Is Fertility Decline Stalling in Sub-Saharan Africa?: Re-examination of Fertility Trends

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Extended abstract prepared for the Annual Meeting of the Population Association of America, Detroit
Poster Session 5, 1 May 2009

INTRODUCTION

Fertility in developing countries has markedly declined since the late 1960s. The decline is most pervasive in Asia and Latin America and the total fertility rates have dropped by approximately 60 percent in the last four decades reaching below 2.4 children per woman (United Nations 2005). In contrast, sub-Saharan Africa shows a smaller decrease and the average total fertility rate remains as high as 5.13 (United Nations 2005). While Kenya, Botswana and Zimbabwe all reduced fertility rapidly in the 1980s and many countries have followed at a slower pace, some are still pre-transition. Moreover, the speed of decline seems to have decelerated around 2000 (Bongaarts 2002, 2008). In his recent paper, Bongaarts concludes that 12 sub-Saharan African countries have stalled fertility decline in the midst of transitions (Bongaarts 2008). If these observed stalls are genuine, the United Nations Population Division may need to re-estimate the medium scenario where the TFRs in the region are prospected to decline up to 2.53 by 2050.

Despite the growing concern, most prior studies use rather simplistic approaches of identifying fertility stalls. The claimed "stall" often solely relies on selected total fertility rates derived from Demographic and Health Surveys country reports or DHS STATcompiler available online (Bongaarts 2008; Shapiro and Gebreselassie 2008; Westoff and Cross 2006). The rates employed for the purpose are often the TFR from data aggregated across the three years preceding each of the two most recent surveys. The claimed stall is generally identified by a slope between these two estimates. For

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We greatly thank John Cleland and Ian Timæus for their valuable advices.

instance, Bongaarts defines fertility stall as no "absolute decline per year in the TFR between two successive observations" in a mid-transition country (Bongaarts 2008). Based on this definition, he obtains an annual pace of fertility decline by dividing difference in the TFR between two successive surveys by number of years in the inter-survey period. In other words, the pace of decline is determined by only two average estimates of TFR approximately five years apart. This is an overly simple way used for fertility estimation and can produce misleading trends.

DHS provides the most reliable fertility data in sub-Saharan Africa. it is essential to note, however, that DHS data are evidently subjected to sampling and non-sampling errors, particularly age and date misreporting (Arnold 1990; Pullum 2006; Rutstein and Bicego. 1990; Sullivan 2008). While age exaggeration of older women and incompleteness of birth dates of children have decreased over the years, age displacement of children has been considered to remain a critical problem (Pullum 2006; Sullivan 2008). Interviewers have potential incentives to transfer child's age outside a period of eligibility for additional questions on child health and anthropometry in order to reduce their workloads. This error have been found in many surveys from sub-Saharan African countries resulting in underestimation of births in the eligible period and overstatement in the earlier period (Pullum 2006). Therefore, simply connecting two separate average total fertility estimates approximately 5 years apart may not provide accurate long-term fertility trends. The lack of careful assessment of data quality and fine details may lead to inaccurate depictions of fertility trends.

Given the lack of assessment of the data quality and fairly simplistic approach for fertility estimation, some of the claimed stalls can be spurious. This is likely to account for the different views on the countries which stall the fertility decline (Agyei-Mensah 2007; Bongaarts 2006, 2008; Garenne 2008; Schoumaker 2008; Shapiro and Gebreselassie 2008). It may be also attributed to the mixed and inconclusive results of potential causes of stalls (Bongaarts 2006; Moultrie et al. 2008; Shapiro and Gebreselassie 2008; Westoff and Cross 2006). Although it is of crucial importance to acknowledge stalls, the approach used and the prevalence of the unexpected phenomenon should be explored.

The primary objective of this paper is to re-examine the national fertility trends in sub-Saharan African countries by assessing DHS data quality and introducing a more rigorous fertility estimation method. First, retrospective fertility estimates in the last two decades are obtained by reconstructing the birth histories to increase the information on fertility trends and detect potential errors. The results are compared with the published estimates available in the STATcompiler which have been used for prior studies. Then identified errors are further investigated. Lastly, we present adjusted fertility estimates and trends, controlling for detected errors.

LITERATURE REVIEWS

Definitions of fertility stall

Before embarking on the data assessment, literatures on definitions of a fertility stall are reviewed. The term has been used and studied, but there is no consistent definition yet (Moultrie et al. 2008). Few prior studies discuss the criteria and most are urged to focus on investigating potential causes of stalls (Aghajanian 1991; Bongaarts 2006; Eltigani 2003; Shapiro and Gebreselassie 2008; Westoff and Cross 2006). The term is usually considered to refer a fertility pattern where TFR fails to decline between two surveys in a mid-transitional country.

Gendell is the first person who identified a fertility stall and also established four criteria of stall (Gendell 1985, 1989). Firstly, the fertility transition must have been initiated by the fertility falling from more than 5 children in TFR by at least 20 percent. The twenty percent is twice the 10 percent decline which is historically used as a sign of onset of fertility transition (Casterline 2001). Secondly, the decline should have averaged at least 0.15 TFR units annually for the five years preceding the supposed stall. Thirdly, there should be no decline during the stalled period or the rate of decline should be the half the rate at most in the preceding time period of stall. The duration is defined as at least 5 years, acceptably 4 years in the case the decline resumes. Fourth, the stall should occur at well above the replacement level.

Moultrie et al develop the Gendell's definition more rigorously (Moultrie et al. 2008). They propose to define a period of stall as duration when the rates of fertility decline between two time periods do not show a statistically significant difference. This definition requires a significant change in *pace* between two time periods, which Bongaarts considered as unnecessary (Bongaarts 2008). It is further suggested that there should be no significant difference from zero in the slope of the line between the two recent data points.

Bongaarts and Garenne employ more simple criteria. Bongaarts defines a stall as no statistically significant decline in the TFR between two successive observations, using the TFR from data aggregated over three years preceding each of the two most recent surveys (Bongaarts 2008). Furthermore, the countries with limited decline of less than 0.25 births per women are regarded to have stalled (Bongaarts 2008). Similarly, Garenne defines a stall "as periods during which the slope changed from negative to nil or positive, the change in slope being significant at the P<0.05 level" (Garenne 2007).

In this analysis, fertility stall is considered as duration when there is no significant departure from zero in the slope of the line between two *inflection* points. Annual estimates of TFRs we obtain from DHS birth histories allows us to identify the time points when a pace of fertility decline changes from the previous time period. This permits us to determine the directions of trends, either acceleration or deceleration, rather than observe a slope during a fairly short time between two data points which is likely to be skewed by local fluctuations and errors. Each time period we identify already has a statistically different pace from in the previous period. Therefore, it may be too stringent to impose no negative change in pace as a criterion on the region where the pace of decline lags behind. With this criterion, any deceleration would be picked up even when it is in the middle of a rapid decline. Moreover, the second and third Gendell's criteria may also be too strict. The African fertility decline is generally very slow and would not achieve a decline of 0.15 or double pace in TFR in a period prior to stall. The minimum duration of four years is used because five-year period is more likely to be affected by the potential data quality problem which will be discussed later. This four-year time period was also suggested by Gendell. With respect to the onset of fertility transition, we use the conventional criterion of at least 10 percent decline from the peak value of total fertility rate (Casterline 2001). The countries in pre-transition are not regarded as ones with fertility stalls.

DHS data quality

Demographic and Health Surveys provide the most reliable nationally representative information on fertility in sub-Saharan African countries. The key strength of DHS is inclusion of full birth histories, whereby every woman in reproductive age, generally 15-49 years old, are asked about the dates of every live birth. This feature allows DHS to become a principal source of fertility research.

However, no survey is immune to sampling and non-sampling errors. In the 1990s the quality of World Fertility Surveys (WFS) and DHS-I was carefully scrutinised and the errors occurring in this type of household survey were identified and their degrees were measured. The potential errors were misreporting of age and birth year of women and children, displacement of birth dates and age of women and children, omission of births, incompleteness of reporting as well as sampling errors. Most of the errors were more prevalent in sub-Saharan Africa than other parts of developing world (Arnold 1990; Cleland and Scott 1987). Pullum recently made a comprehensive examination on age and date reporting in the DHS surveys undertaken between 1985 and 2003 and concluded that the data from sub-Saharan Africa still contains more errors of age transfers, i.e. downward age transfer for women and upward for children, than other regions.

Among the several types of errors, age displacement of children has been considered to remain a critical problem (Pullum 2006; Sullivan 2008). If women have children born during the window for the eligibility, the respondents are asked about a range of questions, such as antenatal care during pregnancy, delivery, breast feeding practice, immunisation and nutrition status, and symptoms and treatment of diarrhoea. It is reasonable to consider that interviewers could be motivated to transfer dates of childbirths backward and avoid the additional questions to reduce their workloads. The cut-off point for the eligibility generally falls in January of the fifth full calendar year prior the year interview started. In other words, births occurred 0-5 years before a survey are tended to be pushed backwards, resulting in underestimation of births in the period and overestimation in six and more years before the survey. This transference sometimes exaggerates the speed of fertility decline. The published TFR in DHS reports are generally an average of TFRs during the three years before a survey. If the displacement is severe, the published rates may be underestimated, and may cause a stall if the second last survey is more severely underestimated than the last survey.

Regardless of recognition of the errors, the more questions, such as about anaemia, malaria and HIV, are added in response to increasing demands for information on maternal and child health. The concern about the lengthy questionnaire which may adversely affect the data quality has been increasing (Murray et al. 2007). In fact, several studies reveal that omissions and severe displacement of births, especially among deceased children, adversely affect child mortality estimation (Johnson, Rutstein and Govindasamy 2005; Sullivan 2008). Child mortality in Ghana had been considered to be stalled between two DHS survey in 1998 and 2003. But further investigation concludes that it was a spurious stall due to more severe omission of deceased children in 1998 survey (Johnson et al. 2005).

In the context of fertility stall, Schoumaker recently undertook extensive assessments of the data quality and this enhances our understanding of stalls (Schoumaker 2008). He identifies two types of data quality problems which affect fertility trends; omission/displacement of births and different sampling implementation between surveys. Adjusted fertility estimates controlling for these errors are then obtained. It is concluded that the claimed fertility stalls are all spurious except Kenya and possibly Rwanda. Although his methods are very innovative and the most plausible amongst other studies, the errors seems somewhat over-exaggerated. For instance, fertility after a cut-off year is corrected under an assumption that the estimates before the cut-off year are accurate. However, it has been known that the births are often inflated not only a year before the cut-off year but also in 5-15 years preceding the survey (Blacker 2002; Potter 1977). Without more detailed analysis, such as comparison of fertility by birth cohorts, it is not plausible to determine that the observed lower fertility in recent years is only due to underestimation. If this is the case, the adjusted estimates after the cut-off year may be overestimated. Furthermore, if fertility in a period after a cut-off year in the last survey is lower than during the period before the cut-off year, it is hard to determine whether the lower fertility is due to omission/displacement of birth, and/or a real fertility decline. There is no more recent survey to confirm the observed trend retrospectively.

In this study, we explore the potential errors affecting fertility trends and then present adjusted fertility trends in the last two decades in the selected sub-Saharan Africa countries.

METHODS

Data

DHS is the most reliable and internationally comparable data source on fertility in sub-Saharan African countries. To examine the fertility trends for long enough periods, 16 countries which have undertaken three or more DHS surveys were selected; namely Benin, Burkina Faso, Cameroon, Ghana, Kenya, Madagascar, Malawi, Mali, Niger, Nigeria, Rwanda, Senegal Tanzania, Uganda, Zambia and Zimbabwe. Uganda DHS 1988 was excluded from this analysis due to the limited coverage and a total of 56 surveys were used in this analysis.

Analysis

1) Reconstruction of retrospective fertility trends

Retrospective total fertility rates in single calendar year are obtained by reconstructing birth histories for 10 years preceding each survey. The method has been commonly used for data assessment of WFS and DHS-I in the 1980s and for more recent fertility estimation (Garenne 2007; Garenne and Joseph 2002; Schoumaker 2008; Schoumaker and Hayford 2004; Timaeus and Balasubramanian 1984). This aims to depict the detailed levels and trends of fertility as well as to explore whether there is a discrepancy between successive surveys when the retrospective estimates from two successive surveys overlap. The total fertility rates computed are partial total fertility rates by cumulating age-specific fertility rates among women aged 15-39 years old because women aged 40-49 at the time of surveys are truncated as dating back for 10 years. Locally weighted scatter point smoothing (LOWESS) is employed to capture an overview of trends in the entire period in individual countries.

2)Differentials in compositions of women

With few exceptions, DHS surveys select nationally representative samples using stratified two- or three-stage cluster sampling methods[1]. Therefore, the demographic and socioeconomic characteristics of respondents in successive surveys are expected to remain constant or show a gradual change across surveys. If one survey over-represents a group of women who are more susceptible to fertility decline due to different sampling implementation, fertility may be underestimated compared to other surveys. For instance, women's levels of highest educational attainment is an important determinant of fertility decline and the proportions of women do not change dramatically between two surveys at national level unless a large number of women go on to the higher institutions between two successive surveys. These changes are mostly expected in the two youngest birth cohorts aged 15-24 at the time of survey. Suppose one second last survey samples a higher proportion of women with secondary education in the same birth cohorts compared to the last survey, this implies over-representation of educated women in the survey and may result in lower fertility than expected. These different compositions across surveys may also leads to a false fertility stall because the second to the last survey would produce relatively lower fertility compared to estimates from the last survey, if other conditions are the same. For this analysis, the proportions of women with three different highest educational attainment (no/primary /secondary or higher education) by 5-year birth cohorts are obtained from each survey and compared within each country.

3) Fitting adjusted fertility trends controlling for errors

There are many approaches to estimate fertility. As we are more interested in change in pace, spline Poisson regression is employed to examine underlying trends behind the annual retrospective estimates obtained in this analysis. This allows us to obtain more rigorous estimates based on number of births and person-years rather than smoothing annual estimates of TFRs. The strength of the spline method is not to allow a break of slope at an inflection point, unlike polynomial regression, as well as to allow assessment

[1] To ensure comparability in the data for the entire period, Uganda datasets exclude the current 2 western and 4 northern districts. For the same reason, North-East province and 4 other northern districts which were covered only in Kenya DHS 2003 are excluded from this analysis. Mali DHS 1987did not cover nomadic population in region of Gao, resulting in the coverage in rural areas was 90 percent.

of non-linear trends. The slopes are jointed and restricted by previous splines. In practice spline analysis requires a specification of number and locations of knots, i.e. inflection points. In the absence of specific information, it is common to place knots to separate the observed time period evenly (Marsh and Cormier 2001). A five-year interval has been conventionally used for mortality estimation (Hill et al. 1999; Notkola, Timaeus and Siiskonen 2000). However, five-year interval is not appropriate for this analysis because it is likely that a knot falls in the cut-off year for questions on child health. This can result in exhibiting false positive trends, when there is a plunge in reported number of births in the 5th year before the survey. Although a six-year interval is suggested in a few studies for child mortality estimation, four-year interval is selected for this analysis to detail more recent trends (Sullivan 2008). Also, a four-year period is suggested to be a minimum length of time for a stall by Gendell (Gendell 1985). After three or four datasets are utilised for each country, the knots are firstly defined by going backward in four-year intervals from the year when the last survey was conducted[2]. Next, the inflection points, i.e. knots, where the pace is changed from previous four-year period, are identified by eliminating insignificant splines. For analysis in Kenya, for instance, knots are placed in 1987, 1991, 1995 and 1999 respectively. Then, if there is no significant change in pace between the period 1995-1999 and 1999-2003, the two 4-year periods are merged.

Adopting Schoumaker's method, two dummy and survey variables are included into the spline Poisson regression model to control for errors (Schoumaker 2008). One dummy indicates the cut-off year and another is one year before the cut-off year which will detect inflation of births due to the displacement of birth dates from the cut-off year. The dummy for the observations which were collected after the cut-off year is only used to see the effects. As mentioned earlier, controlling for the last dummy may lead to overestimation of fertility in the period because this variable may control out the effect of genuine decline. Therefore, the variable is only used to see the effect and not included in the model to compute fitted fertility estimates. The survey dummies are expected to encompass the effects of sample differentials.

[2] Six-year time period is used for Senegal where there is huge increases in a year before each survey following substantially lower fertility in 1-5 years before each survey.

The selection of models is made based on Wald test and Likelihood Ratio Test (LRT). Since spline models are not nested each other, Akaike's Information Criterion (AIC) and BIC (Baysian Information Criteria) are employed to identify appropriate numbers of knots. By using these criteria, four-year periods with insignificant change are merged into previous period. This analysis allows for survey design and differentials of sample sizes between surveys. At last, fitted fertility estimates are computed by controlling for displacement of births and any other differentials between surveys.

RESULTS AND DISCUSSIONS

1) Reconstruction of retrospective fertility trends

Figures 1 presents partial total fertility rates in single calendar year for 10 years preceding each survey in the 16 countries. Firstly, the smoothed LOWESS lines provide broad overviews on the long-term trends in individual countries. Despite the varied degree of local fluctuations, it appears that fertility has declined in the most countries at different degrees in the last two decades. For Cameroon, which is considered by Bongaarts to levelled off, the fertility decline appears continuous. In contrast, Kenya clearly decelerated the pace after 1996 and the decline appears to plateau at 4.5 children per woman. Since Kenya has very good agreement in the estimates across the surveys, the stall is likely to be certain. Although Burkina Faso, Mali, Senegal, Uganda and Zimbabwe appear to continue decline fertility, there are large fluctuations. The data need to be further assessed because the depicted smoothing estimates are unadjusted. The adjusted annual paces of decline are to be presented later.

Secondly, there are substantial discrepancies between successive surveys during the overlapping periods, e.g. Cameroon in 1995-1998 between 1998 and 2004 surveys. There is 1.36 children difference in the rates in 1996 derived from Cameroon DHS 2004 and 1998 data. Given the irregular shape of trend in the 1998 survey, the number of births between 1995 and 1998 is likely to be understated or omitted. Therefore, the published average TFRs from the country reports appears to fail to decline in 2003, but the claimed stall is spurious. With respect to the overlapping periods between the last and the second to last surveys, Benin, Ghana, Nigeria seems to have similar discrepancies.

Also important to note is that the rates from recent surveys are always higher than ones from earlier surveys during the overlapping periods. This may be due to a combination of overstatement of births in the recent surveys and understatement in earlier surveys, or as a result of either one of the two misstatements. It is hard to determine the cause from Figure 1 without further supporting evidence. Another possible explanation of the discrepancies may be differentials in sample composition between surveys. This may create different slopes and level of fertility estimates in overlapping periods.

Thirdly, the annual retrospective TFRs clearly illustrate age displacement across the boundaries of eligibility for the additional questions on child health in many DHS surveys. The rate in the earliest year of a window sharply dropped and the estimate of a year before the window is grossly inflated. In Ghana, the spike in the rate in 1989 is substantial and indicates age displacement of births (Ghana Statistical Service and Macro International Inc. 1994). Interestingly, the degrees of displacement vary within and across countries. Overall, the results help visually recognize the displacement of births and discrepancies between surveys.

Sampling implementation

Figure 2 exhibits the proportions of women by three different levels of highest educational attainment, birth cohort and survey. The agreements are good and the proportions of educated women uniformly increase in younger birth cohorts. With regard to the recent trends, the data from the last surveys in Benin, Ghana and Madagascar contain slightly higher proportions of less educated women compared to those in the second last survey. Conversely, Nigeria DHS1999 has clearly higher proportion of women with secondary or higher education and lower proportion with no education in almost all birth cohorts. This may again contribute to underestimation of fertility in this survey. These effects will be controlled for in the next fertility estimation analysis. Some of the deviations in the older cohorts which are seen in Zimbabwe, for example, are due to relatively higher proportions of educated women sampled from very small sample sizes. Discrepancies in younger cohorts should be attributable to change of educational attainment between successive surveys. They are 15-24 years old at the time of survey and are more likely to seek higher education during the inter-survey periods.

Fitting adjusted fertility trends controlling for errors

Table 1 and 2 present the output of spline Poisson regression for Kenya and annual relative pace of fertility decline after controlling for the effects of age displacement for children and surveys, respectively. Kenya's fertility level has clearly levelled off since 1995. Given the good agreement in the retrospective estimates between surveys and relatively small birth transference, the stall in Kenya is likely to be genuine.

Benin and Nigeria have shown upward trends in at least the four years before the last survey. The estimated annual increase is almost 3 percent in Nigeria, much faster than in Benin. As the slopes for the 8-year period before the last survey are also plateaued, fertility in the two countries appears to stall or reverse in the recent years, based on the data available. However great care is needed to reach firm conclusions. Both countries apparently depict more severe understatement of births in the second to last survey than other successive surveys, which could lead to spurious stalls (National Population Commission[Nigeria] 2000; Pullum 2008). The analysis in the previous section shows that Nigeria 1998 survey has a higher proportion of less educated women. Therefore, although survey effects are controlled in the models, Nigeria might offset the understatement of births to some extent, but the real effects are unknown. Benin 2006 survey has a slightly higher proportion of less educated women in the last survey, which might result in the upward trend.

The fertility in Madagascar, Rwanda and Zambia seems to constantly decline in the recent 8-year period, whereas stalls are observed for the 4-year period before the last survey. For Madagascar, there is possibly more than 20 percent displacement of births from the cut-off year to a year before. Rwanda fertility could be affected by the genocide in 1994, but the effect on the demographic patterns are not clear (Chandrasekhar, Gebreselassie and Jayaraman 2008; Verwimp and Van Bavel 2007). While Zambia has a relatively good quality of data, the fertility level has not been greatly changed in the last five years. The future trend needs to be carefully examined. Malawi has continued to decline since 1992, but the pace is as slow as 0.46 percent per annum.

The other six countries (Burkina Faso, Cameroon, Ghana, Senegal, Tanzania and Zimbabwe) show consistent declines of at least 1 percent per annum. Mali, Niger and Uganda are considered in pre-transition in this analysis. Therefore, the stalls in Cameroon, Ghana, Tanzania and Zimbabwe claimed by Bongaarts are likely to be spurious. However, it is important to note that the paces of decline in the recent years are decelerated in Cameroon, Senegal and Zimbabwe as well.

CONCLUSIONS

The results reveal a more comprehensive view on fertility trends in sub-Saharan Africa. Although DHS produces the most reliable data on fertility, it is evident that there are several errors and the fertility trends are adversely affected by the errors. The data assessment leads to the results that several of the previously claimed stalls are spurious. We conclude that only Kenya has stalling fertility decline with certainty. However, Benin, Madagascar, Malawi, Rwanda and Zambia, which present recent short-term stalls, reversals or very slow decline, need close attention on their future fertility trends.

REFERENCES

Aghajanian, A. 1991. Population Change in Iran 1966-1986: A Stalled Demographic Transition. *Population and Development Review.* 17(4):703-715.

Agyei-Mensah, S. 2007. New Times, New Families: The Stall in Ghanaian Fertility. Presented at Union for African Population Studies. Fifth African Population Conference. 10-14 December 2007. Arusha, Tanzania.

Arnold, F. 1990. Assessment of the Quality of Birth History Data in the Demographic and Health Surveys. *An Assessment of DHS-I Data Quality*. No.1. Columbia, Maryland: Institute for Resource Development / Macro System, Inc.

Blacker, J. 2002. Kenya's Fertility Transition: How low will it go? Presented at Expert Group Meeting on Completing the Fertility Transition. 11-14 March 2002. New York.

Bongaarts, J. 2002. *The End of the Fertility Transition in the Developing World*. New York: Population Council.

—. 2006. The Causes of Stalling Fertility Transitions. *Studies in Family Planning.* 37(1):1-16.

—. 2008. Fertility Transitions in Developing Countries: Progress or Stagnation? *Studies in Family Planning.* 39(2):105-110.

Casterline, J. 2001. The Pace of Fertility Transition: National Patterns in the Second Half of the Twentieth Century. *Population and Development Review.* 27(Supplement):17-52.

Chandrasekhar, S., Gebreselassie, T., and Jayaraman, A. 2008. Factors Affecting Maternal Health Care Seeking Behavior in Rwanda. *DHS Working Papers*. No.59. Calverton, Maryland, USA: Macro International Inc.

Cleland, J. and Scott, C. 1987. *World Fertility Survey*: Oxford University Press.

Eltigani, E. 2003. Stalled fertility decline in Egypt, Why? *Population and Environment.* 25(1).

Garenne, M. 2007. Situations of fertility stall in sub-Saharan Africa. Presented at Fifth Conference of African Population Association. 10-14 December 2007. Arusha, Tanzania.

—. 2008. Fertility Changes in Sub-Saharan Africa. *DHS Comparative Reports No. 18*. Calverton, Maryland, USA: Macro International Inc.

Garenne, M.and Joseph, V. 2002. The Timing of the Fertility Transition in Sub-Saharan Africa. *World Development.* 30(10):1835-1843.

Gendell, M. 1985. Stalls in the fertility decline in Costa Rica, Korea, and Sri Lanka. *World Bank Staff Working Papers No. 693;Population and Development Series No. 18*. Washington, D.C., World Bank, 1985.

—. 1989. Stalls in the fertility decline in Costa Rica and South Korea. *International Family Planning Perspectives.* 15(1):15-21.

Ghana Statistical Service and Macro International Inc. 1994. Ghana Demographic and Health Survey 1993. Calverton, Maryland: Ghana Statistical Service Macro International Inc.

Hill, K., Pande, R., Mahy, M., and Jones, G. 1999. Trends in Child Mortality in the Developing World: 1960 to 1996. pp. 223. New York: UNICEF.

Johnson, K., Rutstein, S., and Govindasamy, P. 2005. The Stall in Mortality Decline in Ghana: Further Analysis of Demographic and Health Surveys data. Calverton, Maryland, USA: ORC Macro.

Marsh, L.and Cormier, D. 2001. *Spline Regression Models*. London, United Kingdom: Sage Publication, Inc.

Moultrie, T.A., Hosegood, V., McGrath, N., Hill, C., and Herbst, K. 2008. Refining the Criteria for Stalled Fertility Declines: An Application to Rural KwaZulu-Natal, South Africa, 1990-2005. *Studies in Family Planning.* 39(1):39-48.

Murray, C.J., Laakso, T., Shibuya, K., Hill, K., and Lopez, A.D. 2007. Can We Achieve Millennium Development Goal 4?: New Analysis of Country Trends and Forecasts of under-5 mortality to 2015. *The Lancet.* 370(9592):1040-1054.

National Population Commission[Nigeria]. 2000. Nigeria Demographic and Health Survey 1999. Calverton, Maryland: National Population Commission and ORC/Macro.

Notkola, V., Timaeus, I.M., and Siiskonen, H. 2000. Mortality Transition in the Ovamboland Region of Namibia, 1930-1990. pp. 153-167 *Population Studies*.

Potter, J.E. 1977. Problems in Using Birth History Analysis to Estimate Trends in Fertility. *Population Studies.* 31(2):335-364.

Pullum, T.W. 2006. An Assessment of Age and Date Reporting in the DHS Surveys, 1985-2003. *Methodological Reports*. No.5. Calverton, Maryland: Macro International Inc.

—. 2008. An assessment of the quality of data on health and nutrition in the DHS survey, 1993-2003. *Methodological Reports*. Calverton, Maryland, USA: Macro International Inc.

Rutstein, S.O.and Bicego., G.T. 1990. Assessment of the Quality of Data Used to Ascertain Eligibility and Age in the Demographic and Health Surveys. *An Assessment of DHS-I Data Quality*. No.1. Columbia, Maryland: Institute for Resource Development / Macro System, Inc.

Schoumaker, B. 2008. Stalls and Reversals in Fertility Transitions in Sub-Saharan Africa: Real or Spurious? Presented at IUSSP Seminar on Human Fertility in Africa. Trends in the last decade and prospects for change. 16-18 September 2008. Cape Coast, Ghana.

Schoumaker, B.and Hayford, S. 2004. A Person-Period Approach to Analysing Birth Histories. *Population.* 59(5):689-701.

Shapiro, D.and Gebreselassie, T. 2008. Falling and stalling fertility in sub-Saharan Africa. Presented at International Union for the Scientific Study of Population International Seminar on Human Fertility in Africa. 16-18 September, 2008. Cape Coast, Ghana.

Sullivan, J. 2008. An Assessment of the Credibility of Child Mortality Declines Estimated from DHS Mortality Rates (Working Draft). UNICEF.

Timaeus, I.M.and Balasubramanian, K. 1984. Evaluation of the Lesotho Fertility Survey 1977. *WFS Scientific Reports*. No.58. London.

United Nations. 2005. World Population Prospects: The 2005 Revision. New York: United Nations Population Division.

Verwimp, P.and Van Bavel, J. 2007. Child Survival and the Fertility of Refugees in Rwanda after the Genocide. *PRUS Working Paper no. 26*. Poverty Research Unit at Sussex University.

Westoff, C.F.and Cross, A.R. 2006. The Stall in the Fertility Transition in Kenya. *DHS Analytical Studies*. No.9. Calverton, Maryland, USA: ORC Macro, MEASURE DHS.

TABLE1: Incidence rate ratios for the underlying trend in age-specific fertility rates in Kenya 1980-2003

Variable	Incidence Rate Ratio	P>z	[95% Confidence Interval]	
Age of Mother[1]				
10-14	0.0228	0.000	0.0198	0.0262
15-19	0.5241	0.000	0.5053	0.5437
20-24	1.0527	0.000	1.0287	1.0772
25-29 (reference)	0	-	-	-
30-34	0.8399	0.000	0.8170	0.8634
35-39	0.6101	0.000	0.5856	0.6356
40-44	0.3268	0.000	0.3025	0.3531
45-49	0.1167	0.000	0.0908	0.1499
Year[2]				
1980-1987	0.9795	0.000	0.9716	0.9874
1987-1991	0.9396	0.000	0.9290	0.9503
1991-1995	0.9698	0.000	0.9577	0.9820
1995-2003	0.9937	0.086	0.9865	1.0009
Survey[3]				
DHS1989	0.8721	0.001	0.8065	0.9431
DHS1993	0.9090	0.011	0.8449	0.9779
DHS1998	0.9420	0.062	0.8846	1.0030
DHS2003 (reference)	0	-	-	-
Displacement/omission dummy[4]				
A year before cut-off year of DHS1989 (1982)	1.2338	0.000	1.1697	1.3013
A year before cut-off year of DHS1993 (1987)	1.0666	0.035	1.0046	1.1325
Cut-off year of DHS1989 (1983)	0.8887	0.002	0.8255	0.9567
Cut-off year of DHS1993 (1988)	0.8838	0.000	0.8275	0.9439
Cut-off year of DHS1998 (1995)	0.9126	0.015	0.8478	0.9824
Cut-off year of DHS2003 (1998)	0.9220	0.021	0.8607	0.9877

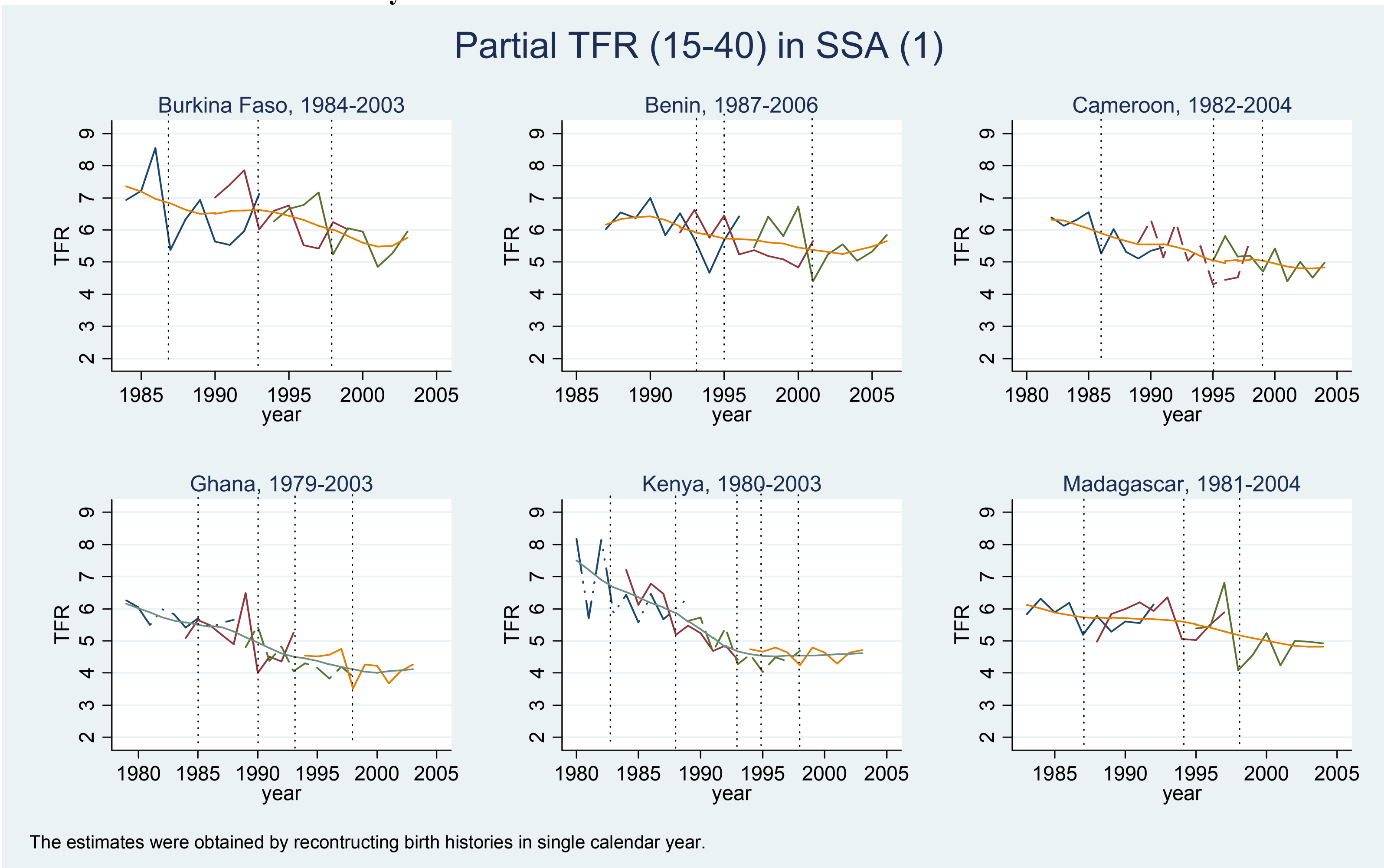
Notes:
1. These IRRs effectively define the pattern of the fertility schedule.
2. These are absolute IRRs. Each of these is statistically different from one in the previous period (the relative IRRs are not shown here). This indicates there is approximately a 2 % decline per annum in 1980-1987, 6 % in 1987-1991, 3 % in 1991-1995 and a stall in 1995-2003.
3. These present the effects arising from different surveys. Fertility estimates from DHS1989 are 13 % lower compared to the estimates from DHS2003, after controlling for other variables.
4. These dummies are intended to measure the degree of omission or/and displacement of births. There is a 23 % increase in a year before the cut-off year of DHS 1989 while 11 % reduction in the following year. This coupled abrupt change is a clear indication of displacement of births from a cut-off year to previous year. There is no sign of increase in a year before the cut-off year of DHS1998 and 2003.

TABLE2: Pace of Fertility Decline

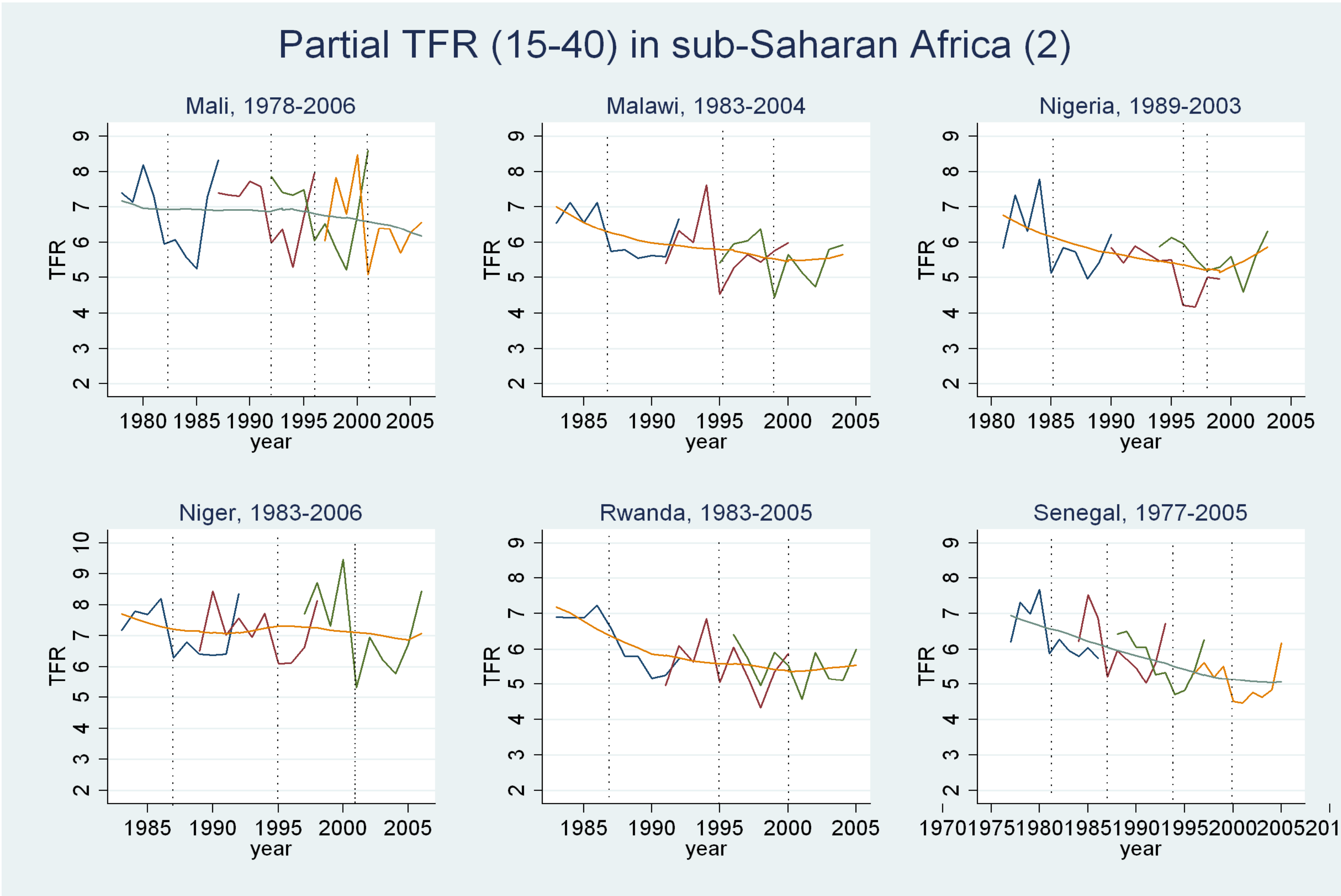
Country	Period	Pace of decline per annum (%)	p-value	
Benin	1987-94	-2.68	***	
	1994-98	-0.64		
	1998-2002	-2.88	***	
	2002-06	1.21	**	increase
Burkina Faso	1984-91	-1.99	***	
	1991-03	-3.08	***	decline
Cameroon	1982-88	-3.50	***	
	1988-92	-0.14		
	1992-96	-4.43	***	
	1996-2004	-1.67	***	decline
Ghana	1979-87	-1.05	**	
	1987-2003	-2.24	***	decline
Kenya	1980-87	-2.05	***	
	1987-91	-6.04	***	
	1991-95	-3.02	***	
	1995-2004	-0.63		stall
Madagascar	1983-88	-2.48	***	
	1988-92	2.69	***	
	1992-2005	-1.52	***	decline
Malawi	1983-88	-5.20	***	
	1988-92	3.77	***	
	1992-2004	-0.46	*	decline
Nigeria	19981-87	-2.93	***	
	1987-91	1.62		
	1991-95	-1.66	**	
	1995-99	-4.61	***	
	1999-2003	2.93	***	increase
Rwanda	1983-89	-4.40	***	
	1989-93	1.25		
	1993-2005	-1.46	***	decline
Senegal	1977-87	-0.87	**	
	1987-93	-2.76	***	
	1993-2005	-1.21	***	decline
Tanzania	1983-2004	-1.15	***	decline
Zambia	1983-90	-1.50	***	
	1990-94	0.36		
	1994-2002	-2.84	***	decline
Zimbabwe	1979-85	-2.54	***	
	1985-93	-4.58	***	
	1993-2005	-1.76	***	decline

***<0.001 **<0.01, * <0.05

FIGURE 1: Partial Total Fertility Rates



Note: dash vertical lines indicate cut-off years of eligibility for the questions on child health.



Partial TFR (15-40) in sub-Saharan Africa (2)
Mali, 1978-2006
Malawi, 1983-2004
Nigeria, 1989-2003
Niger, 1983-2006
Rwanda, 1983-2005
Senegal, 1977-2005
TFR
year

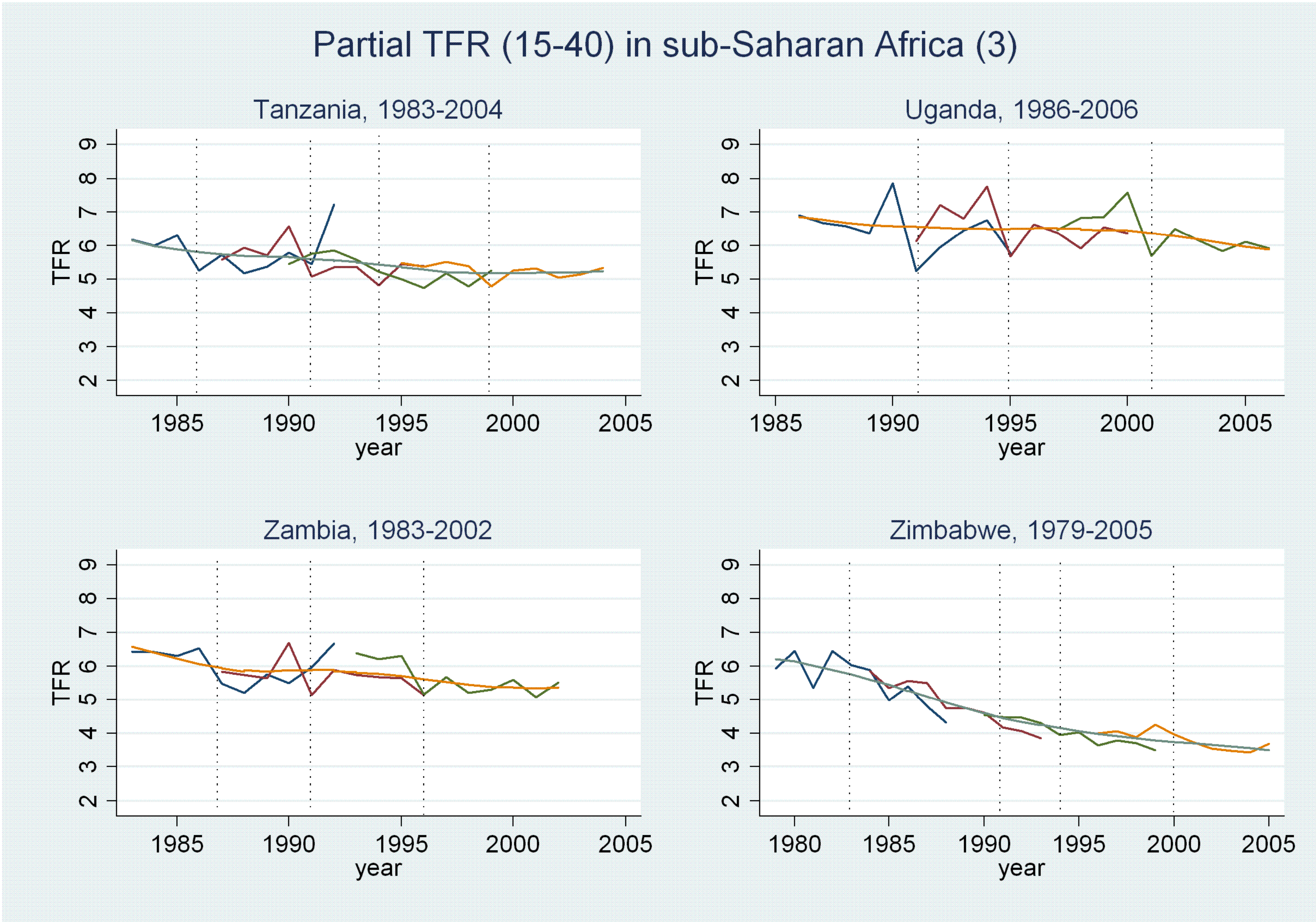
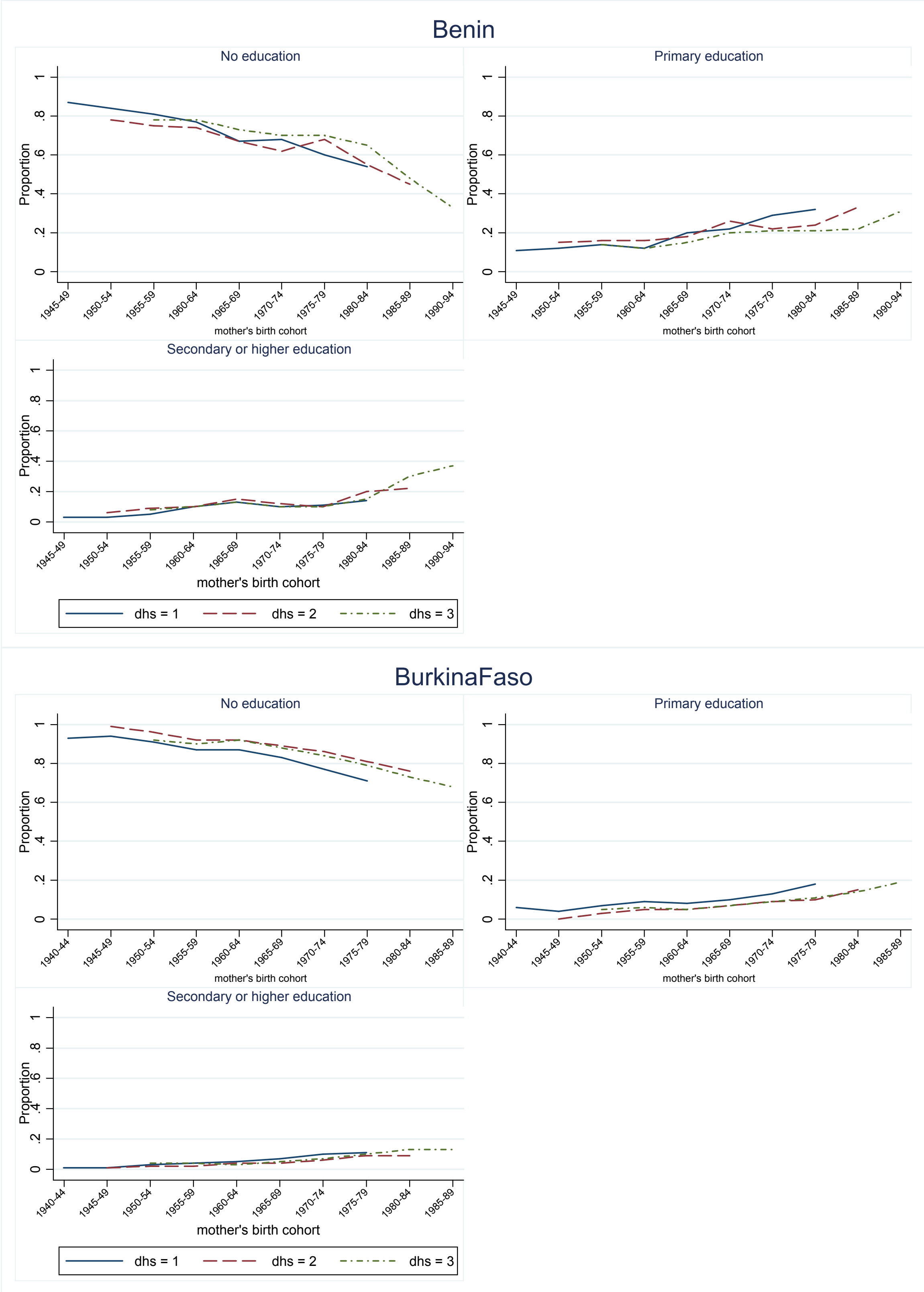
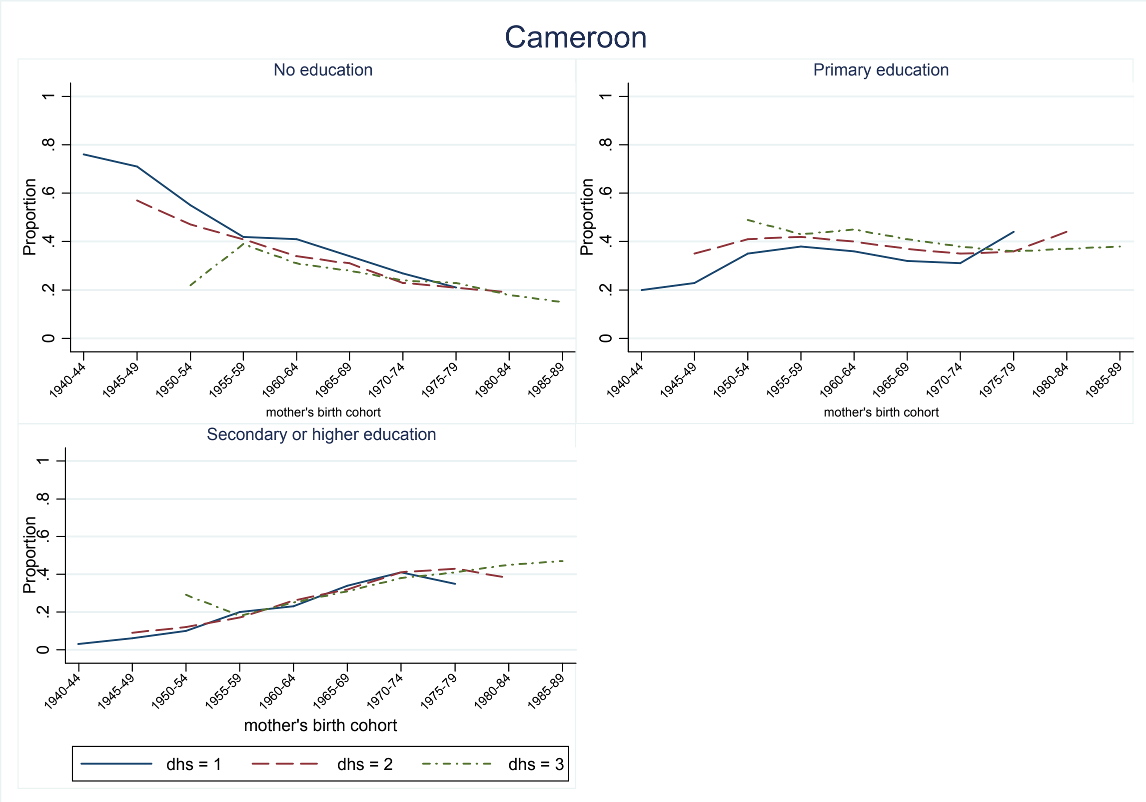
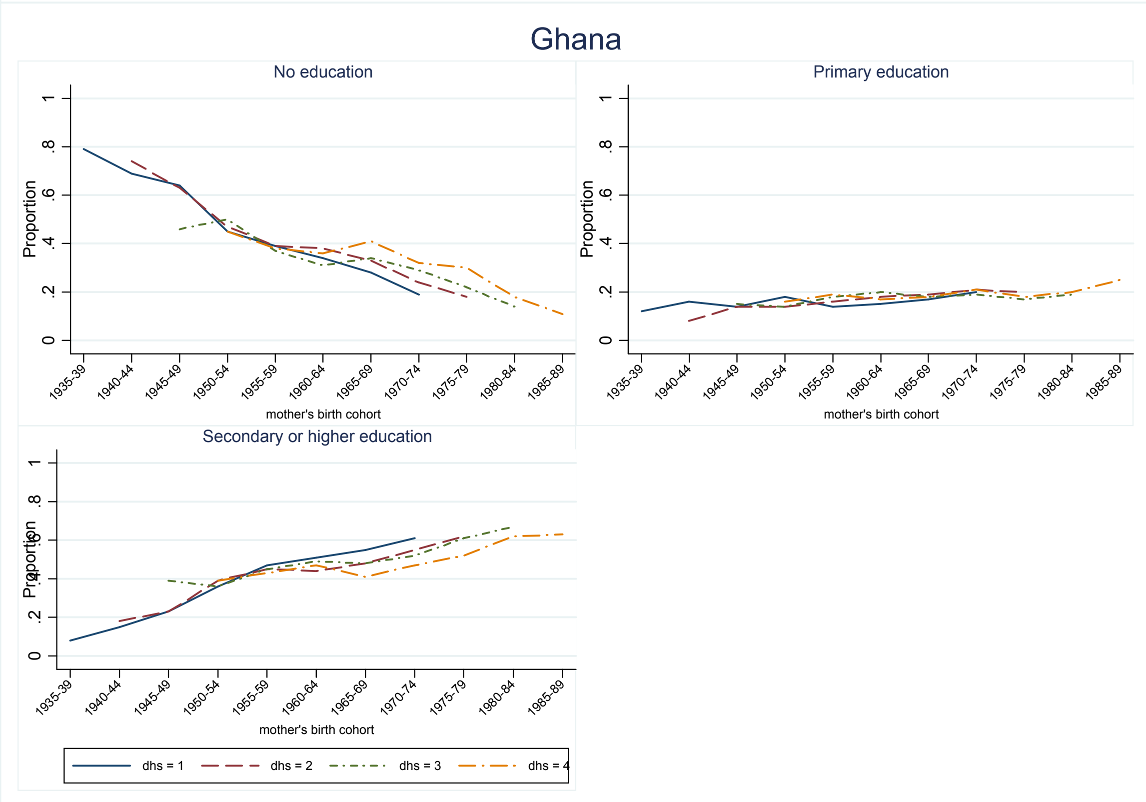

Partial TFR (15-40) in sub-Saharan Africa (3)
Tanzania, 1983-2004
Uganda, 1986-2006
Zambia, 1983-2002
Zimbabwe, 1979-2005
TFR
year
2 3 4 5 6 7 8 9
1980 1985 1990 1995 2000 2005

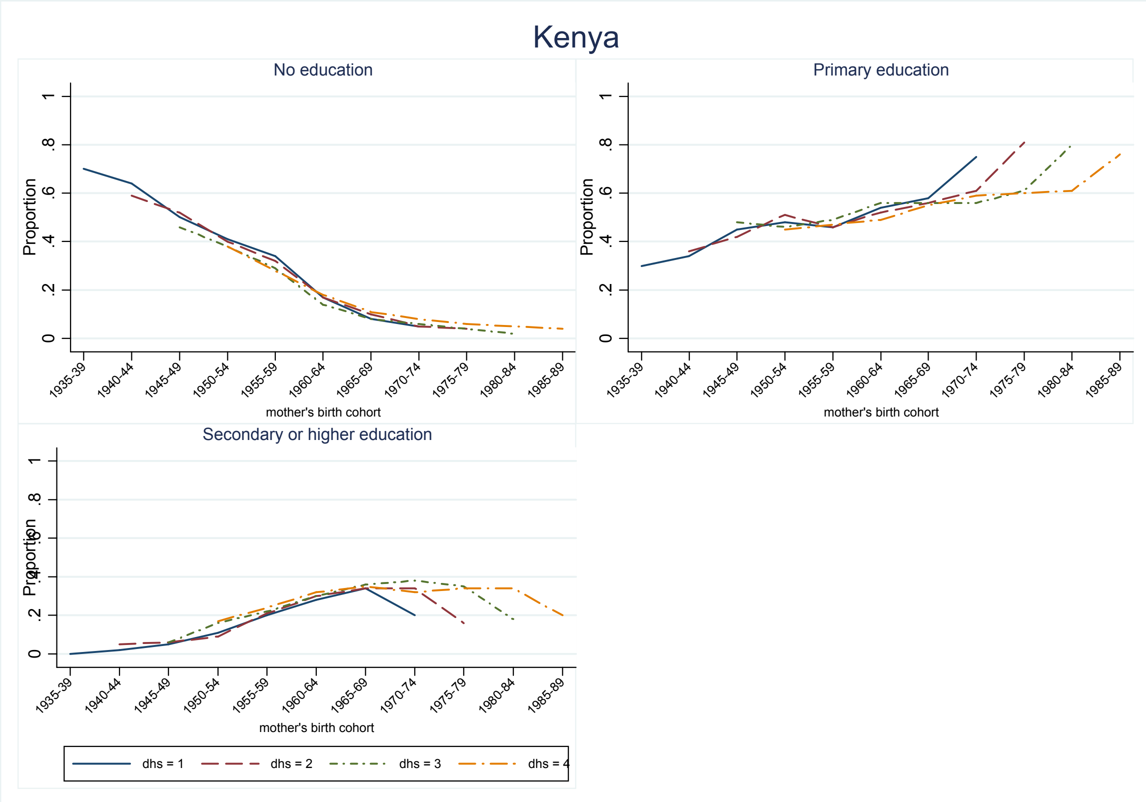
FIGURE 2 : Proportions of women with no/primary/secondary or higher education by birth cohorts and survey

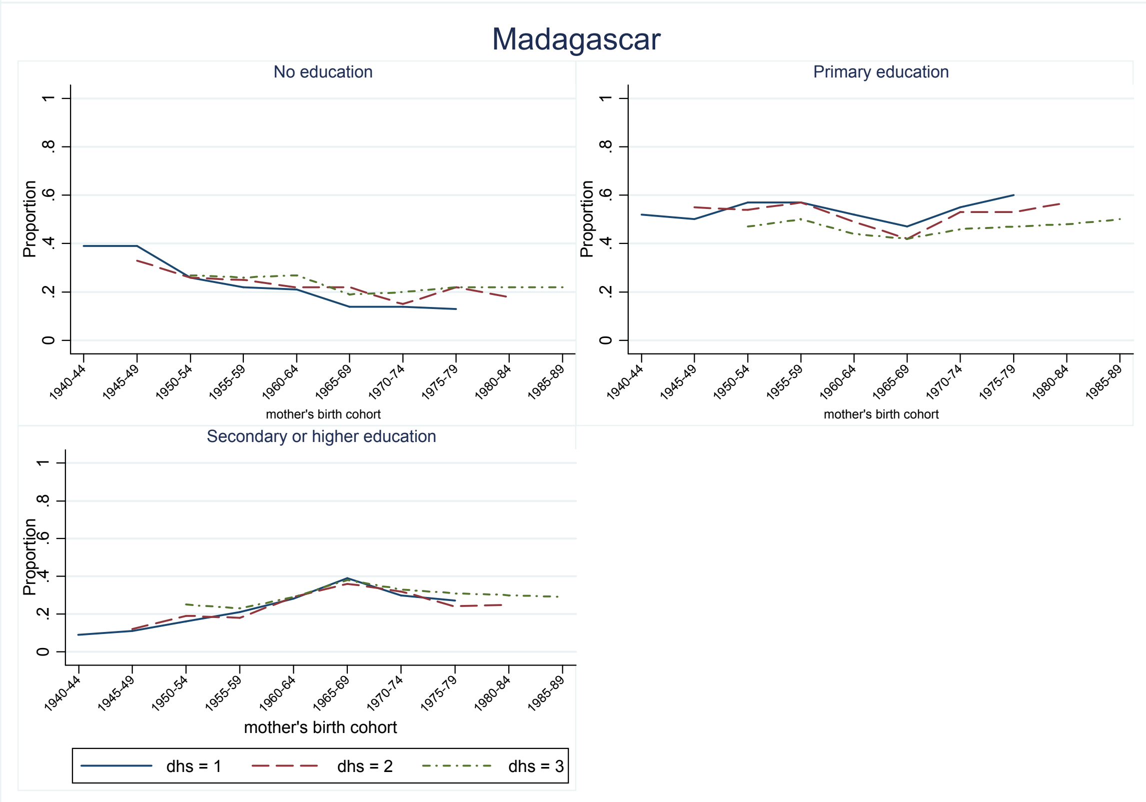


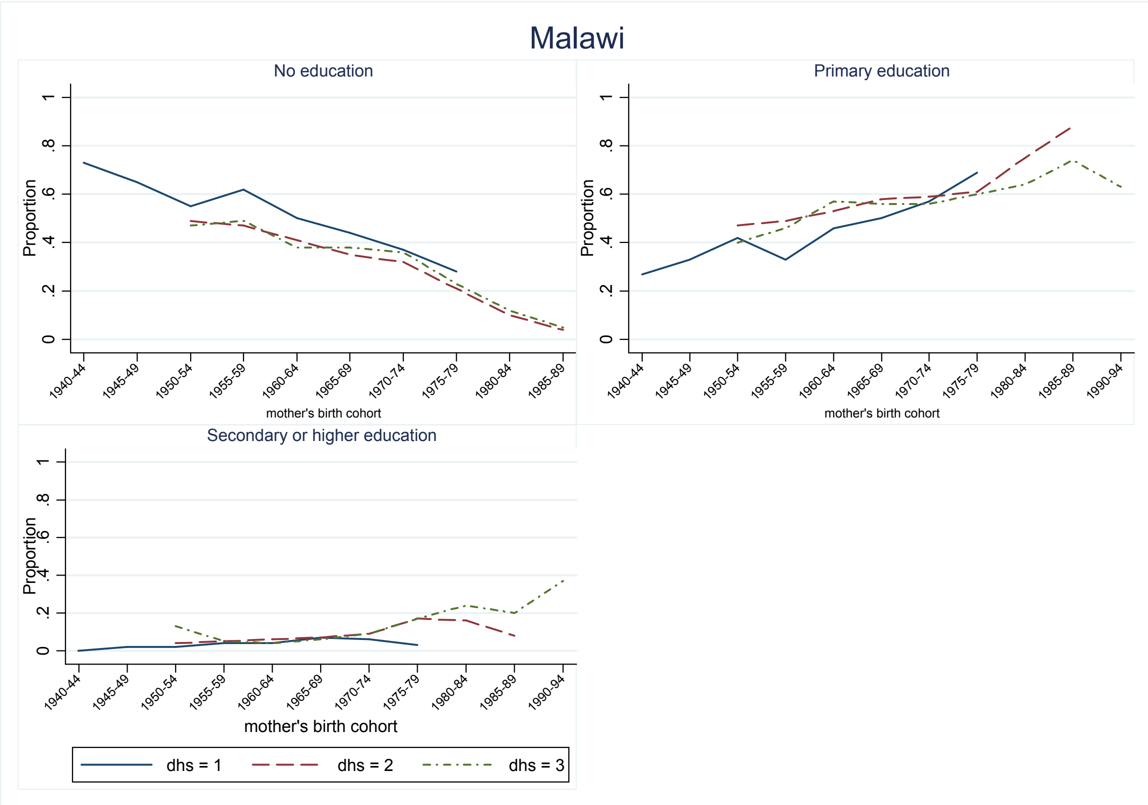


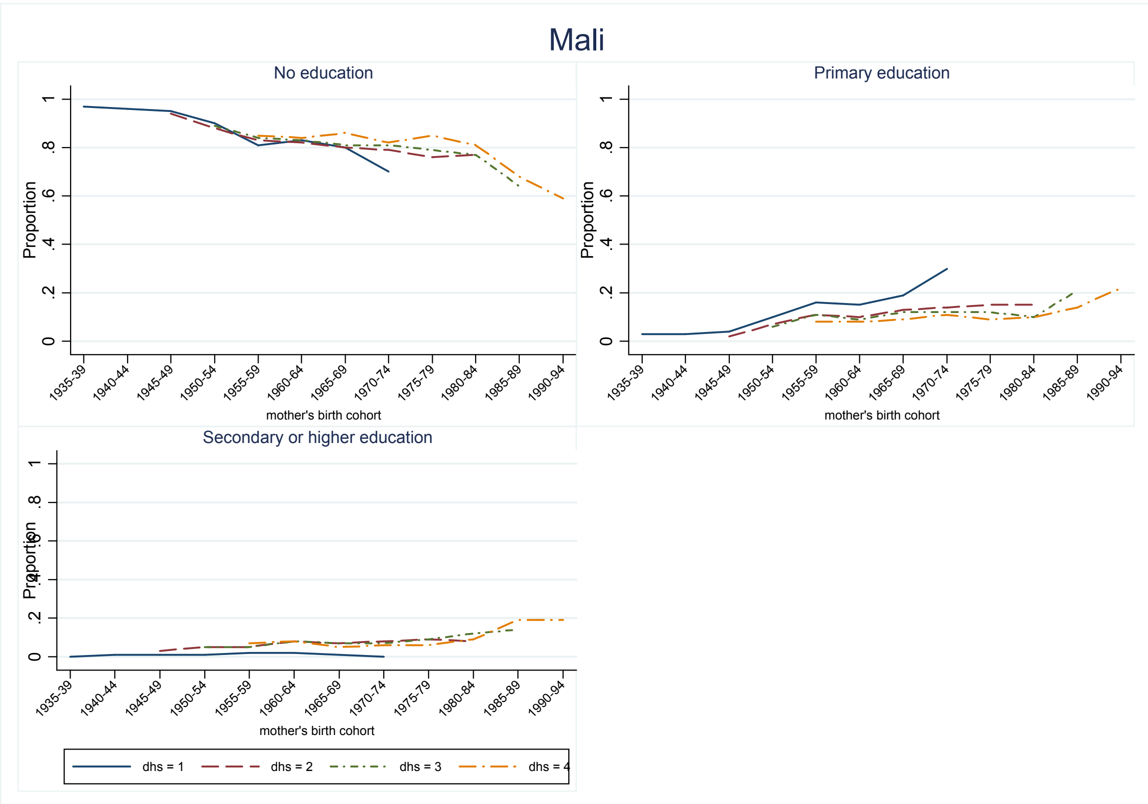


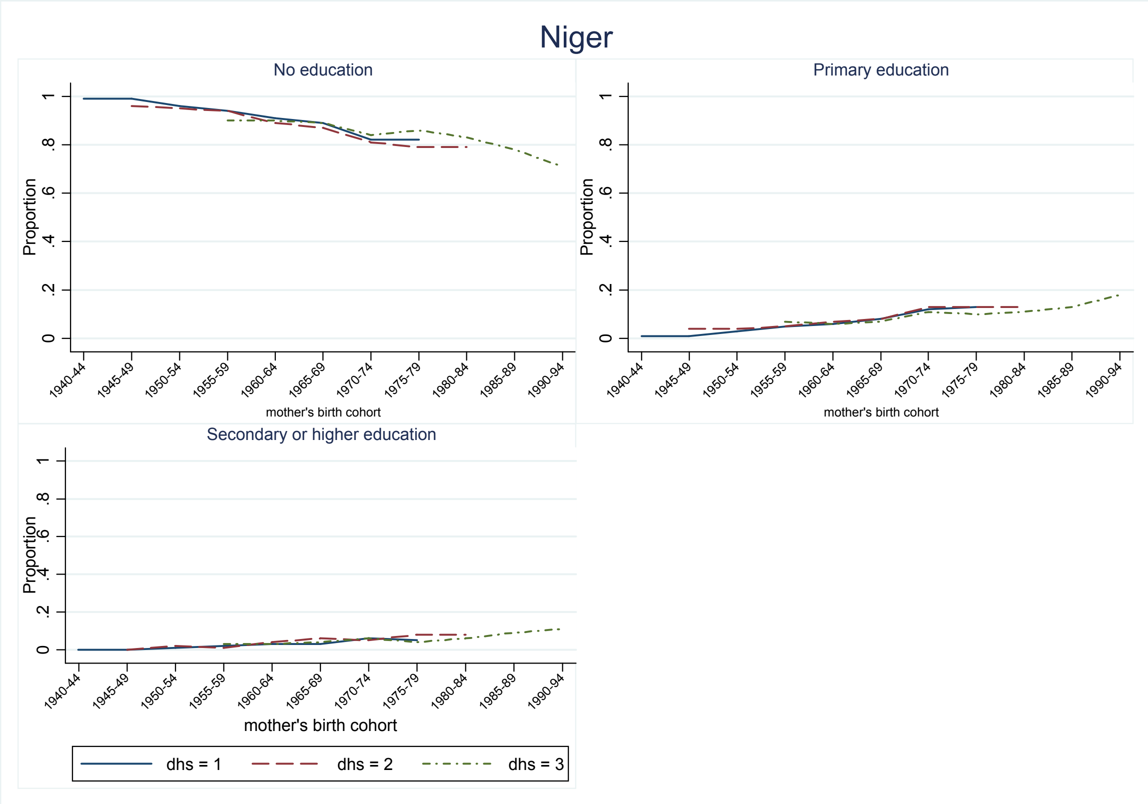
NB: The women who declared their highest education was primary education, but have 7 years and more education were recategorised as women with secondary or higher education in Ghana.

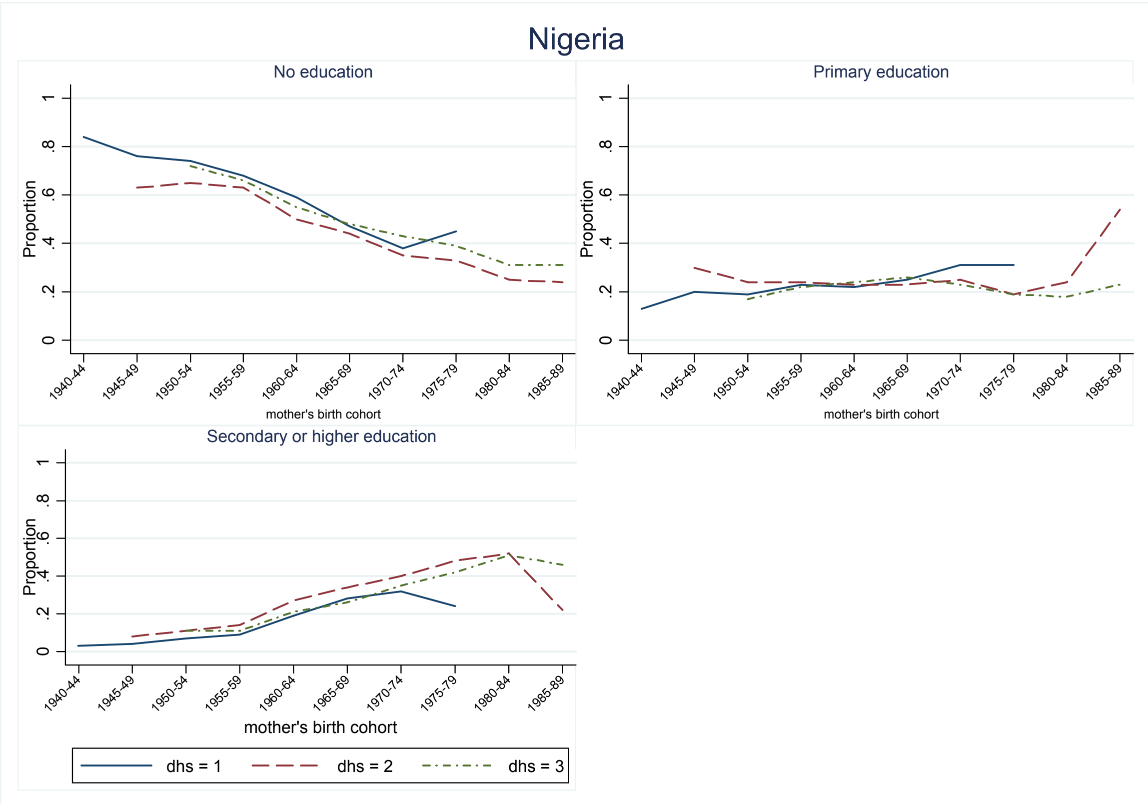

Kenya
No education
Primary education
Secondary or higher education
Proportion
mother's birth cohort
1935-39
1940-44
1945-49
1950-54
1955-59
1960-64
1965-69
1970-74
1975-79
1980-84
1985-89
dhs = 1
dhs = 2
dhs = 3
dhs = 4


Madagascar
No education
Primary education
Secondary or higher education
Proportion
mother's birth cohort
1940-44
1945-49
1950-54
1955-59
1960-64
1965-69
1970-74
1975-79
1980-84
1985-89
dhs = 1
dhs = 2
dhs = 3

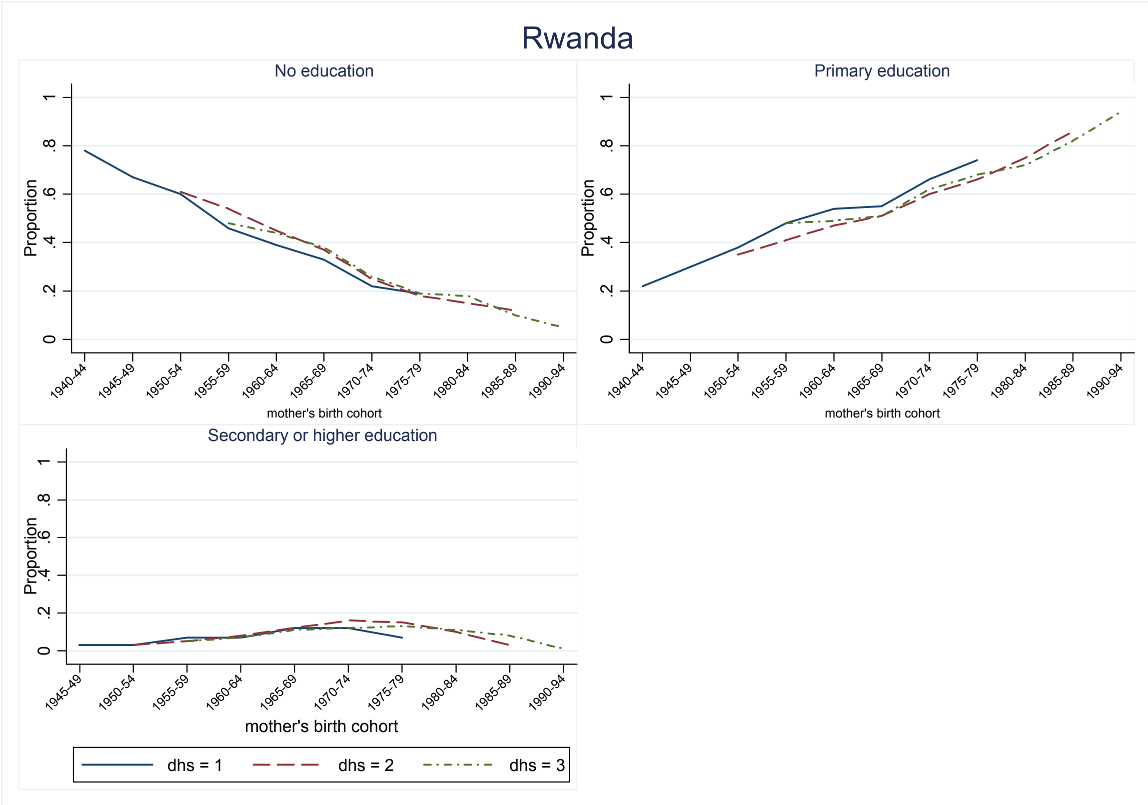

Malawi
No education
Primary education
Secondary or higher education
Proportion
0
.2
.4
.6
.8
1
1940-44
1945-49
1950-54
1955-59
1960-64
1965-69
1970-74
1975-79
1980-84
1985-89
1990-94
mother's birth cohort
dhs = 1
dhs = 2
dhs = 3

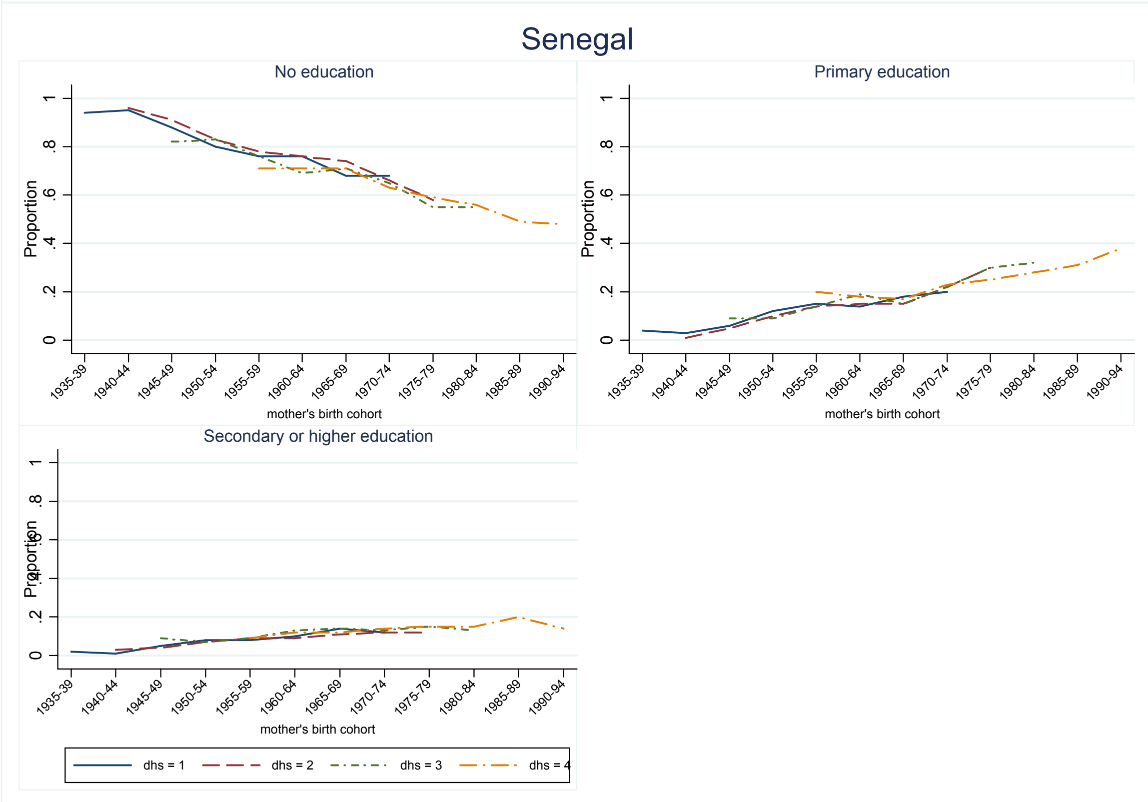

Mali
No education
Primary education
Secondary or higher education
Proportion
0
.2
.4
.6
.8
1
1935-39
1940-44
1945-49
1950-54
1955-59
1960-64
1965-69
1970-74
1975-79
1980-84
1985-89
1990-94
mother's birth cohort
dhs = 1
dhs = 2
dhs = 3
dhs = 4



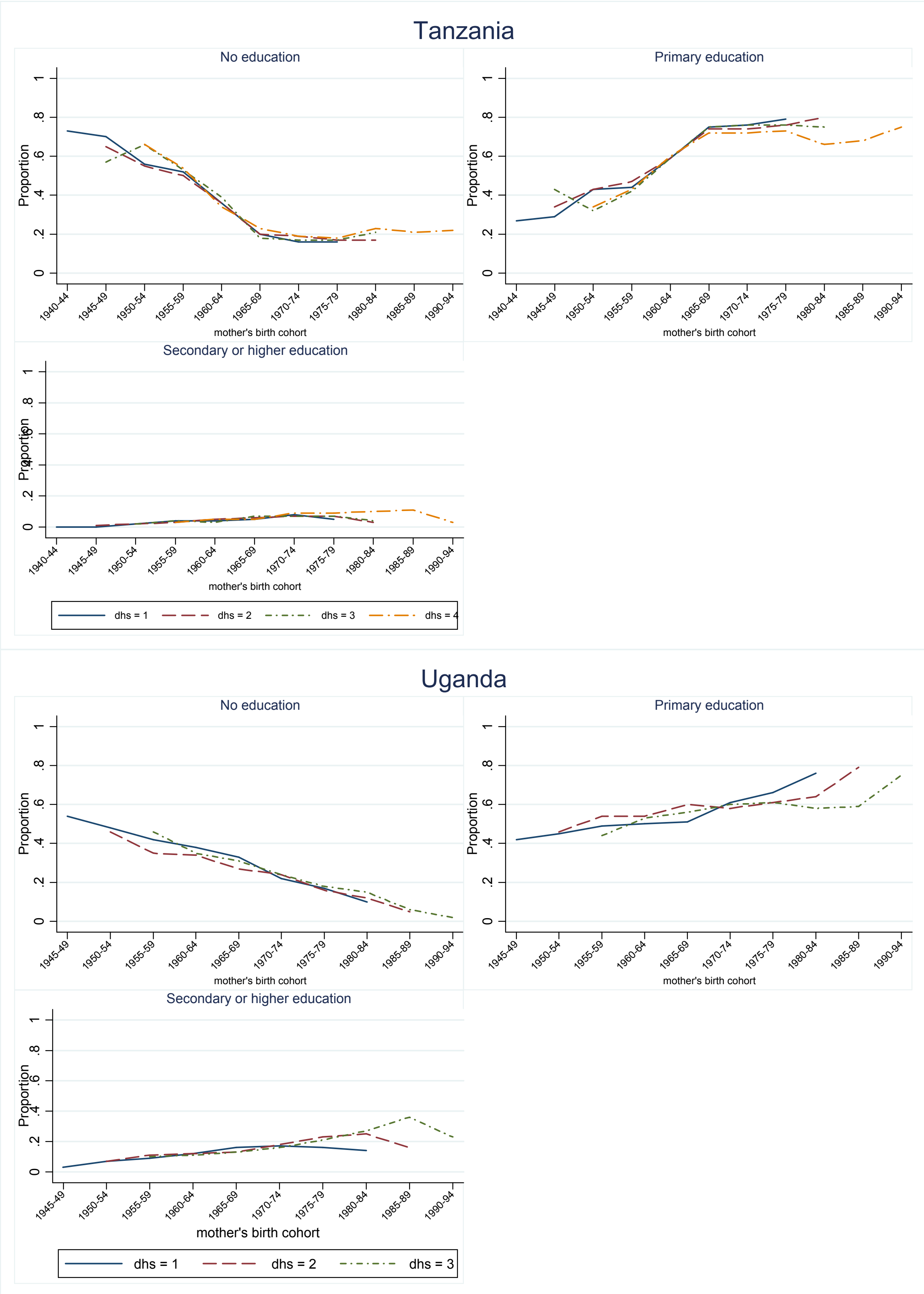


NB. Nigeria 2(1999) interviewed women aged 10-49 years old.

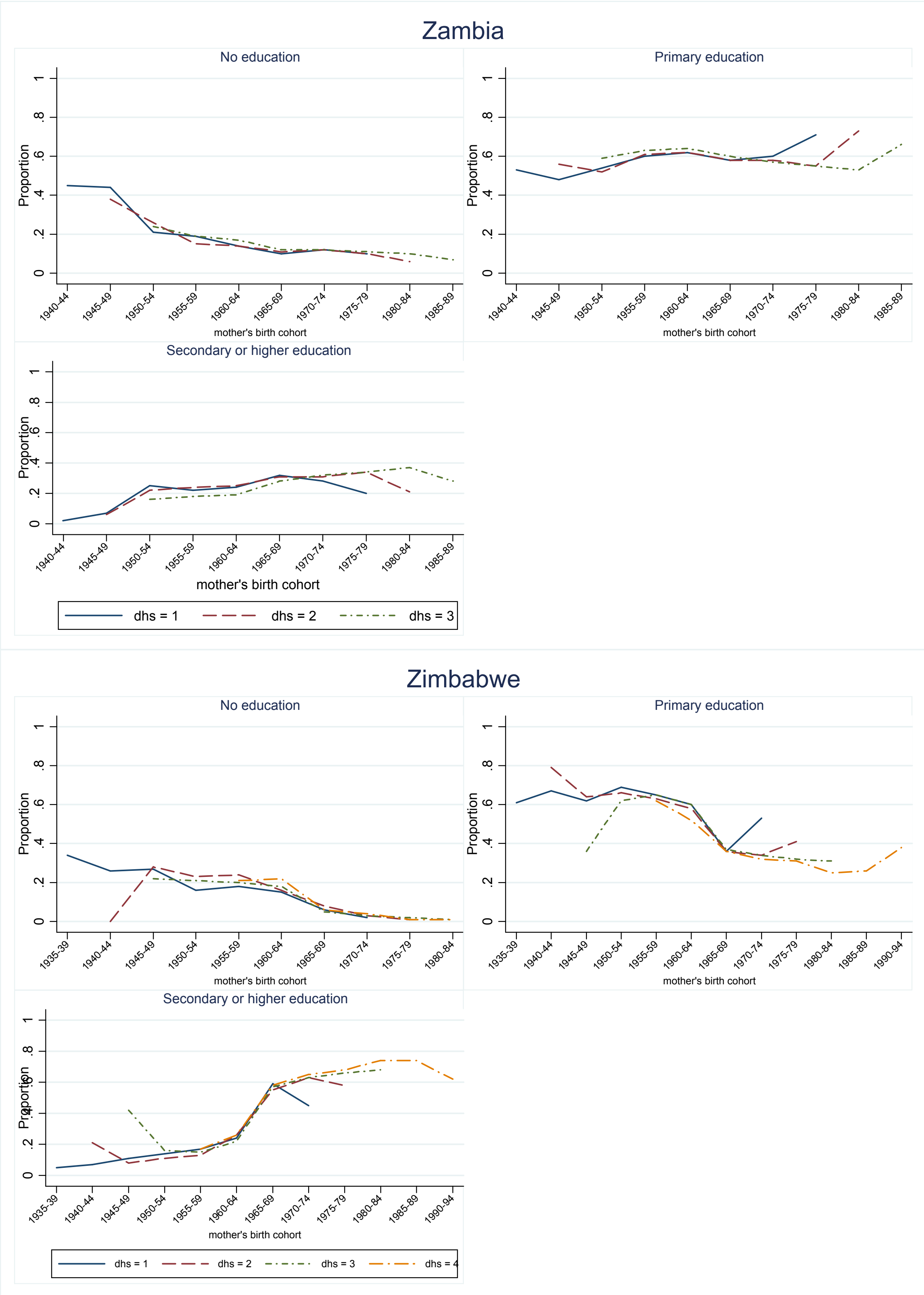

Rwanda
No education
Primary education
Secondary or higher education
Proportion
mother's birth cohort
0 .2 .4 .6 .8 1
1940-44 1945-49 1950-54 1955-59 1960-64 1965-69 1970-74 1975-79 1980-84 1985-89 1990-94
dhs = 1
dhs = 2
dhs = 3


Senegal
No education
Primary education
Secondary or higher education
Proportion
mother's birth cohort
0 .2 .4 .6 .8 1
1935-39 1940-44 1945-49 1950-54 1955-59 1960-64 1965-69 1970-74 1975-79 1980-84 1985-89 1990-94
dhs = 1
dhs = 2
dhs = 3
dhs = 4

.



NB: In Tanzania, 13 women with “other” education in DHS2 (1996) was excluded from this analysis.



Zambia
No education
Primary education
Secondary or higher education
Proportion
mother's birth cohort
dhs = 1
dhs = 2
dhs = 3
Zimbabwe
No education
Primary education
Secondary or higher education
Proportion
mother's birth cohort
dhs = 1
dhs = 2
dhs = 3
dhs = 4