006) on the causes of stalling fertility transitions in developing countries included these two African countries (Bongaarts, 2006). Westoff and Cross (2006) provided a detailed analysis of the stall in Kenya between 1998 and 2003, and Agyei-Mensah (2007) analyzed the stall in Ghana between 1998 and 2003. Recently, several African countries and regions have been added to the list of countries with stalling transitions (Bongaarts, 2008; Dodoo and Frost, 2008; Garenne, 2007; Moultrie et al., 2008; Schoumaker and Tabutin, 2008; Shapiro and Gebreselassie, 2007). Shapiro and Gebreselassie (2007) documented a stall in three midtransition countries (Ghana, Kenya and Cameroon) and in five other countries (Guinea, Mozambique, Rwanda, Senegal and Tanzania). Bongaarts' (2008) recent study on the progress of fertility transition in developing countries concluded that as many as 12 sub-Saharan African countries had recently experienced a stall. As a result, the overall pace of fertility decline in Africa is thought to have considerably slowed down in the second part of the 1990s and early 2000s (Bongaarts, 2008).

[1] This paper was presented at the IUSSP Seminar on "Human Fertility in Africa. Trends in the Last Decade and Prospects for Change", Cape Coast, Ghana, 16-18 September 2008.

Few detailed studies of the reasons for these stalls have been published so far (Bongaarts, 2006; Garenne, 2007; Moultrie et al., 2008; Shapiro and Gebreselassie, 2007; Westoff and Cross, 2006). In these studies, several hypotheses have been discussed for explaining the slowing down or reversals of the fertility decline. Some authors have tried to link changes in proximate determinants of fertility and stalls in fertility (Bongaarts, 2006; Westoff and Cross, 2006). The relationships between trends in socio-economic determinants and stalling transitions were also examined in several studies (Bongaarts, 2006; Shapiro and Gebreselassie, 2007; Westoff and Cross, 2006). The impact of HIV/AIDS, notably through its effect on child mortality, has also been presented as a possible cause of fertility stalls (Moultrie et al., 2008; Westoff and Cross, 2006).

Overall, these studies have provided mixed results and, as stated by Moultrie et al. (2008, p.44), "no consensus exists about the causes of such stalls". In Kenya, Westoff and Cross (2006, p. ix) concluded for example that "although the analysis has identified the demographic dynamics of the stall in the fertility transition in Kenya, a full explanation is lacking". Bongaarts' early study (2006) showed no significant link between trends in socio-economic development and the presence of a stall. Our analysis of fertility stalls at the regional level (Schoumaker and Tabutin, 2008) also indicated that trends in two proximate determinants (age at marriage and contraceptive use) and three socio-economic and health variables (under-five mortality, female education, and economic development) failed to account for fertility stalls in the large majority of cases.

One possible 'explanation' for the stalls that has received very little attention so far, is that they are spurious and reflect data quality problems. Bongaarts (2006) commented on potential measurement errors in his study on stalling transitions, but did not discuss data quality in detail. Garenne (2007, p.7) also found that the case of Ghana was "not understandable with the available information on proximate determinants", which "could be due to spurious effects in the data". A few studies on child mortality have provided evidence of data quality problems in DHS birth histories, notably in Africa (Sullivan, 2008; Becker and Suliman, 2005; Johnson et al., 2005), and early studies from the DHS program identified common problems in DHS fertility data[2]. The quality of fertility data was also touched upon in some DHS reports, but no work has provided a detailed analysis of data quality issues in relation with the stalling transitions.

Our hypothesis is that an in-depth analysis of data quality in countries with stalling transitions is likely to reveal that several stalls are spurious. The idea that (some of the) fertility stalls may be spurious is

[2] Some detailed studies in the early 1990s were published by the DHS program (Institute for Resource Development, 1990), but few studies have been published recently.

important in several respects. First, the issue of stalling transitions is significant from a policy point of view. Stalls in fertility transition have been linked to the slowing down of investments in family planning programs in several settings. Westoff and Cross (2006) suggested that the Kenyan stall may partly result from shortages of contraceptive supplies; Ageyi-Mensah (2007, p.18), in searching for explanations for the stall in Ghana, mentioned that “there is a possibility that family planning programmes have been slowed down in favour of HIV/AIDS programmes”. Gillespie et al. (2007, p.104) also stated that “recent stalls in the fertility transitions of several sub-Saharan African countries show the need for intensification of family planning intervention efforts”. Very recently, Steven Sinding (2008)[3], during an online interview organized by the Population Reference Bureau, stated about fertility stalls in sub-saharan Africa “I don't think they are spurious and I think the cause is very clear: the redirecting of resources away from family planning and toward other (usually health-related) programs, most especially HIV/AIDS”. Strong evidence for stalls – or absence of stalls – is thus not policy neutral.

Evidence for stalls also has theoretical implications. For instance, the plateauing of the decline in fertility in some countries, despite economic progress, is at odds with the demographic transition theory. The apparent stalls may also be the consequence of the overestimation of the speed of past fertility declines. The fact that fertility declines in the early 1990s were more rapid than expected from changes in socioeconomic determinants could be interpreted as evidence for diffusion effects. The demonstration that some stalls are spurious – and that past fertility changes were overestimated – would then lead to different conclusions. Finally, from a methodological point of view, the demonstration that some stalls (based on published data) may be spurious could influence the way survey data are collected, used and published.

The data used in the study are presented in the first section of this paper. Using published data, we identify nine sub-Saharan African countries with stalled transitions. In the following section, we try to answer the following question: are the stalls real or spurious? Two complementary approaches are used. First, we compare observed fertility trends with expected fertility trends from proximate and socio-economic determinants. Secondly, we use birth histories to compare retrospective fertility trends obtained from consecutive surveys. These two approaches suggest that most stalls reflect data quality problems. In the last part of the paper, we further discuss data quality issues, and we show that birth displacements and omissions are major issues in most surveys. We also present adjusted estimates of fertility trends in a few countries.

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[3] Steven Sinding was until 2006 the director general of the International Planned Parenthood Federation.

2. Data

The analyses rely on data from the Demographic and Health Surveys conducted in Sub-Saharan Africa since the 1980s. We retain all the countries of Sub-Saharan Africa where at least two comparable surveys have been conducted since the 1990s, and for which data files are available[4]. Overall, 24 countries (71 surveys) are included in this study[5].

Both published data and individual data files are used. Published data are taken from the STATcompiler website and from DHS country reports (www.measuredhs.com). Since the identification of stalls is usually based on the comparison of published total fertiliy rates (TFRs) in consecutive surveys, published data are used to identify the countries where fertility appears to be stalling. Socio-economic and proximate determinants at the country level are also obtained from the STATcompiler website and from DHS reports. The TFRs we use (published on STATcompiler) are measured in the three years preceding the survey. TFRs published in country reports are also often computed for the three years preceding the survey, although a period of five years before the survey is also often used. Because the same time period was used across all surveys on the STATcompiler website, we decided to use these data. Three indicators of proximate determinants of fertility are used: (1) the percentage of married women using a modern method of contraception, (2) the median age at first marriage among women aged 25-29, and (3) the median duration of the postpartum insusceptible period. The three socio-economic and health indicators are: (1) the percentage of women aged 15-49 with secondary or higher education, (2) the level of under-five mortality, and (3) a development index computed as a linear combination of seven variables on housing and assets[6].

Individual data files are used to reconstruct fertility trends using birth histories, as well as to evaluate differences in sample compositions between consecutive surveys.

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[4] Eritrea was excluded from the analyses in which individual data files were needed, as they were not available from Macro International.

[5] A few countries and surveys were dropped for some analyses, because some indicators were not available in all the surveys.

[6] The seven variables are the percentage of households with piped water, flushed toilets, electricity, finished floor, radio, television and a fridge. The index was computed using principal components analysis, pooling the aggregated data of all the available surveys.

3. Fertility Stalls in Africa

We start by identifying countries in Sub-Saharan Africa that have experienced fertility stalls. Our approach is similar to the one used by Bongaarts (2008), although it differs in some respects.

3.1 Definition of stalls

The definitions of stalls have varied between authors (Moultrie et al., 2008). However, the general idea is that "a stall implies that an ongoing fertility transition is interrupted by a period of no significant change in fertility before the country reaches the end of the transition" (Bongaarts, 2008, p.109). Two steps are thus necessary to identify countries where fertility has been stalling.

First, a criterion must be used to consider that a fertility transition is underway. In this study, we consider that fertility transition has begun if the TFR is at least 10% lower than it was in a previous survey, or than the average number of children ever born (CEB) among women aged 40-49 in the first DHS[7].

Secondly, one needs to measure the interruption of the decline in fertility. In this study, countries where the decline has stopped are those where the TFR in one survey (measured over the last three years) is at least as high as the TFR in the previous survey. This is somewhat a conservative approach to the identification of stalls, because small fertility declines may not be statistically significant (Bongaarts, 2008). In such cases, countries with small but not significant fertility decrease would be considered as stalling. Given that it does not influence the overall conclusions of this paper, we opted for this simple and clear-cut approach.

Using this definition, 9 out of the 24 countries are identified as stalling (Table 1). Five of the 12 countries that were classified as stalling by Bongaarts (2008) are not considered as such by us (Cote d'Ivoire, Ethiopia, Uganda, Zambia and Zimbabwe). For some of these countries, this is due to the way the transition is defined (e.g. Uganda), and for others, to the way the interruption of fertility decline is measured (e.g. Ethiopia). In contrast, our classification includes two countries that were not in Bongaarts' list of stalling countries (Benin and Guinea). For Benin, this is due to the fact that the most recent survey was not included in Bongaarts' study. For Guinea, we consider that the fertility transition is underway (based on the parity at age

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[7] In contrast, Bongaarts (2008) considers a fertility transition is underway if the TFR has decreased by at least 10 percent compared to a previous survey, or if contraceptive prevalence among married women is over 10 percent. The use of contraceptive prevalence is justified when only two surveys are available on the ground that a 10 percent increase in contraceptive prevalence corresponds approximately to a 10 percent decrease in fertility.

40-49), while Bongaarts considered it as a pre-transitional country. Out of the remaining 15 countries, 11 are considered as countries where fertility has decreased in a regular way and no fertility decline in discernible in 4 countries (Table 1).

Table 1: Classification of countries according to the type of fertility decline

Stalling fertility (9 countries)			**Decreasing fertility (11 countries)**			**No change (4 countries)**		
Surveys	TFR	CEB	Surveys	TFR	CEB	Surveys	TFR	CEB
Benin			Burkina Faso			Chad		
1996 2001 2006	6.0 5.6 5.7	7.2	1992 1998 2003	6.5 6.4 5.9	7.5	1996 2004	6.4 6.3	6.6
Cameroon			Cote d'Ivoire			Mali		
1991 1998 2004	5.8 4.8 5.0	6.2	1994 1998 (2005)	5.3 5.2 4.6	6.7	1987 1995 2001 2006	7.1 6.7 6.8 6.6	7.1
Ghana			(Eritrea)			Niger		
1988 1993 1998 2003	6.4 5.2 4.4 4.4	6.9	1995 2002	6.1 4.8	6.2	1992 1998 2003	7.0 7.2 7.0	7.5
Guinea			Ethiopia			Uganda		
1999 2005	5.5 5.7	6.5	2000 2005	5.5 5.4	7.0	1988 1995 2000 2006	7.4 6.9 6.9 6.7	7.5
Kenya (a)			Madagascar					
1988 1993 1998 2003	6.7 5.4 4.7 4.9	7.5	1992 1997 2003	6.1 6.0 5.2	6.8			
Mozambique			Malawi					
1997 2003	5.2 5.5	5.8	1992 1997 2003	6.7 6.3 6.0	7.1			
Nigeria			Namibia					
1990 1999 2003	6.0 4.7 5.7	6.5	1992 2000	5.4 4.2	5.7			
Rwanda			Senegal					
1992 2000 2005	6.2 5.8 6.1	7.8	1986 1992 1997 2005	6.4 6.0 5.7 5.3	7.1			

Table 1 (continued): classification of countries according to the type of fertility decline

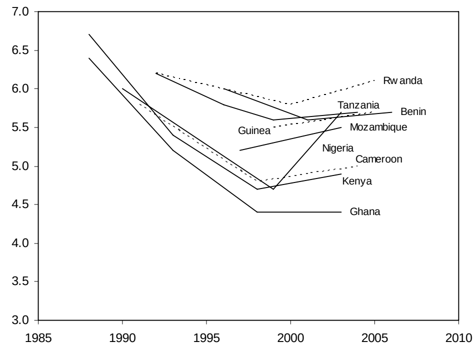
Stalling fertility (9 countries)			**Decreasing fertility (11 countries)**			**No change (4 countries)**
Tanzania			Togo			
1992	6.2	6.9	1988	6.4	7.1	
1996	5.8		1998	5.2		
1999	5.6					
2004	5.7					
(a) The North-eastern region was excluded from the 2003 Kenya DHS survey, because the region had not been included in earlier surveys.			Zambia			
			1992	6.5	7.7	
			1996	6.1		
			2001	5.9		
			Zimbabwe			
			1988	5.4	6.6	
			1994	4.3		
			1999	4.0		
			2005	3.8		

Source of data: DHS surveys. Indicators published on the STATcompiler website (www.measuredhs.com).
TFR : Total fertility rate among women aged 15-49
CEB: Children ever born among women aged 40-49.

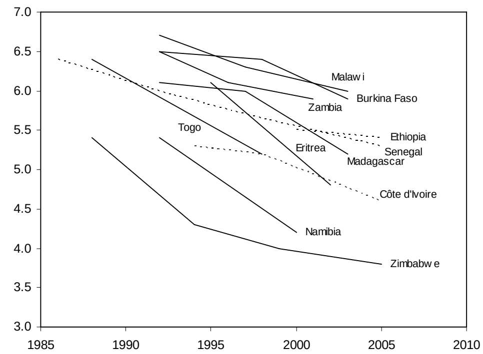
Figures 1a, 1b, and 1c show fertility trends in the 24 countries of Table 1. As shown on Figure 1a (stalling transitions), the TFR increased between the next to last and the last survey in eight countries, and remained constant in one country (Ghana). The increase of fertility is particularly striking in Nigeria, where it went up from 4.7 children in 1999 to 5.7 in 2003. Interestingly, Bongaarts discarded the 1999 Nigerian DHS data from his study, on the ground that the 1999 DHS report presented “persuasive evidence of substantial underreporting of events, resulting in the underestimation of levels of fertility” (Bongaarts, 2008, p.106). As we shall see later, although the Nigerian case is spectacular, this is not an isolated case. Figure 1b shows that fertility declined in a substantial number of countries, but at different paces. In a few of these countries, the decline also seems to have slowed down (Ethiopia, Zimbabwe). In others, it seems to have accelerated (Burkina Faso, Madagascar, Côte d’Ivoire). Finally the four countries on Figure 1c are pre-transitional countries. Fertility may have slightly declined in recent years, but it has changed very little and remains very high.

Figure 1: Fertility changes in 24 sub-Saharan African countries, by type of fertility decline

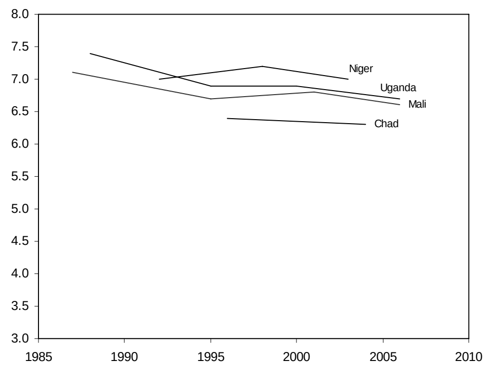
(a) Stalling fertility
(9 countries)



(b) Decreasing fertility
(11 countries)



(c) No change
(4 countries)



Source of data: DHS surveys. Indicators published on the STATcompiler website (www.measuredhs.com).

4. Are the stalls real or spurious?

As seen in the previous section, fertility appears to be stalling in approximately one third of sub-Saharan African countries. If real, this large number of countries with stalling fertility is an important finding, as this has not been observed in other regions to such a large extent. However, before searching for explanation for these stalls, a preliminary step is to check whether the stalls are real or spurious.

In this section, we use two approaches to evaluate the quality of data and the genuineness of the stalls. First, we compare fertility trends and trends in proximate and socio-economic determinants of fertility. The objective is to verify if the fertility trends measured from consecutive surveys are expected from the trends in the determinants of fertility. Large discrepancies between observed and expected fertility trends would suggest that data quality issues might be responsible for some of the stalls. In contrast, consistency between observed trends and trends expected from trends of fertility determinants would provide evidence for the stalls[8].

The second approach relies on comparing fertility trends based on the published values of TFRs (used to identify stalling transitions) with retrospective estimates of TFR computed from birth histories over the 15 years before the survey. For a specific time period, retrospective fertility estimates should be approximately equal to fertility estimates from a previous survey. In contrast, large discrepancies across surveys indicate probable data quality problems.

4.1 Comparison of observed and predicted fertility trends

The first approach consists in comparing the observed fertility trends (based on the values of TFRs published in country reports) with trends in proximate and socio-economic determinants. Regression models of fertility are used to predict levels and trends of fertility based on the values of socio-economic and proximate determinants of fertility. All the countries with at least two comparable surveys are included in the regression models[9]. The longitudinal regression models we estimate are of the following form:

$$TFR_{it} = \beta_0 + \sum_{k=1}^{K} \beta_k . X_{ki0} + \sum_{k=1}^{K} \gamma_k . Z_{kit} + e_{it} \qquad \text{(Eq. 1)}$$

Where X_{ki0} is the value of the explanatory variable X_k for the country *i* measured at time 0, that is at the first available survey for that

[8] However, as we shall see, data quality issues may also affect determinants of fertility.

[9] The surveys conducted up to 1990 were not included in the analyses because the development index could not be computed from the available data.

country. $Z_{kit}=X_{kit}-X_{ki0}$ measures the change in X_k for the country *i* between the value at time t and the value at time 0.

This type of model produces two series of regression coefficients (Diggle et al., 1994). Coefficients β_1 to β_k measure the cross-sectional effects ("between effects") of explanatory variables, i.e. the effects of explanatory variables on differences of TFR across countries. Coefficients γ_1 to γ_k measure the longitudinal effects ("within effects") of explanatory variables, i.e. the effects of changes in explanatory variables on changes of TFR within countries. From a causal point of view, the within effects are preferred to the between effects, as they are less likely to be affected by omitted variables biases. The causal interpretation will not be developed here, as their main objective is to predict expected levels of fertility.

Three models are fitted. The first model includes three proximate determinants of fertility: (1) the prevalence of modern contraception among women in union, (2) the median age at first marriage among women aged 20-29, and (3) the median length of insusceptible period. The second model includes three socio-economic determinants of fertility: (1) the percentage of women aged 15-49 with secondary or tertiary education, (2) the level of under-five mortality in the five years preceding the survey, and (3) the index of economic development. The third model considers proximate and socioeconomic determinants together.

The first model shows that, as expected, contraceptive prevalence and age at first marriage negatively and significantly influence fertility[10]. In the second model (socioeconomic and health determinants), the cross-sectional (between) effects are all highly significant and of the expected sign, and the R^2 is overall quite high. Longitudinal effects, while they are of the expected sign, are not significant. In other words, changes in socioeconomic determinants within countries are not related to changes in fertility in a statistically significant way. This may be due to the fact that the magnitude of changes is relatively small, and to data quality issues. The third is a model including socioeconomic and proximate determinants. Most variables are of the expected sign, and four of them are significant (all measure cross sectional effects). The adjusted R^2, equal to 0.72, indicates an overall good fit of the model. This third model is used to predict total fertility rates and to compute residuals, i.e. the differences between the observed and predicted TFR for each survey.

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[10] Note that between and within effects are quite different. Because these models are used to predict expected TFRs from the values of the proximate and socioeconomic determinants, we will not interpret their coefficients in details.

Table 2: Regression models of TFR on proximate and socio-economic determinants in 24 sub-Saharan African countries.

Variables	Proximate determinants only	Socioeconomic determinants only	Proximate and Socioeconomic determinants
Proximate determinants			
Contraception (between)	-0.70***	-	-0.27*
Contraception (within)	-0.45*	-	-0.19 (ns)
Marriage (b)	-0.22*	-	0.08 (ns)
Marriage (w)	-0.94***	-	-0.18 (ns)
Insusceptibility (b)	-0.30***	-	-0.31***
Insusceptibility (w)	0.16 (ns)	-	-0.09 (ns)
Socioeconomic and health determinants			
Education (b)	-	-0.23**	-0.37***
Education (w)	-	-0.42 (ns)	-0.08 (ns)
Development (b)	-	-0.10**	-0.05 (ns)
Development (w)	-	-0.18 (ns)	-0.17 (ns)
Mortality (b)	-	0.43***	0.41***
Mortality (w)	-	0.16 (ns)	0.17 (ns)
Adjusted R^2	0.50	0.68	0.72
Number of observations	59	60	59

Significance levels : *:p<0.10; **:p<0.05; ***:p<0.01; ns: not significant

Togo and Malawi were not included in the datasets, because the development index could not be computed for a minimum of two surveys.

Surveys conducted before 1990 were not included in the models because the development index could not be computed with the available data.

No data on proximate determinants were available in the 2006 Côte d'Ivoire Survey. As a result, the total number of cases is 59 when proximate determinants are included in the models (and 60 when no proximate determinants are in the models).

Note: the original variables were standardized before creating variables of changes (w). As a result, the magnitudes of the coefficients are comparable across all variables.

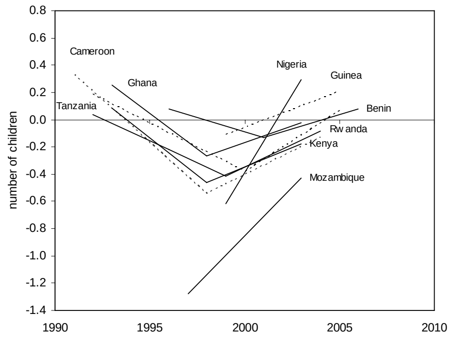
Source of data: DHS surveys. Indicators published on the STATcompiler website (www.measuredhs.com).

Residuals are presented separately for the three groups of countries on Figures 2a, 2b and 2c[11]. The residuals for countries with decreasing fertility (Figure 2b) and without fertility change (Figure 2c) show no specific pattern. In some countries, fertility seems much higher than expected (e.g. Uganda), or fertility declines seem much faster than expected (e.g. Eritrea), but there is no consistent pattern across countries. In contrast, Figure 2a shows a very clear pattern of residuals for countries with stalling transitions. In the seven countries where three surveys could be used, residuals clearly

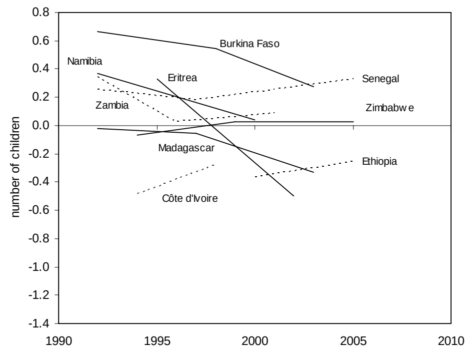
[11] Residuals for the first two models lead to essentially the same conclusions.

Figure 2: Differences between observed (published) fertility and predicted fertility using a regression model (including proximate and socio-economic determinants) in 24 sub-Saharan African countries, by type of fertility decline

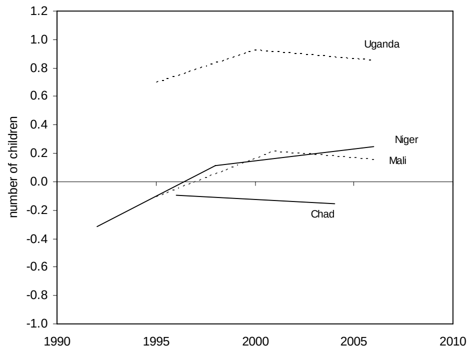
(a) Stalling fertility
(9 countries)



(b) Decreasing fertility
(11 countries)



(c) No change
(4 countries)



Source of data: DHS surveys. Computation by the author using indicators published on the STATcompiler website (www.measuredhs.com).

show a V-shaped pattern. This pattern suggests that fertility is lower than expected at the second survey: the decrease between the first and the second survey, and the upward trend between the second and the third survey are not accounted for by changes in socioeconomic and proximate determinants. The data for Mozambique and Nigeria – where only two surveys could be used - lead to a similar conclusion: fertility seems to be underestimated in the surveys conducted at the end of the 1990s compared to the more recent surveys. In sum, the patterns of residuals suggest that the stalls and reversal of fertility reflect an underestimation of fertility at the end of the 1990s. This also indicates that fertility declines in the 1990s may have been overestimated.

Admittedly, the regression model is simple and does not capture possible non linear effects, or lags – and does not include all the possibly relevant fertility determinants (e.g. abortion). Another limitation of the model is that it is estimated to check the validity of fertility data, but is estimated using the very same data. However, its merit is to provide realistic expected values (benchmarks) of TFRs, with which observed TFRs can be compared. The very clear pattern that emerges for countries with stalling transition illustrates the usefulness of this tool, and suggests that fertility stalls are at least partly spurious. However, a more detailed analysis is needed to evaluate the genuineness of these stalls.

4.2 Comparison of retrospective fertility trends from consecutive surveys

The second approach we use relies on the computation of retrospective total fertility rates. Using birth histories, it is possible to reconstruct trends in TFR from one survey. Retrospective trends obtained from consecutive surveys in a country can then be compared. In the absence of data quality problems, these trends should match. In contrast, discrepancies between retrospective trends computed from consecutive surveys point to data quality problems

First, we computed TFRs for three-year periods, over the fifteen years preceding the survey. As a result, five retrospective estimates of TFRs are available for each survey. A three-year period was used so that the TFRs are comparable with those published on the STATcompiler website. Retrospective TFRs were computed over a fifteen-year period so that the overlap across surveys is large enough to detect differences across surveys. The TFRs are estimated using Poisson regression with a person period dataset, in which dummy variables for age groups and time periods are included as explanatory variables. The method is presented briefly in Appendix (and in detail in Schoumaker, 2004). The basic assumption of this method is that the shape of the age pattern of fertility is constant over time. Although the assumption does not strictly hold, simulations indicate that it gives reliable estimates of TFRs over 15 years (Schoumaker, 2006). Figure 3(a) to Figure 3(i) show, for the nine countries with stalling fertility transitions, the retrospective TFRs obtained from consecutive surveys. Three or four surveys are available in seven of these countries, and in two countries (Guinea and Mozambique) only two surveys are available.

Figure 3: Comparisons across surveys of retrospective fertility trends (TFR) in nine sub-Saharan African countries with stalling fertility

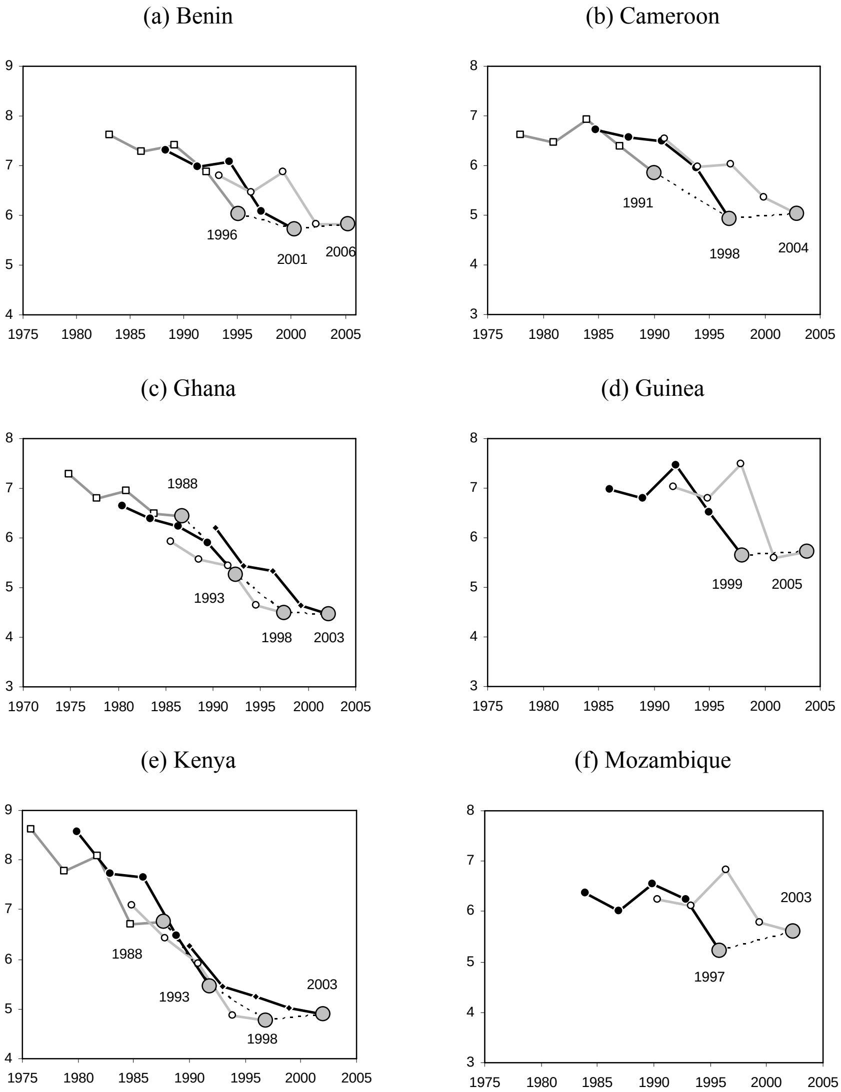
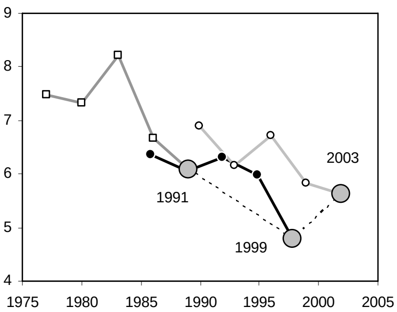
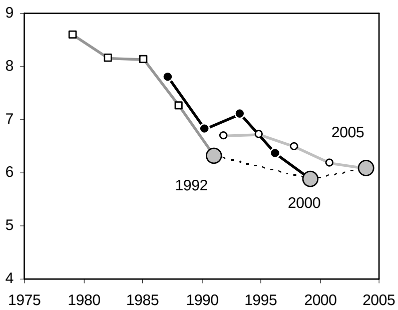


Figure 3 (continued): Comparisons across surveys of retrospective fertility trends (TFR) in nine sub-Saharan African countries with stalling fertility

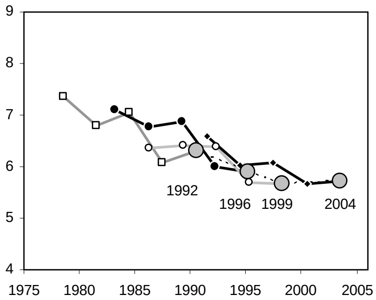
(g) Nigeria



(h) Rwanda



(i) Tanzania



Note: large grey dots represent TFRs published on the STATcompiler website (three-year period before the survey). The dotted lines represent fertility trends inferred from the comparison of published TFRs. The other points are TFRs computed on three-year periods.

Source of data: DHS surveys. Computation by the author using individual data files.

We start by discussing the Nigerian case, as it is almost a textbook case (Figure 3(g). For the three-year period just prior to the 1999 survey, the TFR was estimated at 4.7 children. The comparison of the 1999 survey and the 1990 survey indicates a steep fertility decline between the late 1980s and the late 1990s, from about 6 children to 4.7 children. In the 2003 survey, the total fertility rate for the three years prior to the survey was estimated at 5.7 children, suggesting a major reversal in the fertility trend. However, retrospective fertility trends tell another story. In the 1999 survey, fertility dropped implausibly from 6 children to 4.7 children in three years time, indicating probable omissions of births in the three years before the 1999 survey. The comparison of the estimates from the 1999 survey and the 2003 survey for the same three-year period is even more convincing. The 2003 survey suggest that the TFR was close to 6 children per woman in the three years before the 1999 survey, more than 1 child higher that the estimates from the 1999 survey. If the TFR for the three years before the 1999 survey is discarded, the conclusion is that fertility decreased only very little between the late 1980s and the early 2000s. Interestingly, the 1999 Nigerian data had already been shown to be of dubious quality, and, as a result, was not retained in Bongaarts' (2008) study on fertility progresses and stagnation. The 1999 DHS report (National Population Commission - Nigeria, 2000, p.36) indicated that "there was probably some omission of births in the three-year period immediately prior to the survey" (p.36), and that "this shortfall results in an underestimate of current fertility of about 16-17 percent" (p.207). As we shall see later, the 1999 survey was not only affected by massive omission of births, but also differences in sample compositions compared to the 1990 and 2003 surveys, which is another source of bias in fertility trends.

Figure 3(a) to Figure 3(i) clearly show that Nigeria is not an isolated case. In Benin, Cameroon, Guinea, Mozambique and Rwanda, the comparison of fertility trends from consecutive surveys point to similar problems as the one observed in Nigeria: the TFR computed over the three-year period before the next-to-last survey is much lower (often between 1 and 2 children) than the TFR for the corresponding period obtained from the following survey. The case of Cameroon is also interesting. The recent level of fertility seems to be underestimated in all the surveys (1991, 1998, 2004), probably because of omissions of births. However, the underestimation seems more severe in the 1998 survey than in the 2004 survey, leading to an apparent stall in the fertility transition. Retrospective fertility trends clearly do not provide evidence of stalling transitions.

The cases of Kenya, Ghana and Tanzania point less clearly to omissions of births in the years preceding the surveys, but they also show discrepancies of TFR estimates from consecutive surveys. In Ghana, the TFR for the three-year period before the survey was estimated at 4.4 in both the 1998 and 2003 surveys, leading several researchers to conclude that there was a stall in the fertility transition in Ghana[12]. However, retrospective fertility estimates obtained from the 2003 survey are higher than estimates from the 1998 survey for all the time periods. The Kenyan and Tanzanian cases point to similar problems.

Before examining the causes of the discrepancies across surveys, it is worth mentioning that similar problems are encountered in a large number of other countries as well. Retrospective estimates of fertility for the other 15 countries are shown on Figure annex 1(a) to 1(m). In the 10 countries with decreasing fertility, at least four show relatively large discrepancies across surveys (Burkina Faso, Ethiopia, Zambia, and Senegal). Large discrepancies

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[12] The DHS report mentions that "the fertility trend […] should be interpreted with caution" (p.57), but also that "the demographic transition experienced in Ghana in the 1980s and 1990s seems to have slowed in the last three years even though contraceptive use has continued to rise. Further investigation, outside the scope of this report, is necessary to examine the underlying causes for this unexpected trend."

across surveys are also recorded in the four countries with stable fertility. The cases of Burkina Faso, Niger and Mali are typical of countries with severe omissions and displacements of births backward in time, leading to underestimates of fertility just before the survey. Cases such as Zambia and Ethiopia may be affected by differences in sample implementation: fertility estimates from the most recent survey are higher than estimates from the previous survey for the whole length of the comparison period.

* * *

In summary, the comparisons of retrospective fertility estimates from consecutive surveys show serious disagreements in fertility trends in approximately three quarters of the 23 countries examined. In seven of the nine countries with apparent stalling, retrospective trends suggest serious data quality problems. The cases of Kenya and Tanzania seem less severely affected, although data quality issues cannot be ruled out either. The comparison of observed fertility trends and expected fertility trends based on proximate and socioeconomic determinants also questions the genuineness of the stalls. In all the countries with apparent stalling fertility, the residuals (differences between observed and predicted fertility) suggest that fertility was underestimated in the next to last survey, and that the recent interruptions in fertility decline or the recent fertility increases are at least partly spurious. We next turn to data quality issues that may help understand the stalls.

5. Explaining discrepancies

In the previous section, we have shown data that quality problems are likely to be the cause of the apparent stalls in fertility transitions in most countries. In this section, we try to gain an in-depth understanding of the data quality problems and their impact on fertility levels and trends. We distinguish two broad types of data quality issues.

We call the first one the “sample implementation issue”. In this category, we consider the differences in the composition of samples across surveys that may affect fertility levels. For example, if educated women are underrepresented in a survey, the level of fertility estimated from that survey is likely to be overestimated. Fertility trends from consecutive surveys may be biased if the extent of over or under-representation varies across surveys.

The second type of data quality issue is the underreporting of births during some specific time period. This may be due to the omission of births altogether, or to the displacement of births backward in time. A major reason for this type of data quality problem in DHS is the fact that the health section of the questionnaires applies to recent births (usually approximately the 5-year period before the survey), and that interviewers may be tempted to omit recording some of the births, or displace them backward in time, to reduce their workload (Institute for Resource Development, 1990; Becker and Suliman, 2005).

5.1 Differences in sample implementation

We start discussing the issue of sample implementation with the case of Ghana. Table 3 shows the TFR and the proximate and socioeconomic determinants of fertility in 1993, 1998 and 2003. As previously said, fertility apparently stalled at 4.4 children between 1998 and 2003. Overall, the trends in socioeconomic and proximate determinants failed to account for the stall, as shown by the predicted levels of fertility which continued to decline (second row of Table 3). Looking more closely at the data, it is clear that contraceptive use and age at first marriage continued to increase, and that a continuation of the fertility decline was expected from the trends in the proximate determinants[13]. The development index also increased significantly, suggesting that there was no slowdown in economic development. However, two indicators show signs of stalling. Between the 1998 and 2003 survey, the percentage of women with secondary education slightly decreased, and the level of under-five mortality slightly increased.

Table 3: Levels of fertility, proximate determinants and socio-economic determinants in the 1993, 1998 and 2003 DHS surveys in Ghana

Variables	**DHS survey**		
	1993	1998	2003
Observed TFR (children)	5.2	4.4	4.4
Predicted TFR (children)	4.9	4.7	4.4
Difference between observed and predicted TFR (children)	0.3	-0.3	0.0
Contraceptive use among married women (%)	10.1	13.3	18.7
Median age at first marriage (years)	18.9	19.6	20.0
Median duration of insusceptible period (months)	16.2	14.0	13.8
Percentage of women with secondary or higher education (%)	47.1	52.8	51.8
Development index	0.96	2.31	3.52
Under five mortality (‰)	119.4	107.6	111.2

Note – percentage of educated women was corrected in the 1993 Ghana survey to make it comparable across surveys.

Source of data: DHS surveys. Indicators published on the STATcompiler website (www.measuredhs.com).

[13] Data on abortion is not available. A decrease in the rate of abortion might partly account for the stall, but little evidence is available to support this hypothesis.

Are the stalls in education and child mortality responsible for the stall in fertility? This is unlikely given the upward trend in contraceptive use and the increase in age at marriage, but the question is worth examining. Our view is that the stalls in education and child mortality, which might at first glance partly explain the stalls, themselves partly result from data quality problems. Data quality problems for under-five mortality were identified by Johnson et al. (2005), who showed that the increase in child mortality between 1998 and 2003 was partly due to an underestimation of child mortality in 1998 (due to omissions and displacements of births). According to these authors, under-five mortality did not increase, and rather decreased very slowly. Another issue that has not been discussed is the possibility that some categories of people were not adequately covered in one survey or another. We check that for two characteristics: education and marital status of women.

The DHS surveys give the possibility to estimate retrospectively the composition of the sample for some socio-demographic characteristics in a specific age group. For example, it is possible to estimate retrospectively the proportion of women aged 15-34 with a specific level of education (i.e. secondary or higher education) and marital status (ever married vs. never married) over a fifteen-year period[14]. Like for fertility, the retrospective estimates of the percentage of women aged 15-34 with the specific characteristics (education, marital status) should match across surveys for the same periods. Figure 4 (a1) to Figure 4(i2) show, for the fifteen years preceding each survey, the percentage of women 15-34 with secondary or higher education and who have ever been married.

The Ghanaian data show interesting features. Table 3 suggested a stall in the percentage of women with secondary or higher education between the 1998 and 2003 surveys. Figure 4(c1) tells a different story. While the percentages of educated women match quite well in the 1993 and 1998 surveys, the percentage of educated women is clearly much lower in the 2003 survey than in the previous surveys. For example, for the year 1998, the percentage of women aged 15-34 with secondary education is 52% according to the 1998 survey, while it is estimated retrospectively at 45% with the 2003 survey. Clearly, educated women seem to be underrepresented in the 2003 survey,

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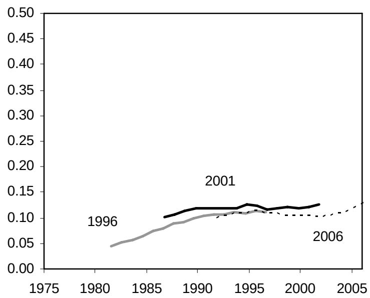
14 The method is simple: at the time of the survey, the percentage of women aged 15-34 with secondary or higher education is computed directly. One year before the survey, the percentage of women aged 15-34 with secondary or higher education is equal to the percentage of educated women aged 16-35 at the time of the survey, who were thus aged 15-34 one year before the survey. This operation can be repeated for fifteen years before the survey. Fifteen years before the survey, the percentage is estimated among women aged 30-49 at the time of the survey. The percentages could be estimated over a longer time period if the age range was restricted; alternatively, a shorter time period should be taken if a larger age range was used. We selected the 15-34 age range as a large part of fertility is achieved by age 35, and this allows reliable comparisons across surveys.

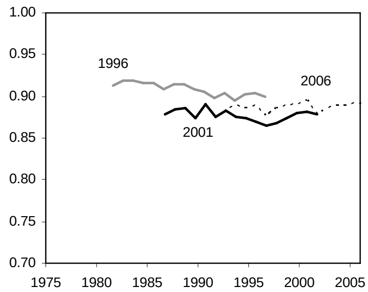
which could partly account for the apparent stall in fertility transition. In addition, this result indicates that the “stall” in education can not be the cause of the stalling fertility transition, as it is itself spurious. The comparison of retrospective data on marital status also shows significant discrepancies across surveys (Figure 4c1). In this case, the 1998 and 2003 surveys seem to match relatively well, as do the 1988 and 1993 surveys. However, the percentage of ever-married women is much lower in the 1998 and 2003 survey than it was in the previous surveys, indicating differences in sample composition.

Figure 4: Comparisons across surveys of retrospective trends in the percentage of women aged 15-34 with secondary education and in the percentage of women who have ever been married, in nine countries with stalling fertility.

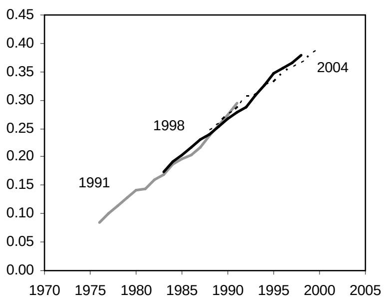
(a1) Benin – education



(a2) Benin – marital status



(b1) Cameroon - education



(b2) Cameroon – marital status

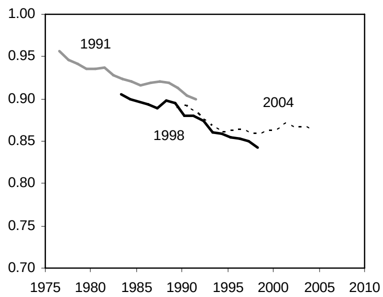
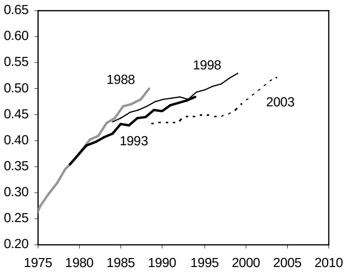
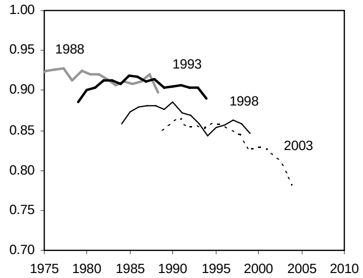


Figure 4 (continued): Comparisons across surveys of retrospective trends in the percentage of women aged 15-34 with secondary education and in the percentage of women who have ever been married, in nine countries with stalling fertility.

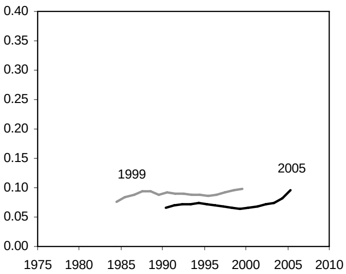
(c1) Ghana - education



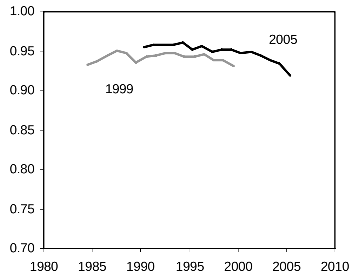
(c2) Ghana - marital status



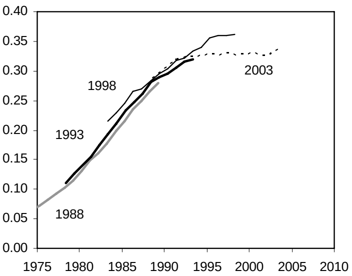
(d1) Guinea – education



(d2) Guinea – marital status



(e1) Kenya – education



(e2) Kenya – marital Status

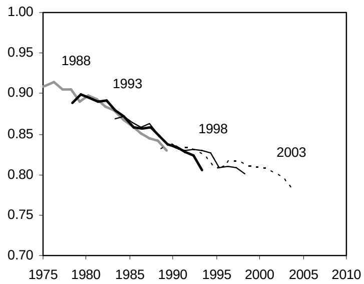
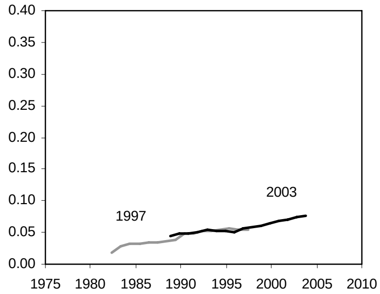
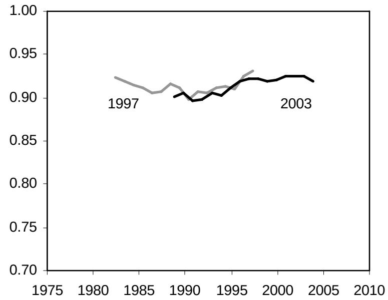


Figure 4 (continued): Comparisons across surveys of retrospective trends in the percentage of women aged 15-34 with secondary education and in the percentage of women who have ever been married, in nine countries with stalling fertility.

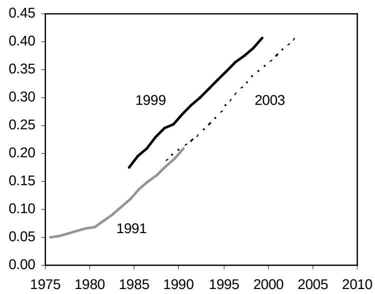
(f1) Mozambique – education



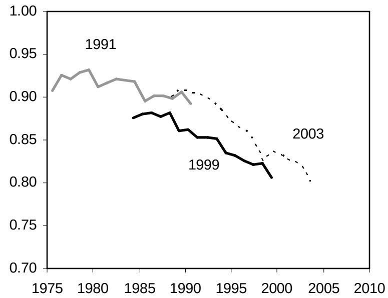
(f2) Mozambique – marital status



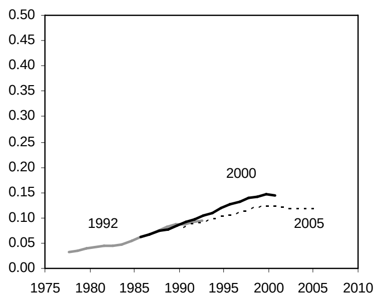
(g1) Nigeria – education



(g2) Nigeria – marital status



(h1) Rwanda – education



(h1) Rwanda – marital status

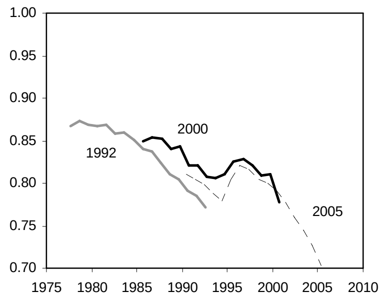
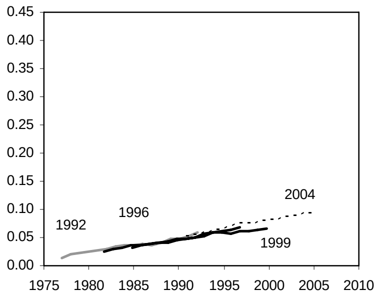
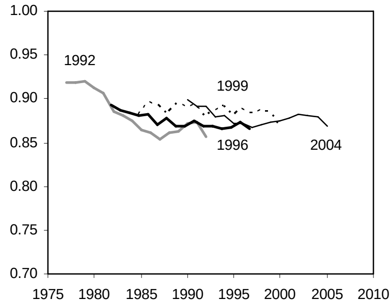


Figure 4 (continued): Comparisons across surveys of retrospective trends in the percentage of women aged 15-34 with secondary education and in the percentage of women who have ever been married, in nine countries with stalling fertility.

(i1) Tanzania – education



(i2) Tanzania – marital status



Source of data: DHS surveys. Computation by the author using individual data files.

Results in the other countries with stalling fertility show that, apart from Mozambique, all the countries seem affected to some extent by differences in sample compositions. Nigeria once again is almost a textbook case (Figure 4g1 and Figure 4g2). The percentage of women with secondary or higher education matches almost perfectly in the 1990 and 2003 surveys. In contrast, the percentage of educated women was much higher in the 1999 survey. The same pattern is found for the percentage of ever married women, much lower in the 1999 survey than in the 1990 and 2003 surveys. This overrepresentation of unmarried and educated women in the 1999 survey may have contributed to the underestimation of fertility in 1999. Interestingly, this difference in sample composition between surveys had gone unnoticed in the DHS report. In Kenya, percentages of ever married women match very well across surveys. The percentages of educated women also match well in the 1988, 1993 and 1998 surveys. However, female education seems to plateau in the 2003 survey from 1992, while no such trend was recorded in the previous survey. This suggests that the underestimation of education in Kenya's 2003 survey may be responsible for the stall in fertility decline. It is worth noting that patterns of differences in sample compositions across surveys are consistent with spurious stalling. In virtually all the countries, fertility in the next-to-last survey is likely to be underestimated compared to the last survey, because of differences in sample composition[15].

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[15] Let us emphasize that countries with decreasing and stable fertility are affected by similar problems. For the sake of parsimony, results are not presented here.

What is the impact of the differences in sample compositions on fertility levels? To estimate this impact, we computed post-stratification weights. The method relies on reweighting cases in one survey so that the distribution of the samples by education and marital status are equal in the consecutive surveys for the same date. More precisely, the distribution of the sample by education and marital status is computed at the time of the survey for the next-to-last survey among women aged 15-34 (i.e. in 1999 in the 1999 survey). The same distribution, at the same date, is computed using the data of the following survey (i.e., in 1999 in the 2003 survey). If, for example, uneducated married women represent 52% at the time of the first survey, and represent 60% at the second survey, the post-stratification weight for uneducated married women at the first survey will be equal to 60/52. The same approach method is applied for the four combinations of these two variables. These weights are then multiplied by the sampling weights, and used in the analyses.

Table 4: Comparisons of fertility levels without post-stratification weights and with post-stratification weights in the next-to-last surveys in nine countries with stalling fertility transition

	Without post-stratification weights	With post-stratification weights	Difference
Benin 2001	5.59	5.61	0.02
Cameroon 1998	4.81	4.87	0.06
Ghana 1998	4.43	4.47	0.04
Guinea 1999	5.51	5.65	0.14
Kenya 1998	4.70	4.77	0.07
Mozambique 1997	5.15	5.10	-0.05
Nigeria 1999	4.72	4.86	0.14
Rwanda 2000	5.83	5.89	0.06
Tanzania 1999	5.55	5.57	0.02

Source of data: DHS surveys. Computation by the author using individual data files.

For all the next to last surveys, in which fertility is thought to be underestimated, TFRs were computed with post-stratification weights and without post-stratification weights (Table 4). Comparisons of TFRs show that the differences in sample compositions (for the two variables taken into account) have only a minor impact on fertility differences, ranging from 0.02 children in Benin to 0.14 children in Guinea and Nigeria. Even in Nigeria, where differences in sampling compositions are very large, the TFR for the three years preceding the 1999 survey is only 0.14 children higher if the composition of the sample in terms of education and marital status in the 1999 survey is adjusted to match the composition in the 2003 survey.

In summary, although the differences in sample compositions across surveys may be quite large, their impacts on fertility levels are small[16]. Nevertheless, an important consequence of the differences in sample compositions across surveys is that some of the socio-economic determinants of fertility are biased. For example, education in Ghana is significantly underestimated in the 2003 survey in Ghana compared to the 1998 survey. As a result, the apparent stall in education in Ghana that may be used in macro-level studies to explain the stall in fertility is itself spurious because of differences in sample implementation.

5.2 Omissions and displacements of births

Omissions of recent births and displacements of births backward in time are the other data quality problems that may help understand the stalls. This type of problems has been long known in DHS surveys (Institute for Resource Development, 1990). The displacement of births is notably linked to the fact that some interviewers change the birth dates of some children to avoid having to administer the lengthy health module in the DHS[17]. Displacements of births lead to underestimating recent fertility, and to overestimate past levels of fertility. The omission of recent births is another possible consequence of the desire to avoid the health module[18]. The impact of omissions of recent births is to underestimate levels of fertility a few years before the survey. The detection of omissions and displacements is not easy – and the distinction between the omissions and displacement of births is not clear-cut either.

To evaluate the extent of omissions and displacements of births in the next to last surveys in each country, we computed retrospective estimates of total fertility rates by calendar years for the last two surveys (Figure 5). Vertical lines are drawn to indicate the cut-off dates for the health module in the surveys. A sharp fertility decrease after the cut-off date is a sign of omissions and displacements of births. In addition, an increase in fertility one or two years before the cut-off date is a sign of displacements of births before the cut-off date. The comparison of the level of fertility between surveys for the same periods, as in section 4, also provides evidence for omission and displacements.

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[16] Only two variables could be taken into account. Differences in sample compositions across other variables might also contribute to differences in fertility levels across surveys.

[17] The cut-off date for the health module is often January five years before the survey.

[18] Other factors may also explain omissions, e.g. if respondents are not willing to mention deceased children.

Figure 5: Comparisons across surveys of retrospective fertility trends (by single years) in nine sub-Saharan African countries with stalling fertility

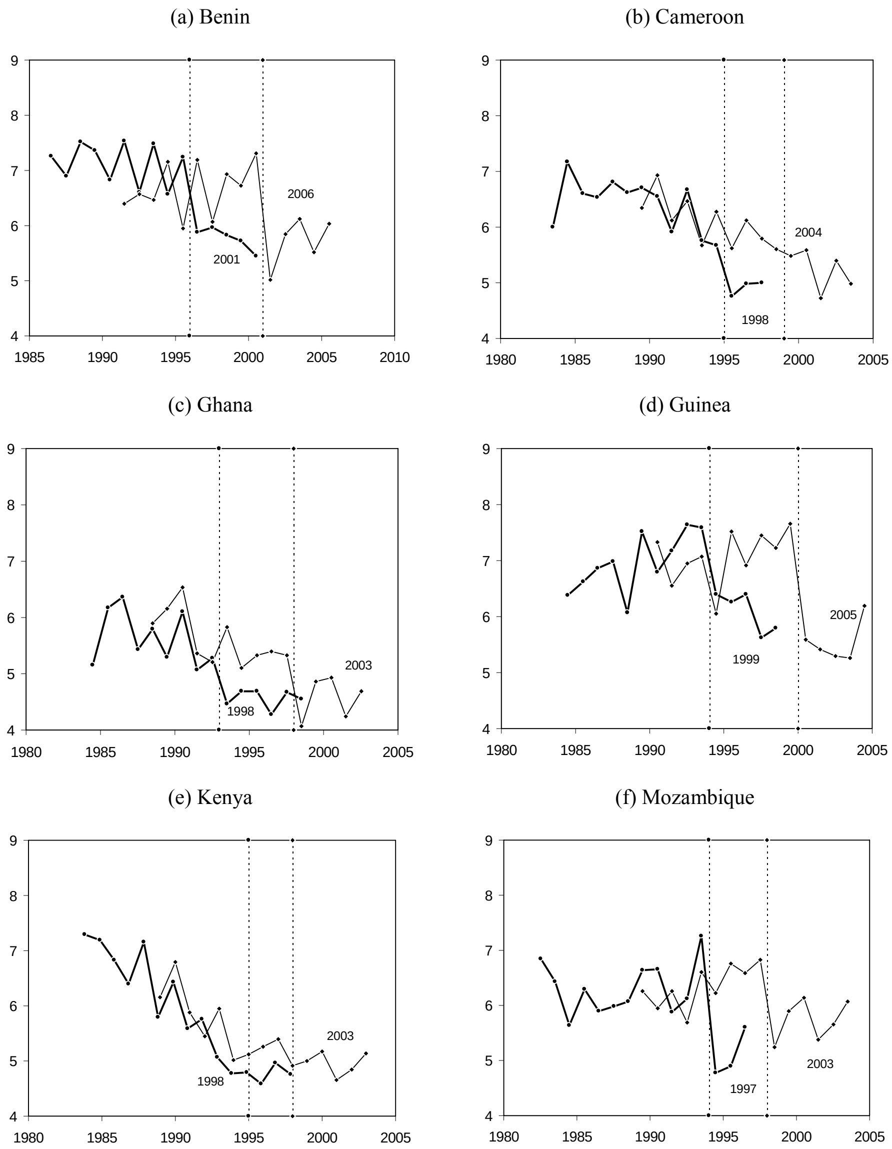
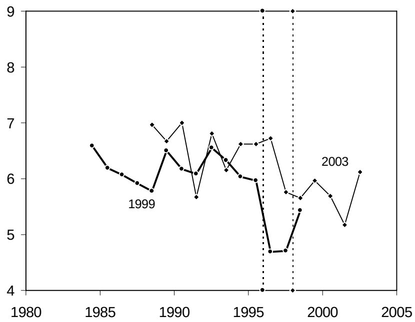
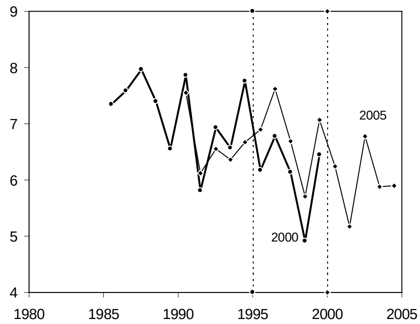


Figure 5 (continued): Comparisons across surveys of retrospective fertility trends (by single years) in nine sub-Saharan African countries with stalling fertility

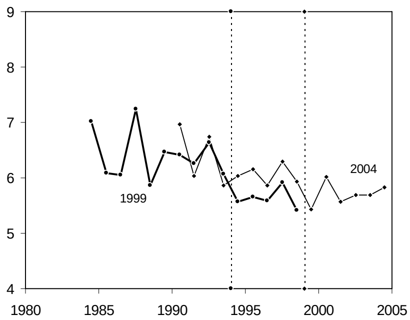
(g) Nigeria



(h) Rwanda



(i) Tanzania



Source of data: DHS surveys. Computation by the author using individual data files.

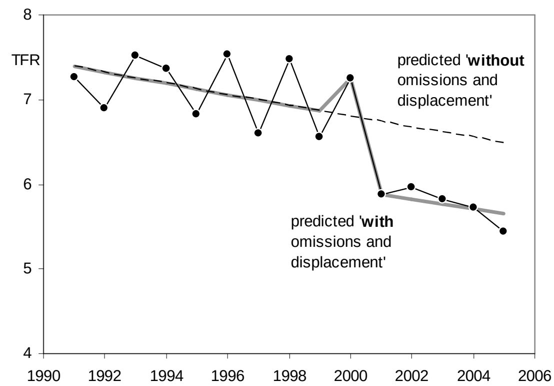
In most surveys, fertility declines steeply after the cut-off date of the health module, indicating serious omissions and/or birth displacements. Mozambique is a clear example (Figure 5f). In the 1997 survey, the TFR was estimated at 6.2 children per woman in 1993 and at 4.7 in 1994. The cut-off date for the health module was January 1994. The same type of problem is found in the 2003 survey: The TFR was estimated at 7.1 children per woman in 1997, and at 5.5 in 1998 (the cut-off date for the health module was January 1998). Apart from Kenya, where the effect of the health module is not obvious, the health module seems to lead to serious underestimation of fertility in most surveys. Analyses by level of education indicate that omissions are systematically more pronounced among the less educated (results not shown).

We next try to quantify the omission and displacement of births by modelling fertility trends. The approach we use, a kind of interrupted regression analysis, allows estimating the extent of underestimation of fertility. For each survey, a Poisson regression model is estimated using 4 explanatory variables:

- A variable measuring a linear trend in the logarithm of fertility rates;
- A dummy variable measuring whether the year was before or after the cut-off date (the variable takes the value 0 for all the years before the cut-off date and 1 for the years from the cut-off date). This measures omissions of births
- A dummy variable indicating the year of the start of the health module. This variable measures the decrease of fertility that may be due to displacement of births in the cut-off year.
- A dummy variable indicating the year just before the cut-off date. This variable measures the increase in fertility just before the cut-off that may be due to displacement of births.

Predicted fertility is computed for each year from the regression coefficients, and can be compared with annual values of TFRs (Figure 6). The model also allows estimating 'true' fertility levels after the cut-off date, e.g. the level of fertility that would have been observed if there were no omissions and displacements of births. This is done by using the regression coefficient of the linear trend only to estimate fertility over the whole period. In other words, the effects of the health module (measured by the three dummy variables) are removed. Figure 6 shows the fertility trends obtained using this method for the 2001 survey in Benin. The impact of omissions and displacements is estimated to be around 0.84 children.

Figure 6: Comparison of fertility trends in Benin (2001 DHS survey) estimated with and without omission and displacements of births.



Source of data: DHS surveys. Computation by the author using individual data files.

The same method was used for the last two surveys in the nine countries with stalling fertility transitions. In all the surveys but three (the two Kenyan surveys and the 2005 Rwandan survey are the exceptions), fertility after the cut-off date is lower than expected from the linear trend, indicating omissions and/or displacement of births. The degree of omissions/displacements varies widely across countries and across surveys. Figure 7(a) to Figure 7(i) show the linear fertility trend estimated if there were no omissions and displacements of births. In some countries, the degree of omissions is very large (Mozambique, Nigeria, Guinea) at both surveys. In others, the degree of omissions varies largely from one survey to the other. For example, omissions are significant in the 1998 Ghana survey, but much lower in the 2003 survey. Finally, in Kenya, the method indicates no significant omissions of births.

Figure 7: Comparisons across surveys of retrospective fertility trends (by single years) in nine sub-Saharan African countries with stalling fertility, and trends correcting for omissions and displacements.

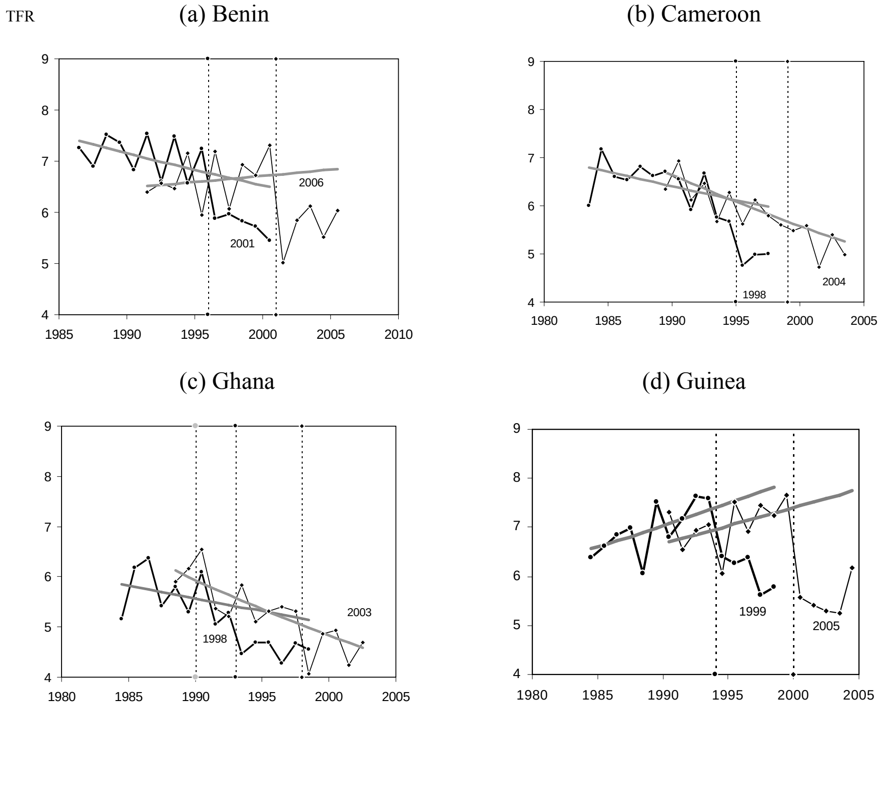
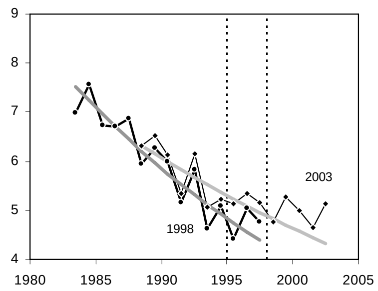


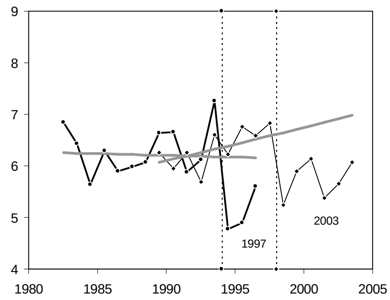
Figure 7 (continued): Comparisons across surveys of retrospective fertility trends (by single years) in nine sub-Saharan African countries with stalling fertility, and trends correcting for omissions and displacements.

TFR

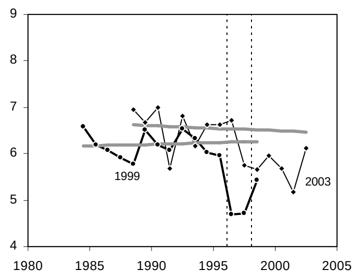
(e) Kenya



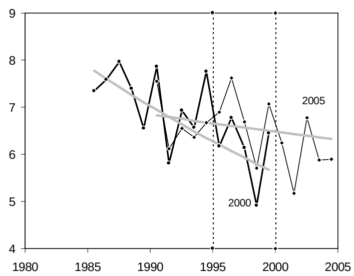
(f) Mozambique



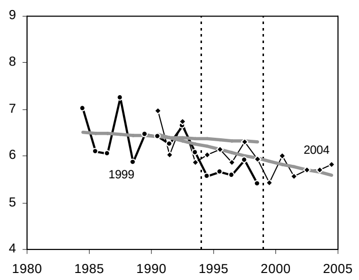
(g) Nigeria



(h) Rwanda



(i) Tanzania



Note: Grey lines represent estimates of fertility trends correcting for omissions and displacement.

Source of data: DHS surveys. Computation by the author using individual data files.

Omissions and displacements of births should be more pronounced in the next to last surveys than in the last survey to account for the stalling of fertility[19]. In other words, fertility should be underestimated to a lesser extent in the most recent survey. This is what happened in Cameroon, Ghana, Nigeria and Tanzania (Table 5). For example, omissions are quite substantial in the 1998 Cameroon survey, and much more limited in the 2004 survey. In these four countries, the stalls appear to be spurious as a result of differential omissions. In Benin, Guinea, Mozambique and Rwanda, the extent of underestimation seems at least as high in the last survey as in the next to last survey. In these countries, fertility was underestimated in both surveys, and they can not really be considered as having started their fertility transition; and as a result would not be considered as countries with stalled transitions. Kenya is the only country that seems to 'pass' the data quality test.

Table 5: Evaluation of the underestimation of fertility in the three years before the surveys, in the nine countries with stalled fertility transition.

Country	Survey	Underestimation
Benin	2001	0.84
	2006	0.93
Cameroon	1998	0.95
	2004	0.11
Ghana	1998	0.66
	2003	0.06
Guinea	1999	1.69
	2005	2.09
Kenya	1998	-0.17
	2003	-0.51
Mozambique	1997	1.07
	2003	1.04
Nigeria	1999	1.31
	2003	0.74
Rwanda	2000	0.19
	2005	-0.43
Tanzania	1999	0.69
	2004	0.04

The extent of underestimation is computed as the average difference between the fertility levels predicted by the model (correcting for omissions and displacements) and the observed fertility levels. A positive value corresponds to an underestimation of fertility.

Source of data: DHS surveys. Computation by the author using individual data files.

6. The way forward: reconstructing fertility trends

An interesting feature of the reconstruction of fertility trends by year is that, except for the periods affected by omissions and/or displacements, the

[19] The extent of omissions was computed for the last three years, as the average difference between the predicted TFRs and the observed TFRs. A positive value indicates that fertility was underestimate (predicted fertility is higher than observed fertility).

fertility estimates from consecutive surveys match very well. This makes it realistic to pool surveys together to reconstruct fertility trends – provided a few adaptations are brought to the model.

The approach we use to reconstruct fertility trends is similar to the one used above with a few modifications:

- Data from the three most recent surveys in one country are pooled together (two surveys are used for Mozambique and Guinea).
- Dummy variables are included to take account of possible omissions and displacement of births, in the same way as described before. However, given that three surveys are pooled together, the variables are equal to one only for the survey to which they refer. For example, if three surveys are pooled together (1993, 1999, 2003), the dummy variable indicating the year 1995 as the cut-off date for the health module in the 1999 DHS survey will be equal to one for all the observations in year 1995 in the 1999 survey. Observations for that year in the 1993 and 2003 surveys will be coded 0.
- Another set of dummy variables is included to control for possible differences in sample compositions across surveys[20]. We consider that, controlling for omissions and displacements, the levels of fertility across surveys should match for the same period. The value of the dummy variables measures the differences in fertility levels across surveys; we interpret these differences as reflecting differences in sample compositions.
- Finally, instead of imposing a linear trend on fertility, we estimate quadratic splines. The number and location of the knots are estimated using a stepwise forward method of selection (Marsh and Cormier, 2001)[21]. The use of quadratic splines is very flexible, and allows fitting a large variety of trends in a parsimonious way.

Retrospective fertility trends are estimated using the regression coefficients of the splines (Marsh and Cormier, 2001) estimated in step 4 (the coefficients of the other variables are not used in the predictions). The trend is interpreted as the trend in fertility, controlling for omissions, displacements and differences in sample composition. If no spline is retained in the model (because no significant trend is found), the level of fertility is considered as constant.

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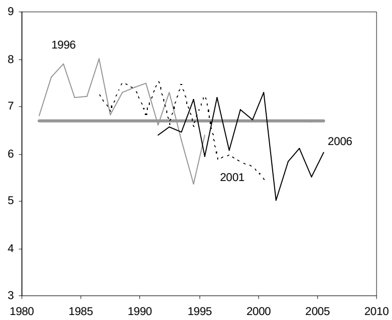
[20] Dummy variables are included to indicate the survey from which the data originate. The last survey is used as the reference category. In this way, the level of fertility is by default adjusted to the level in the last survey.

[21] All the dummy variables for omissions, displacements and differences in sample compositions are "imposed" in the model. In contrast, spline variables are included in the model using stepwise regression. The p-value for a variable to enter the model is set to 0.01 (Wald test), and the p-value for the variable to remain in the model is set to 0.05.

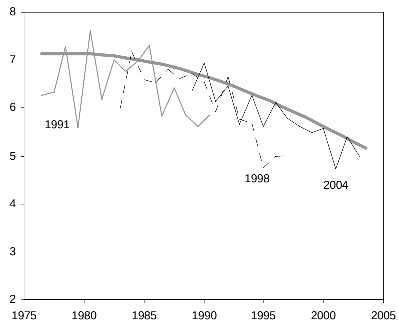
Figure 8a to Figure 8i show the retrospective fertility trends estimated with this method in the nine countries with apparent stalling. Annual fertility levels estimated separately from the consecutive surveys is reported on the same graph[22]. In three countries (Benin, Mozambique, Nigeria), fertility is stable at high levels. In Guinea, the method indicates an upward fertility trend. In three countries (Cameroon, Ghana, Tanzania), the reconstruction of fertility trends suggests that fertility has decreased in a regular way. In other words, no stall is apparent from these data. Finally, in two countries (Rwanda and Kenya), fertility seems to have stalled after a decline of at least 10 percent. The fertility decrease in Rwanda was relatively small, and fertility is still well above 6 children per woman. In contrast, fertility declined significantly in Kenya until the end of 1990s, and has stagnated at a little more that 5 children per woman.

Figure 8: Reconstruction of fertility in nine sub-Saharan African countries, correcting for omissions/displacements of births and differences in sample compositions.

(a) Benin



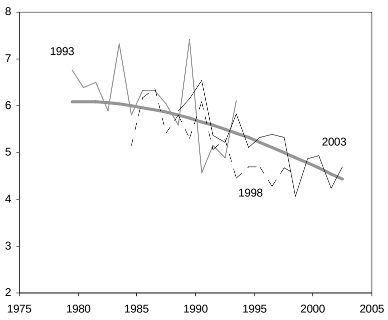
(b) Cameroon



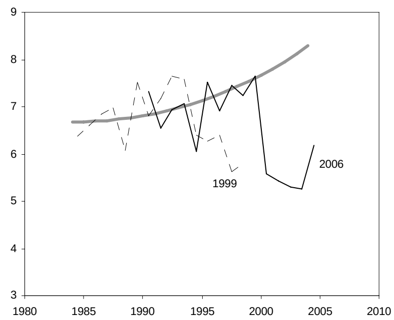
22 The reconstructed fertility trends correct for omissions and displacements of births, as well as differences in sample compositions. For this reason, there may be discrepancies between annual fertility levels estimated from each survey and the reconstructed levels of fertility.

Figure 8 (continued): Reconstruction of fertility in nine sub-Saharan African countries, correcting for omissions/displacements of births and differences in sample compositions.

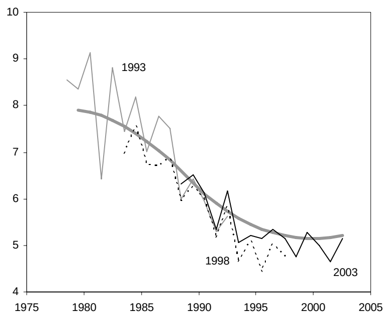
(c) Ghana



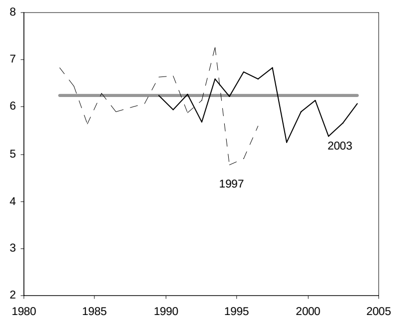
(d) Guinea



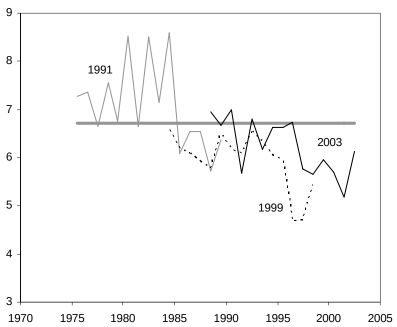
(e) Kenya



(f) Mozambique



(g) Nigeria



(h) Rwanda

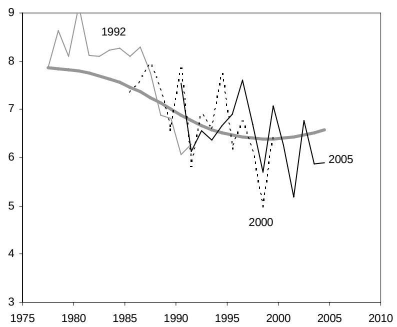
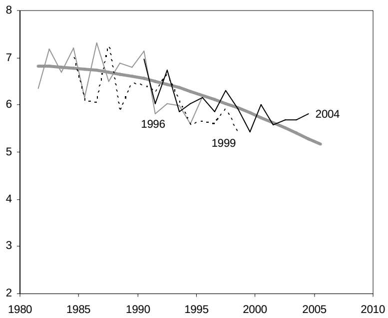


Figure 8 (continued): Reconstruction of fertility in nine sub-Saharan African countries, correcting for omissions/displacements of births and differences in sample compositions.

(i) Tanzania



Continuous grey lines represent corrected fertility trends.

Source of data: DHS surveys. Computation by the author using individual data files.

7. Conclusion

Published DHS data on fertility indicate that fertility transition has stalled in 9 sub-Saharan African countries, and that fertility decline has considerably slowed down in sub-Saharan Africa since the late 1990s. In this paper, we have examined data quality issues in the DHS surveys, to evaluate the genuineness of the stalls. At the end of the day, are the stalls real or spurious?

The analyses in this study suggest that most stalls in Africa are spurious, or at least that no conclusive evidence exists for stalls. The comparison of trends in fertility and trends in its determinants does not provide conclusive evidence for stalls in most countries. Our results also indicate that birth histories suffer from serious data quality problems, leading to underestimating recent fertility in many surveys. In some countries, underestimation of fertility was larger in the next to last survey than in the last survey, leading to an apparent increase in fertility. In other countries, underestimation was large in several surveys, and these countries should be considered as pre-transitional. Kenya is the only obvious exception: the Kenyan data does not seem to be affected by severe data quality problems, and the reconstruction of fertility trends shows that the decline of fertility has significantly slowed down from the mid 1990s. Reconstructed fertility trends indicate that Rwanda might also be considered as a case of stalling transition, but the evidence is less conclusive than in the case of Kenya, and fertility also remains very high in Rwanda.

Given that fertility trends are so much affected by data quality problems, it is worth wondering if fertility estimates are reliable enough to be published as such. One step would be to improve data collection methods. Dissociating the collection of the birth histories from the collection of data on the health of children (health module) would be one way to limit the impact of the lengthy health module on the omission and displacement of births. Another approach would be to interview a larger number of respondents for the birth histories than for the health module. It is expected that the collection of birth histories alone would be more reliable than the collection of birth histories and health data in the same surveys. Data from birth histories alone could be used to estimate the extent of omissions of births when data on the health module are also collected. With the existing data, the way forward is to correct fertility levels and trends[23]. We have suggested one way of correcting fertility trends that could be applied to all the countries. Further research is needed to evaluate the reliability of the method, for example by using simulation studies.

Although this study does not discredit completely fertility stalls in sub-Saharan Africa, it seriously calls into question its pervasive character. It also qualifies the idea that fertility declines slowed down since the end of the 1990s (Bongaarts, 2008) – and the accompanying theoretical and policy conclusions.

To conclude this paper, let us mention that new ‘apparent stalls’ are likely to be found in the coming years in Africa. Fertility seems to have been seriously underestimated in recent surveys in several African countries (Burkina Faso, Madagascar, Ethiopia, Mozambique…); an improvement in data quality in the coming surveys is likely to lead to apparent fertility stalls or increases in these countries. Given the policy and theoretical debates generated by the stalls, close attention to data quality in these surveys will be all the more important.

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[23] At the very least, a systematic analysis of data quality in survey reports is necessary to indicate the extent of omissions and displacements of births and the likely impact on fertility levels and trends.

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Table annex 1: Fertility, proximate determinants and socio-economic variables in 25 sub-Saharan African countries

Category	Country	Survey	TFR	Percentage of married women using modern contraception	Median age at first marriage (25-29)	Median length of insusceptible period (months)	Percentage of females (15-49) with secondary or higher education	Under-five mortality (‰)	Development index
1	Benin	1996	6.0	3.4	18.7	18.9	9.4	166.5	-0.38
1	Benin	2001	5.6	7.2	19.0	15.1	13.9	160.0	0.94
1	Benin	2006	5.7	6.1	18.7	14.4	16.3	125.0	1.30
1	Cameroon	1991	5.8	4.3	16.9	15.8	26.5	125.3	0.53
1	Cameroon	1998	4.8	7.1	18.0	15.5	33.3	150.7	1.03
1	Cameroon	2004	5.0	12.5	18.1	13.7	39.1	143.6	2.05
1	Ghana	1993	5.2	10.1	18.9	16.2	47.0	119.4	0.96
1	Ghana	1998	4.4	13.3	19.6	14.0	52.8	107.6	2.31
1	Ghana	2003	4.4	18.7	20.0	13.8	51.8	111.2	3.51
1	Guinea	1999	5.5	4.2	16.5	22.3	9.4	176.9	-0.67
1	Guinea	2005	5.7	5.7	16.5	21.7	11.1	163.2	-0.20
1	Kenya	1993	5.4	27.3	19.5	12.9	24.5	96.1	-0.87
1	Kenya	1998	4.7	31.5	20.2	11.1	29.2	111.5	-0.01
1	Kenya	2003	4.9	31.5	20.3	11.8	29.3	114.6	0.49
1	Mozambique	1997	5.2	5.1	17.3	16.5	4.4	200.9	-2.35
1	Mozambique	2003	5.5	20.8	17.5	18.0	7.8	152.4	-1.35
1	Nigeria	1999	4.7	8.6	18.6	15.5	36.7	140.1	2.21
1	Nigeria	2003	5.7	8.2	18.5	15.1	37.0	200.7	3.00

Table annex 1 (continued): Fertility, proximate determinants and socio-economic variables in 25 sub-Saharan African countries

Category	Country	Survey	TFR	Percentage of married women using modern contraception	Median age at first marriage (25-29)	Median length of insusceptible period (months)	Percentage of females (15-49) with secondary or higher education	Under-five mortality (‰)	Develop-ment index
1	Rwanda	1992	6.2	12.9	20.9	17.1	7.9	150.8	-2.72
1	Rwanda	2000	5.8	5.7	21.0	15.3	10.6	196.2	-2.13
1	Rwanda	2005	6.1	10.3	20.6	15.3	9.6	152.4	-2.16
1	Tanzania	1992	6.2	6.6	19	15.6	4.8	140.9	-2.18
1	Tanzania	1996	5.8	13.3	18.7	15.7	5.4	136.5	-1.71
1	Tanzania	1999	5.6	16.9	18.8	14.7	5.3	146.6	-1.65
1	Tanzania	2004	5.7	20.0	19.0	13.0	8.6	112.0	-0.89
2	Burkina Faso	1992	6.5	4.2	17.5	22.2	6.6	187.2	-1.92
2	Burkina Faso	1998	6.4	4.8	17.7	22.6	5.8	219.1	-1.66
2	Burkina Faso	2003	5.9	8.8	17.7	19.9	8.7	183.7	-0.67
2	Cote d'Ivoire	1994	5.3	4.3	18.2	16.6	14.0	149.5	2.13
2	Cote d'Ivoire	1998	5.2	7.3	19.7	18.9	15.3	180.7	3.49
2	Cote d'Ivoire	2006	4.6	-	-	-	19.6	127.0	4.21
2	Eritrea	1995	6.1	4.0	17.4	16.6	16.0	136.3	-1.16
2	Eritrea	2002	4.8	7.3	18.4	14.6	20.1	93.3	0.76
2	Ethiopia	2000	5.5	6.3	17.2	19.6	9.1	166.2	-2.87
2	Ethiopia	2005	5.4	13.9	16.6	16.7	11.9	123.5	-2.16

Table annex 1 (continued): Fertility, proximate determinants and socio-economic variables in 25 sub-Saharan African countries

Category	Country	Survey	TFR	Percentage of married women using modern contraception	Median age at first marriage (25-29)	Median length of insusceptible period (months)	Percentage of females (15-49) with sec. or higher education	Under-five mortality (‰)	Development index
2	Madagascar	1992	6.1	5.1	18.9	13.4	26.6	162.8	-2.39
2	Madagascar	1997	6.0	9.7	18.9	12.0	26.9	159.2	-2.15
2	Madagascar	2003	5.2	18.3	18.9	11.1	30.8	93.9	-0.43
2	Namibia	1992	5.4	26.0	25.0	12.8	37.1	83.9	3.30
2	Namibia	2000	4.2	42.6	27.0	18.3	57.4	62.2	4.91
2	Senegal	1992	6.0	4.8	16.8	16.2	9.9	131.8	1.68
2	Senegal	1997	5.7	8.1	18.7	15.1	12.5	139.1	2.27
2	Senegal	2005	5.3	10.3	19.2	12.6	15.2	121.3	5.73
2	Zambia	1992	6.5	8.9	18.0	13.3	23.9	191.2	0.47
2	Zambia	1996	6.1	14.4	18.4	14.1	27.8	196.6	0.25
2	Zambia	2001	5.9	25.3	18.4	14.9	30.0	168.2	0.31
2	Zimbabwe	1994	4.3	42.2	19.3	14.1	41.6	77.1	1.62
2	Zimbabwe	1999	4.0	50.4	19.8	15.6	53.0	102.1	3.34
2	Zimbabwe	2005	3.8	58.4	19.6	15.6	63.1	82.5	3.45
3	Chad	1996	6.4	1.2	15.9	16.6	3.8	194.2	-3.31
3	Chad	2004	6.3	1.6	16.0	14.9	6.4	190.6	-2.96

Table annex 1 (continued): Fertility, proximate determinants and socio-economic variables in 25 sub-Saharan African countries

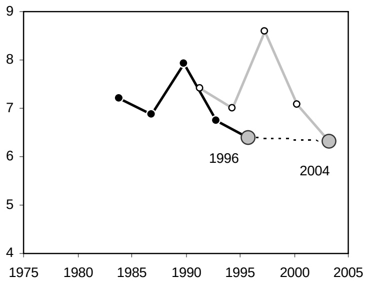
Category	Country	Survey	TFR	Percentage of married women using modern contraception	Median age at first marriage (25-29)	Median length of insusceptible period (months)	Percentage of females (15-49) with secondary or higher education	Under-five mortality (‰)	Develop-ment index
3	Mali	1995	6.7	4.5	16.1	14.4	7.1	237.6	-1.72
3	Mali	2001	6.8	5.7	16.8	12.8	8.7	229.1	-0.53
3	Mali	2006	6.6	6.9	16.7	11.7	10.4	212.0	0.20
3	Niger	1992	7.0	2.3	14.9	16.2	3.1	318.3	-2.64
3	Niger	1998	7.2	4.6	15.3	16.2	5.3	273.8	-2.41
3	Niger	2006	7.0	5.0	15.7	15.9	6.1	197.6	-1.81
3	Uganda	1995	6.9	7.8	17.8	13.4	13.5	147.4	-2.78
3	Uganda	2000	6.9	18.2	18.0	12.2	18.4	151.5	-2.05
3	Uganda	2006	6.7	17.9	18.0	11.7	21.3	127.6	-1.57

Source of data: DHS surveys. Indicators published on the STATcompiler website (www.measuredhs.com)

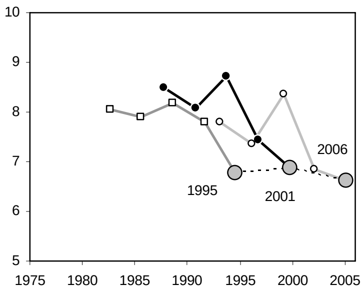
Figure Annex 1: Comparisons across surveys of retrospective fertility trends in sub-Saharan African countries with decreasing and stable fertility

No change

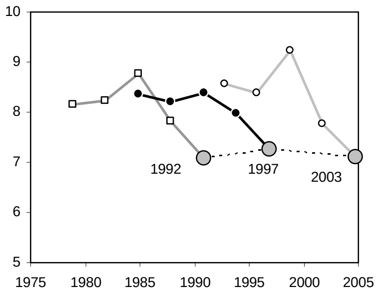
(a) Chad



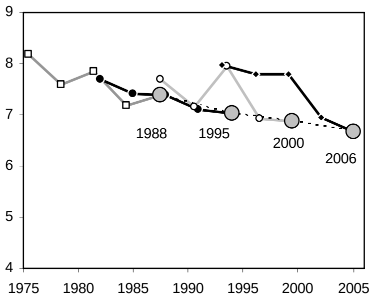
(b) Mali



(c) Niger

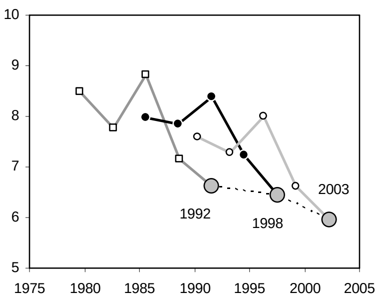


(d) Uganda



Decreasing fertility

(e) Burkina Faso



(f) Côte d'Ivoire

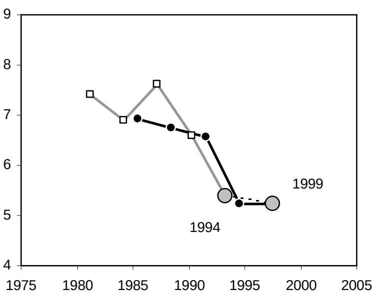
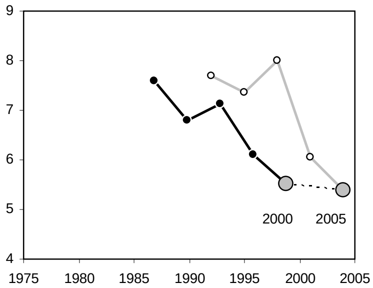
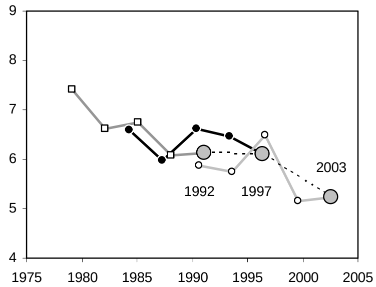


Figure Annex 1 (continued): Comparisons across surveys of retrospective fertility trends in sub-Saharan African countries with decreasing and stable fertility

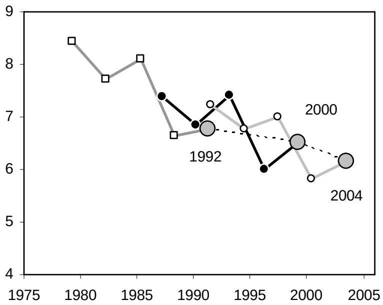
(g) Ethiopia



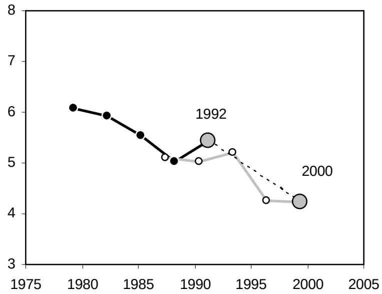
(h) Madagascar



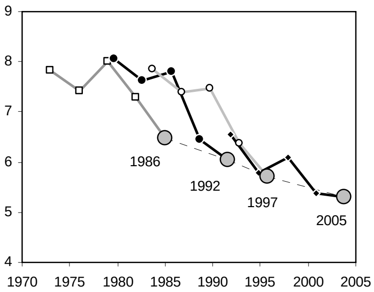
(i) Malawi



(j) Namibia



(k) Senegal



(l) Togo

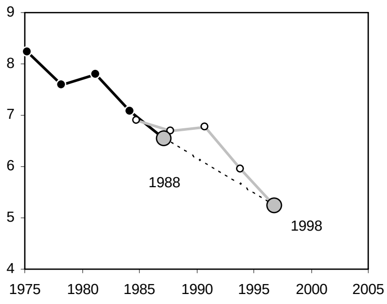
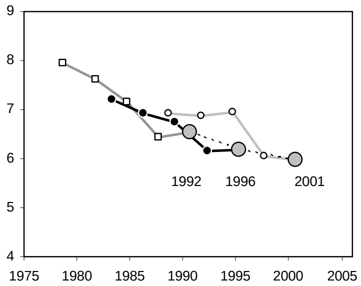
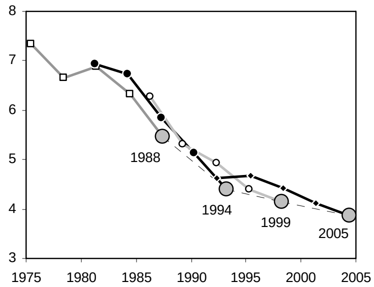


Figure Annex 1 (followed): Comparisons across surveys of retrospective fertility trends in sub-Saharan African countries with decreasing and stable fertility

(m) Zambia



(n) Zimbabwe



Source of data: DHS surveys. Computation by the author using individual data files.

Appendix 1. Method for reconstructing TFR from birth histories

The reconstruction of TFR from birth histories is done using Poisson regression.

The first step is to transform the birth history into a person-period data set. The history of a woman is split into segments. Every time the age of the woman or year changes, a new segment is created. As a result, segments have varying lengths (lower than 12 months). The length of the segments (exposure) is controlled in the models through an offset. In each segment, a woman either gives birth to one or several children, or does not give birth. The number of births in the segment is the dependant variable. The age and year in which the segment is located are used to create dummy variables, indicating age group and time period. These variables are used as explanatory variables.

The second step is to select observations above age 15 for the wome, and from 15 years before the survey.

The next step is to estimate a Poisson regression model using the person period data. The model is of the following form:

$$\ln \mu_i = \ln t_i + \sum_{k=1}^{K} \beta_k . x_{ki}$$

μ_i is the expected number of children born in each time segment, t_i is the length of the time segment (exposure), and x_{ki} are the explanatory variables. Dummy variables are included for the seven age groups, and dummy variables are also included for the time periods or years.

Table annex 1: Example of reconstruction of fertility trends in Zimbabwe, using Poisson regression and person-period data

Age groups	Regression coeff. (β)	Exp(β)		Year	Regression coeff. (β)	Exp(β)	Estimated TFR
15-19	-2.399	0.091		1998 (*Ref.*)	-	-	4.00
20-24	-1.704	0.182		1997	0.0524	1.055	4.22
25-29	-1.759	0.172		1996	0.0796	1.082	4.33
30-34	-1.868	0.154		…	…	…	…
35-39	-2.098	0.123		1988	0.3075	1.360	5.44
40-44	-2.777	0.062		…	…	…	…
45-49	-4.121	0.016		1980	0.4053	1.500	6.03
1998 TFR (reference year)		4.00		1979	0.5637	1.757	7.03

Source of data: Zimbabwe DHS 1999. Computation by the author using individual data files.

The regression coefficients of age groups are exponentiated, summed and multiplied by 5 to obtain the TFR for the reference year (first year of the 15-year period, see Table annex 1). The TFRs for the following years are obtained by multiplying the TFR of the reference year by the exponentials of regression coefficients of the following years.

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