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Research Article

The emergence of birth limitation as a new stage in the fertility transition in sub-Saharan Africa

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Abstract

BACKGROUND

The fertility transition started later in sub-Saharan Africa than in other regions of the world. Moreover, the average number of children per woman declined more slowly there, owing to a distinct mechanism of fertility reduction. It has been argued that the fertility decline in sub-Saharan Africa proceeded through an increase in birth intervals rather than by a limitation of the number of births.

OBJECTIVE

We analyze the fertility transitions in 29 countries to determine which mechanism women resort to in order to reduce their number of children.

METHODS

Using multiple sample surveys, we estimate and cross-validate trends in parity progression ratios and birth intervals. We identify sub-regional regularities and vanguard trends in the interplay between the dynamics of the lengthening of birth intervals and birth limitation over the period 1962–2012.

RESULTS

While initial fertility declines were driven by a lengthening of birth intervals at all parities, we observe a recent onset of birth limitation in regions and countries that are most advanced in the fertility transition.

CONCLUSIONS

The experience of sub-Saharan Africa shows that if all parities contribute to the fertility transition from the outset, the main drivers of the fertility decline switch from a

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lengthening of birth intervals to a limitation of family size when the average fertility reaches about five children per woman.

CONTRIBUTION
Our findings point to the emergence of birth limitation as a new stage in the fertility transition in sub-Saharan Africa. These results have implications for future fertility declines in sub-Saharan Africa.

1. Introduction

The nature of the fertility decline in sub-Saharan Africa (SSA) is a current topic of debate among demographers. Compared to past experiences in Asia and Latin America, the fertility decline in SSA began at much higher levels of fertility and lower levels of economic development, and progressed at a slower pace, mirroring the slower change in socioeconomic structures as well as a pro-natalist culture (Bongaarts 2017; Shapiro and Hinde 2017). The drop in the total fertility rate (TFR) started in the 1970s to 1980s, slowed down in the 1990s, and has resumed since the 2000s. Although all countries have experienced at least some decline, the onset and pace of this trend have varied substantially (Garenne 2008). In 2010–2015, SSA still had the highest TFR in worldwide comparison (5.1 children per woman on average), with Southern Africa leading the decline (2.6) followed by Eastern (4.9), Western (5.5), and Middle Africa (5.9) (United Nations Population Division 2017). In addition to concerns about the high levels of fertility, there is also much uncertainty about the future course of the transitions (Gerland, Biddlecom, and Kantorova 2017; Schoumaker 2017). In this article we aim to better understand the mechanisms of this slow fertility decline in order to help conceive future developments.

A first interpretation of the fertility decline in sub-Saharan Africa is based on Caldwell, Orubuloye, and Caldwell's (1992) predictive conjecture that the sub-Saharan Africa pattern is mainly driven by an increase in birth intervals (Timæus and Moultrie 2008; Hayford and Agadjanian 2019). This diverges from the classic pattern of family limitation in which women stop childbearing once they have achieved their desired family size (Henry 1952). In the SSA pattern of fertility decline, marriages have been deferred to higher ages from the very start of the fertility transition (Shapiro and Gebreselassie 2014; Hertrich 2017; Bongaarts, Mensch, and Blanc 2017) and all birth intervals have lengthened substantially (Johnson-Hanks 2007; Moultrie, Sayi, and Timæus, 2012; Casterline and Odden 2016). A similar pattern was also observed among the Mormons in the United States during the 19th Century (Lee, Mineau, and Anderton 1990).

Recent studies challenge this interpretation of the sub-Saharan African fertility transition as being essentially determined by the lengthening of birth intervals. Similar to the experience in Asia and Latin America, relative fertility decline has been more important at higher ages and has correlated with the drop in ideal family size (Bongaarts and Casterline 2013). Women are increasingly willing to stop childbearing, especially since 2000 and among women with a higher number of previous births (i.e., at higher parities; Casterline and Agyei-Mensah 2017). The more-educated stratum of society has also started implementing these new family ideals (Towriss and Timæus 2018). When compared to experiences in other developing regions, however, national-level fertility preferences are higher in SSA and their decline has not translated into comparable drops in the average number of births per woman. The unwanted fertility rate has stayed constant over the last 20 years because the level of unmet need for contraception is the highest in worldwide comparison (Günther and Harttgen 2016). The main difference of sub-Saharan Africa thus lies in the slower diffusion of modern contraceptives, although the trend is upward in all countries (Tsui, Brown, and Li 2017; United Nations Population Division 2019). In countries with the strongest increase in the prevalence of modern means of birth control (i.e., Southern and Eastern Africa), however, the purpose of the unmet need for contraception has changed from birth spacing to halting childbearing (Lesthaeghe 2014).

Our objective is to show that these two existing and seemingly conflicting interpretations of the African fertility transition are not so contradictory and can be reconciled in a common framework. Both can be conceived of as two successive phases of the same process – the fertility transition. Under this proposed sequential perspective, we argue that the lengthening of birth intervals characterized the onset of fertility decline in SSA, and that the progressive unfolding of fertility limitation in the region can be considered as the most logical subsequent development.

To achieve this, we analyze the fertility trends by women's number of previous births (i.e., parity) and intervals between successive births to investigate the sequence of mechanisms women resort to in order to reduce their number of children (i.e., increase in birth intervals vs. cessation of childbearing). We cover the last five decades in 29 SSA countries, comprising 90% of the total population in 2015. In so doing we document the changes in the quantum and tempo of fertility decline over the course of the fertility transition, because increasing birth intervals also temporarily depress period measures of fertility (Bongaarts and Feeney 1998).

2. Data and methods

Our aim is to identify sub-regional differences and similarities in the parity dynamics that underlie fertility change trajectories between 1962 and 2012 in order to inform current and future fertility developments in 29 sub-Saharan African countries (see Table A-1 in the Appendix). We use data from 124 World Fertility Surveys (WFS) and Demographic and Health Surveys (DHS) that include full birth histories. Small island countries were excluded, as well as countries with less than two surveys (because only short retrospective fertility series can be estimated).

We relied on subsequent fertility surveys per country to estimate, cross-validate, and smooth trends in parity progression ratios and average birth intervals, and we compared the observed and tempo-adjusted levels of total fertility. To better compare the country-specific trajectories of fertility decline we analyze trends over the stages in the national fertility transitions (rather than over calendar years). We focus on differences between sub-regions, as well as on the patterns observed in the countries that are the most advanced in the fertility transition (hereafter referred to as the vanguard countries). Results for other individual countries can be found in the Appendix.

Given the importance of the age of the youngest child in sub-Saharan Africa's unique fertility transition (Moultrie, Sayi, and Timæus 2012), we computed parity-specific measures of fertility. Compared to the TFR, these indicators are better suited to detect early changes in childbearing that can announce a new stage in Africa's fertility development. In this paper we compute the synthetic parity progression ratios (SPPRs) to the first, second, third, fourth, fifth, and sixth birth based on parity- and duration-specific fertility rates (Hinde 1998; Pullum 2004). SPPRs have been applied in various countries[4] to describe the changes in fertility and to assess the quality of survey data, but rarely in the case of sub-Saharan Africa (Spoorenberg and Issaka 2018; Spoorenberg 2019).

Focusing on the 15-year periods preceding each survey, the Nelson-Aalen empirical cumulative hazard function estimate of the survivor function (by month) was computed for sliding (or moving) left- and right-truncated 5-year synthetic cohorts in order to smooth out erratic variations. Nulliparous synthetic cohorts were truncated at age 35 and parity-specific cohorts were truncated after 10 years have elapsed since the

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[4] Afghanistan: Spoorenberg (2013a); Albania: Lerch (2013); Central Asian republics: Spoorenberg (2013b); Guatemala: Grace and Sweeney (2016); India: Spoorenberg (2010), Spoorenberg and Dommaraju (2012); Iran: Hosseini-Chavosi, McDonald, and Abbasi-Shavazi (2006) and McDonald et al. (2015); Mongolia: Spoorenberg (2009).

previous birth; we also truncated the cohorts when the at-risk populations fell below 10 women in order to avoid erratic jumps in parity progressions.[5]

Based on the survival functions (standardized for the level of parity progression), we estimated the singulate mean age at first birth and the singulate mean birth interval (Casterline and Odden 2016; Hajnal 1953). These indicators allow us to examine the tempo of childbearing in sub-Saharan Africa.

2.1 Cross-validation of the survey-specific estimates and smoothing of the trend

There is significant uncertainty in fertility measurement obtained from different surveys within a given country (due to biases related to the selection of the surveyed population, changing composition of the samples, and the omission or displacement of births) (Schoumaker 2014). To increase our understanding of the data problems we cross-validated the survey-specific trends (in SPPRs, mean age at first birth, and mean birth interval) against one another. Figure 1 illustrates the survey-specific trends in the progression ratios of nulliparous women to the first birth (in blue), from the second to the third birth (in red), and from the fourth to the fifth birth (in black) for Ghana – a country that contributes seven independent survey waves. The estimates from different surveys for overlapping years confirm the existence of data problems: the figures for the five years immediately preceding each survey are systematically under-estimated when compared with the retrospective estimates for the same years but derived from subsequent surveys. This can be explained by a well-documented reporting bias (Schoumaker 2014): Women and/or interviewers tend to omit recent births or to shift them backward in time in order to avoid filling out the lengthy questionnaire module on the health status of recent births. However, more distant retrospective estimates from each survey align with one another. Therefore, we believe that the omission of births (rather than their backward-shifting in time) constitutes the main bias in our estimates.

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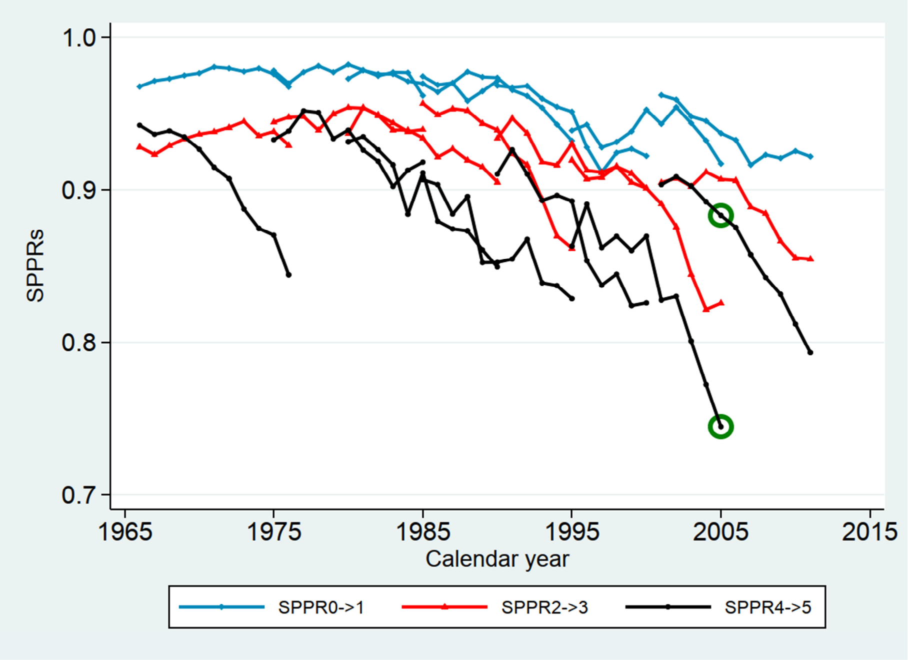
[5] Robustness tests showed that truncating the cohorts when the at-risk population falls below 30 or 50 women does not significantly alter the observed dynamics of fertility change, but tends to underestimate more strongly the overall level of fertility.

Figure 1: Synthetic parity progression ratios (SPPR) to the 1st, 3rd, and 5th births, as estimated from successive surveys, Ghana, 1964–2009



Sources: WFS and DHS.
Note: Estimates refer to sliding left- and right-truncated 5-year synthetic cohorts that are indexed by the central year.

In order to measure the extent to which this quality issue diverges by country and women's parity, we calculated for each pair of successive surveys the absolute difference between the last estimate derived from a given survey (based on data covering the immediately preceding five years) and the estimate for the same period but based on the subsequent survey. The two green dots in Figure 1 illustrate this point. We then averaged these differences over the survey pairs by country and by parity. The average difference increases with parity from less than 2 percentage points for the first birth progression ratio (SPPR0→1) to slightly more than 3 points for the third and fourth birth progression ratios (SPPR2→3 and 3→4), and then jumps more strongly to less than 5 and more than 6 points for the progression ratios to the fifth and sixth birth (SPPR4→5 and 5→6; see Figure A-1). The bias is most pronounced in the Democratic Republic of Congo, Burkina Faso, Ethiopia, Ghana, Liberia, Lesotho, Mozambique, Togo, and Zimbabwe (at least 6 points difference on average in the SPPR4→5 and

5→6; not shown). The differences in the estimates of two successive surveys reach up to 12 percentage points for specific parity progressions and countries. The parity-specific pattern of the biases in the birth histories has implications for the training of interviewers. Particular attention should be paid to the reporting and correct dating of higher order births. More-fertile women are subject to a higher response fatigue when they complete the birth history module, and interviewers can adopt strategies to limit their workload. However, variations in the composition of the relatively small samples of women at higher parities could also play a role.

These problems with the data lead to an underestimation of fertility levels and an overestimation of birth intervals, especially at higher parities and in the periods immediately preceding the last survey when different waves are pooled together (see Figure A-2 and Figure A-3 in the Appendix for a selection of countries). This has implications for our study, which aims to identify whether and when the lengthening of birth intervals stops and is followed by birth limitation. Therefore, we decided not to consider the problematic information from women's birth histories for the five years preceding each survey (i.e., to avoid the problems related to omitted births). The more distant retrospective estimates from subsequent surveys are averaged for overlapping years, and the trend is smoothed (using a running line least squares function; we used a bandwidth of 0.75 in order to smooth the most erratic series of estimates). Our estimates cover the 1960s up until the early 2010s. Table A-1 in the Appendix reports the observation periods by country.

2.2 Estimating total fertility and tempo effects over the course of the fertility transition

A period measure of total fertility (TF) can be obtained based on the smooth estimates of SPPRs: the average lifetime parity achieved by the synthetic cohort. It is computed as a weighted average of the women's parities attained (*i*), with the weights being the parity distribution as implied by the chained *SPPR*s:

$$TF = \left[\sum_{i=1}^{5} i * SPPR_{0\to1} * \dots * (1 - SPPR_{i\to i+1})\right] + avCEBP6 * SPPR_{0\to1} * \dots * SPPR_{5\to6}$$

For the last parity group (women with at least six births) we estimated the attained parity as the average number of children ever born at the survey dates (*avCEBP6*). We then linearly interpolated estimates between surveys (extrapolated for the period before the first survey) and smoothed the trend.

As shown in Figure A-4 in the Appendix, our estimates of total fertility fit the United Nations TFR series (United Nations Population Division 2017) relatively well, except in the earliest and most recent phases of the fertility transition. When fertility peaked in the 1960s and 1970s our survey estimates are systematically below the United Nations estimates (by 0.5 to 1.5 births). This may derive from the fact that the United Nations adjusts the observed TFRs upward to ensure coherence with child cohorts enumerated in successive censuses. By contrast, most recent United Nations estimates are situated below our figures, which do not include the most recent and problematic data from each survey. For comparison purposes we also show a smooth trend in total fertility as estimated based on the survey data that includes the last five years of birth histories (see green line in Figure A-4).[6] This alternative series is indeed closer to the recent UN estimates, for all countries. Thus, our cautious and conservative estimation approach may lead to a slight under-estimation of the fertility decline, but enables a robust analysis of quantum and tempo dynamics in the fertility transition.

The impact of increasing birth intervals on the fertility trends is assessed by comparing the observed level of total fertility with a tempo-adjusted measure, following Bongaarts and Feeney's approach (Bongaarts and Feeney 1998). The series of TFs were recalculated once the observed smoothed SPPRs were adjusted for the change in the singulate mean age at first birth and the singulate mean birth intervals over time.

We analyze fertility trends according to the number of years elapsed since the onset of fertility decline, rather than according to calendar years. This helps to better compare the dynamics in forerunner and laggard countries, and to better conceive future fertility trajectories in high-fertility countries. Using the United Nations series of TFRs (United Nations Population Division 2017), the transition onset is defined as the year when the value last peaked before experiencing a decline of at least 10% (Casterline 2001) (see Table A-1 and Figure A-4). This unconventional threshold for the transition onset (as opposed to the first year in which the TFR is below 10% of the peak level) takes better account of the slow pace of fertility decline in SSA (Shapiro and Hinde 2017).

2.3 Trends by sub-region

Even though this analysis covers 90% of the total population of sub-Saharan Africa in 2015, the observation periods differ substantially by country. We therefore summarize

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[6] Results including the birth history data for last five years preceding a survey are available from the first author, upon request.

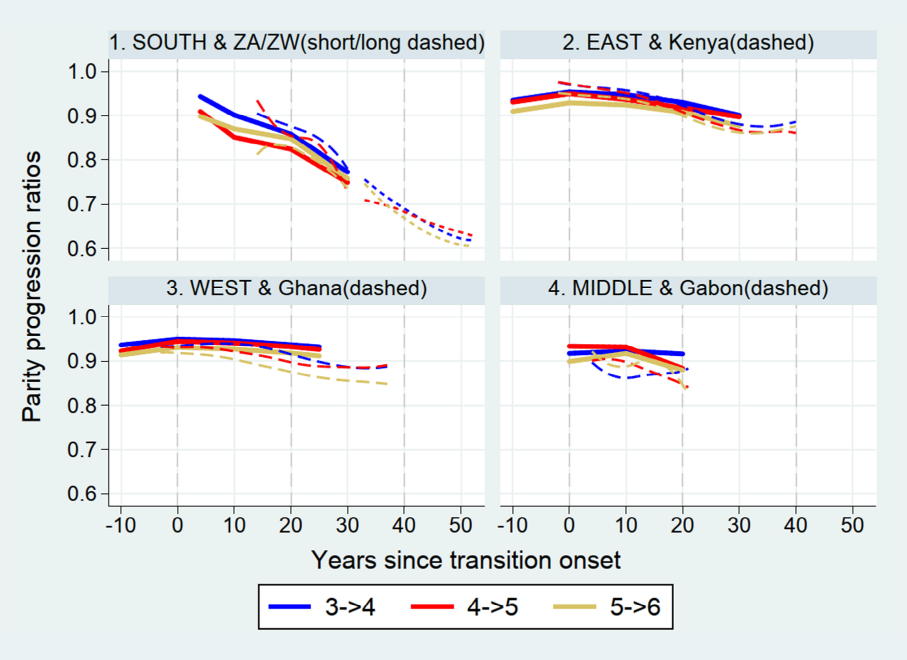
the fertility trends by sub-region using a regression-based approach (Casterline and Odden 2016). We first estimated the average within-country pace of fertility decline per transition decade (based on the annual smooth country-specific series) by linear spline regressions (with knots at the transition onset and 10, 20, 30, and 40 years after) stratified by sub-region and including country fixed effects. The regression coefficients were then used to predict the sub-regional average within-country trend. We adopted the United Nations regional grouping of countries (Southern, Eastern, Western, and Middle Africa), except for Zimbabwe. This Eastern Africa country was reclassified in the Southern group because the trends are similar when compared to those observed in this latter group. Appendix Figures A-4 to A-8 show the trends for individual countries.

3. Limited declines in progression to upper parities and stability in progression to lower parities

In the large majority of SSA, as shown in Figure 2, the transition ratios to upper parities (i.e., from the third to the fourth birth, from the fourth to the fifth, and from the fifth to the sixth) remain above 90%. The exceptions are Southern Africa (with ratios below 80%) and the countries that are the most advanced in the fertility transition in the other regions (Gabon, Ghana, Kenya, and Madagascar; slightly below 90%). In these areas the onset of fertility transition was earlier, and our estimation series cover more advanced stages. The 90% and 80% thresholds of parity progression were crossed, respectively, in the first and third decade after the onset of the fertility transition. In the country that is most advanced in the fertility transition (South Africa) the most recent progression ratios to higher parities approached 60%.

In the countries outside Southern Africa, where the onset of the fertility transition is more recent, the progression ratios to the higher parities have declined only slightly, at best. In Eastern Africa the 90% threshold was reached only in the third transition decade. In Western and Middle Africa, fertility change was very limited. The progression ratios to higher parities have remained high and stable and even seem to have increased in some countries (i.e., Chad and Niger, see Figure A-5 in Appendix).

Figure 2: Synthetic parity progression ratios to the 4th, 5th, and 6th birth over the course of national fertility transition, regions and vanguard countries of sub-Saharan Africa, 1962–2012

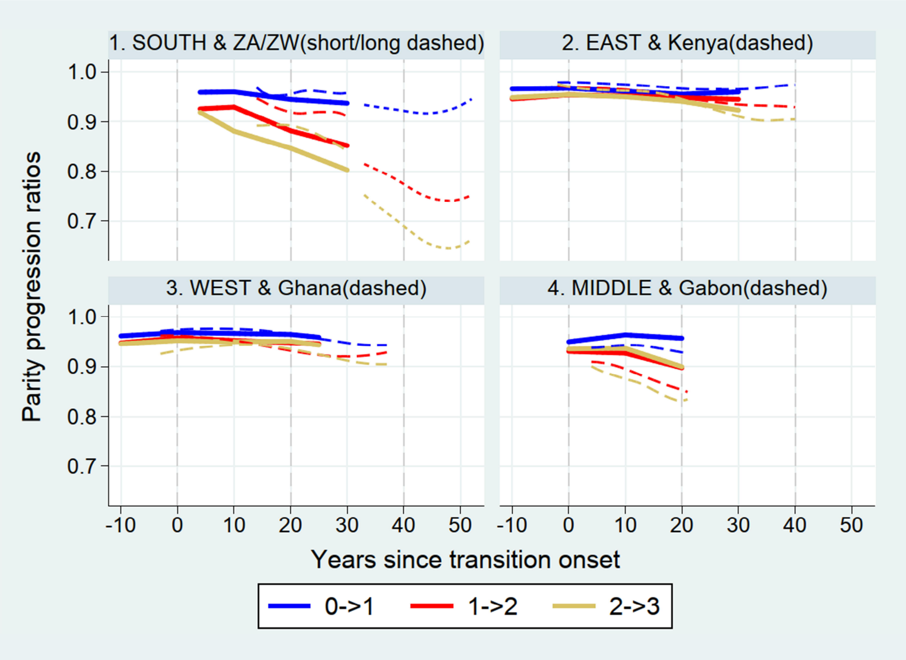


Sources: WFS and DHS.
Notes: ZA = South Africa, ZW = Zimbabwe; the estimates refer to 5-year synthetic cohorts indexed by the central year.

These declines in the progression ratios to the upper parities not only are small, but also do not conform to a classic process of family limitation. There is limited differentiation in the fertility declines by parity. Only in Congo, Ghana, Mozambique, and Zimbabwe is the rate of sixth births significantly lower than that of fourth and fifth births; in Lesotho the rate of fifth births is also slightly inferior to the other two upper parity progression ratios (see Figure A-5 in Appendix).

As with fertility at upper parities, the progression ratios to the lower parities (i.e., first, second, and third births) remain universal (i.e., above 90%) in the majority of countries (Figure 3). The exceptions are again found in Southern Africa, as well as in the highly urbanized country of Gabon, where the progression ratios to lower parities fell to levels between 80% and 90%, or even below in the more advanced transitional stages reached in South Africa. Here, we also find more differentiation between the fertility trends at lower parity groups, when compared to those at upper parities. The declines are steeper in third than in second and first births, providing weak evidence for a pattern of family limitation.

Figure 3: Synthetic parity progression ratios to the 1st, 2nd, and 3rd birth over the course of national fertility transitions, regions and vanguard countries of sub-Saharan Africa, 1962–2012



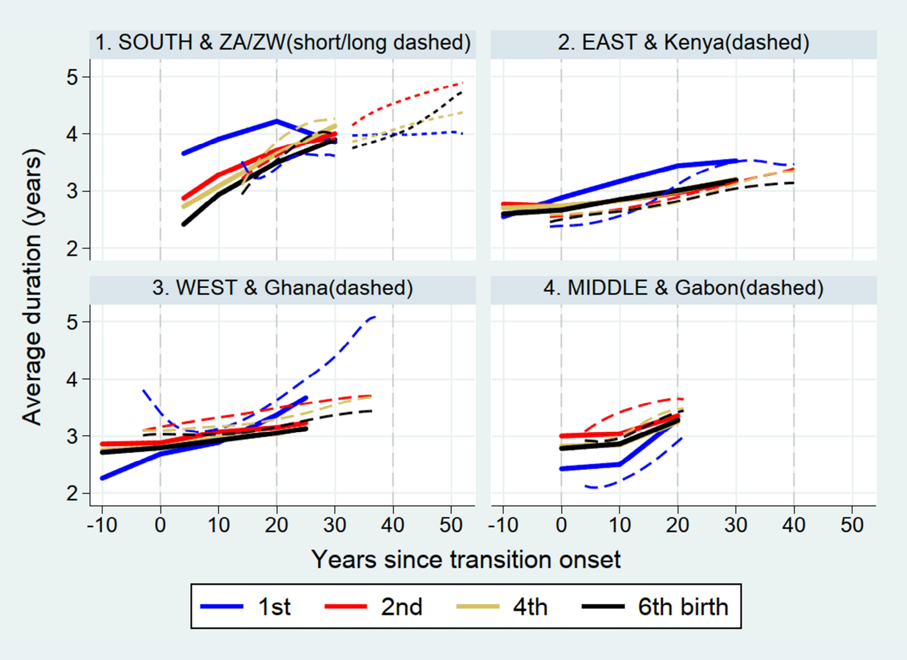
Sources: WFS and DHS.
Notes: ZA = South Africa, ZW = Zimbabwe; the estimates refer to 5-year synthetic cohorts indexed by the central years.

As with fertility at upper parities, the trends at lower parities do not indicate any sign of a fertility decline in Western Africa, which is the least advanced region in the fertility transition. In Liberia, Niger, and Middle Africa (excluding Gabon), we even observe an increase (see Figure A-6 in Appendix).

4. Is a new stage in the fertility transition emerging as the lengthening of birth intervals reaches a limit?

In order to appreciate the importance of birth interval lengthening in SSA, Figure 4 shows the singulate mean birth interval by parity and the singulate mean ages at first birth (from which we subtracted 17 years in order to plot it on a comparable scale).

Figure 4: Singulate mean age at 1st birth and mean birth intervals over the course of national fertility transitions, regions and vanguard countries of sub-Saharan Africa, 1962–2012



Sources: WFS and DHS.
Notes: ZA = South Africa, ZW = Zimbabwe; the estimates refer to 5-year synthetic cohorts indexed by the central year; The mean age at first birth is plotted after subtracting 17 years.

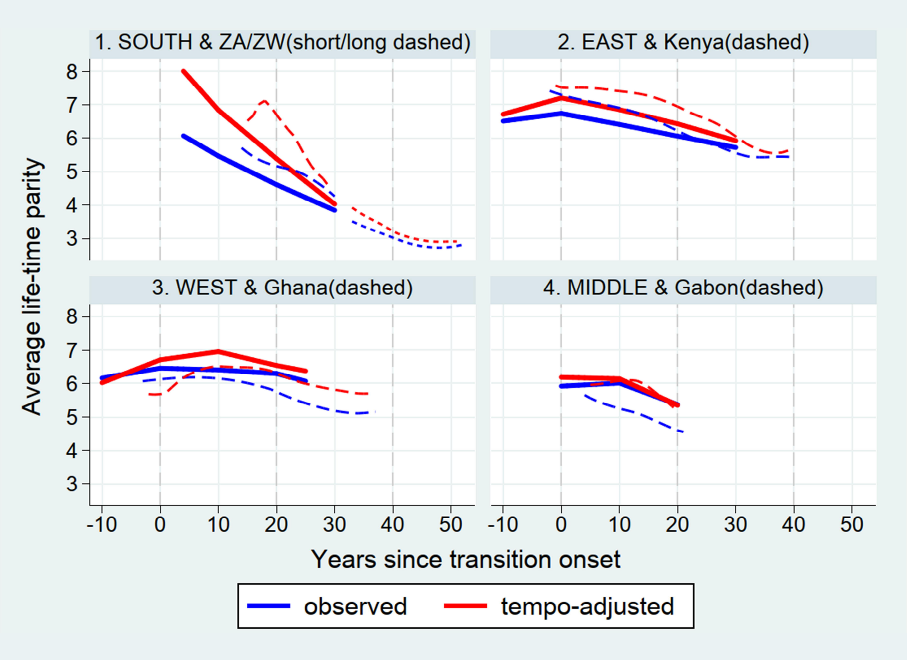
In all regions and the large majority of countries, the singulate mean birth intervals at the onset of the fertility transition were between 2.6 and 3 years. Birth intervals lengthened the most (by at least one year) in Southern and, to a lesser extent, Eastern Africa, where the fertility decline was stronger. Two striking observations are notable, as they confirm previous research. In all regions and almost all countries the average birth interval at the transition onset does not vary significantly by parity. The pace of increase in birth intervals was also the same across parity groups. However, we observe a recent leveling off in the lengthening of birth intervals in the countries that are more advanced in the fertility transition (e.g., Kenya, Gabon, Ghana, Zimbabwe, as well as in Rwanda, Togo, and Senegal; see also Figure A-7 in Appendix). This recent trend may announce a new stage in the fertility transition of SSA. Alternatively, it may be related to the stalls in fertility decline observed in some of these countries (even though many observed stalls have been invalidated due to data problems (Schoumaker 2009)). It must also be acknowledged that in two of the four forerunning Southern African countries (e.g., South Africa and Namibia) the interval to the sixth birth continued to lengthen in the most recent period.

When compared to the timing of higher order births, the mean ages at first birth differed to a greater extent by region. In Eastern, Middle, and particularly Western Africa, where nuptiality has traditionally been universal and early (Caldwell, Orubuloye, and Caldwell 1992; Hertrich 2017), women had the lowest singulate mean age at the first birth (between 19 and 20 years) at the onset of the transitions. In later stages they have continuously postponed the event. In recent years, women in several Western African countries had their first child around the age of 21–22 on average (such as in Ghana, Togo, Senegal), which is at least two years later than 20–30 years ago. Only in Mali, Burkina Faso, Malawi, Mozambique, Liberia, Niger, and Chad do the mean ages remain below 20 years (Figure A-7 in Appendix). The onset of motherhood was also postponed by about one year in several Eastern African countries, such as Burundi, Kenya, and Uganda. Thus Western and to a lesser extent Eastern Africa caught up with the Southern region of the continent, which was historically characterized by later marriages (and more extra-marital births). In the latter region the changes in the timing of first births have been more limited over the last thirty years.

5. The tempo and quantum of fertility change

In order to evaluate the extent to which the fertility trends have been affected by the lengthening of birth intervals in Southern and Eastern Africa and by the later onset of motherhood in Western Africa, we compare the observed and tempo-adjusted levels of total fertility in Figure 5.

Figure 5: Observed and tempo-adjusted level of total fertility over national fertility transitions, regions and vanguard countries of sub-Saharan Africa, 1962–2012



Sources: WFS and DHS.
Notes: ZA = South Africa, ZW = Zimbabwe; the estimates refer to 5-year synthetic cohorts indexed by the central years.

The results reveal a patterned interplay between birth interval lengthening and birth limitation over the course of the fertility transition. In the first transitional decade the tempo-adjusted fertility level remained rather stable (or even slightly increased – except in Southern Africa) but the observed level declined. Thus, fertility dropped mainly because of increasing birth intervals (a tempo effect). By contrast, in the two subsequent decades the tempo-adjusted level of fertility started to drop alongside the observed decline, indicating that women were indeed reducing the number of children they were having (a quantum effect). Twenty-five years after the transition's onset the tempo-adjusted fertility fell even more steeply. As the trend in the observed fertility leveled off, the two indicators converged. Thus, the lengthening of birth intervals slowed down and affected the measurement of fertility less and less.

This pattern of an initial tempo-driven fertility change and a later quantum-driven decline is most clearly visible in Kenya, where our data covers the whole process. The same pattern can also be observed in other sub-regions and countries that are significantly advanced in the fertility transition: Southern and Eastern Africa as well as Ghana, Togo, and Senegal (Figure A-8 in Appendix). As the onset of the fertility transition is too recent or is yet to be observed in most of the other Western and Middle African countries, a halt in the tempo effects is not yet apparent.

6. Discussion

In line with Moultrie, Sayi, and Timæus (2012), our results confirm that the initial stage of the fertility transition in SSA has been driven by increasing birth intervals. The similarity in the tempo of childbearing between countries is rather impressive, given the significant cultural and socioeconomic diversity in the region. The average birth interval did not vary strongly across the region at the onset of the fertility transitions, and subsequently it lengthened to a similar extent at all parities in the vast majority of countries. The pace of the lengthening of birth intervals was stronger in regions and countries that experienced a more pronounced decline in fertility. Moreover, inter-regional differences in the average age at first birth have shrunk. The increase in the duration between all births undoubtedly contributed to improving the health of the mothers and their children. However, the pace of fertility decline was slow, because the parity progression ratios remained very high. This mirrors the persistently low prevalence of modern contraceptive methods in a context of a pro-natalist culture (Caldwell, Orubuloye, and Caldwell 1992). Longer births intervals also contribute to reducing the incidence of birth complications at lower parities, as well as to reducing secondary sterility, sub-fecundity, or miscarriage at older ages. These factors contribute to increase progression to higher parities (Spoorenberg 2019).

At the same time we found evidence of a recent onset of birth limitation, which mirrors recent studies that reveal an increasing willingness to limit family size (Casterline and Agyei-Mensah 2017; Lesthaeghe 2014; United Nations Population Division 2019). While the lengthening of birth intervals tended to level off at more advanced stages of the transition (i.e., after 30 years), the quantum of fertility started to decline. Among lower parities the pace of birth limitation increased with parity, which tends to confirm a classic pattern of family limitation. Yet this association was not found among upper parities. Women with high fertility preferences may be selected in these upper parities, especially in rural areas. Compared to past experiences in Asia and Latin America, the fertility decline in rural SSA was indeed slower, but the transitions in urban areas progressed at an almost identical pace (Lerch 2019).

This analysis indicates that all parities contributed from the outset to the fertility transition in SSA, and that the fertility decline switched from a lengthening of birth intervals to a limitation of births when the TFR reached about five children per woman. Future research may analyze this threshold effect in more detail. In the early stages of the fertility transition, women may have had more freedom to decide on the timing of their births, rather than on their family size. As the transition proceeds, the idea of family limitation seems to be increasingly accepted by society and, as fertility cannot be delayed indefinitely, after a while delayed births are forgone. Such a recent onset of birth limitation was observed not only in Southern Africa but also in vanguard countries in Western and Eastern Africa. One may thus expect a stronger fertility decline in the future as the new pattern diffuses through these regions. Demographers need to pay close attention to fertility changes in the coming decades in order to identify clues that high fertility countries will follow a similar path.

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Appendix

Table A-1: Information on country-specific data used in this study

Region	Country	Onset of transition	Period of observation and total fertility				Survey waves										
			Start	TF start	End	TF end	1st	2nd	3rd	4th	5th	6th	7th	8th	9th	10th	11th
Eastern Africa	Burundi	1987	1972	6.2	2011	6.1	1987	2010	2016								
	Ethiopia	1983	1985	6.3	2011	5.5	2000	2005	2011	2016							
	Kenya	1966	1962	7.4	2009	5.4	1977	1988	1993	1998	2003	2008	2014				
	Madagascar	1970	1977	5.9	2003	5.8	1992	1997	2003	2008							
	Malawi	1980	1977	6.9	2005	6.5	1992	2000	2004	2010							
	Mozambique	1970	1982	5.6	2006	5.5	1997	2003	2011								
	Rwanda	1978	1977	7.3	2009	5.5	1992	2000	2005	2007	2010	2014					
	Tanzania	1975	1976	6.6	2004	5.6	1991	1996	1999	2004	2009						
	Uganda	1985	1973	6.8	2011	6.3	1988	1995	2000	2006	2011	2016					
	Zambia	1972	1977	7.0	2008	6.1	1992	1996	2001	2007	2013						

Table A-1: (Continued)

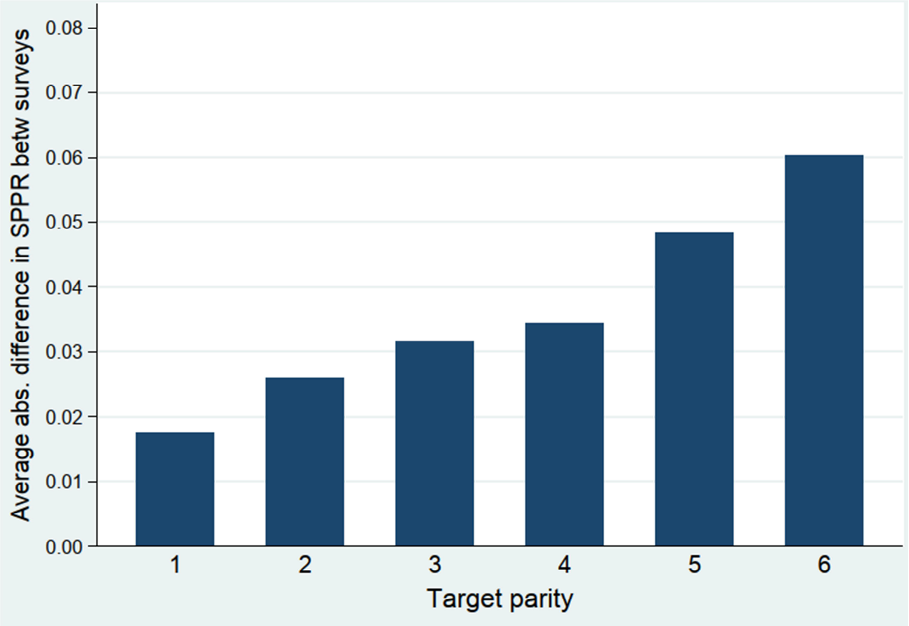
Region	Country	Onset of transition	Period of observation and total fertility				Survey waves										
			Start	TF start	End	TF end	1st	2nd	3rd	4th	5th	6th	7th	8th	9th	10th	11th
Middle Africa	Cameroon	1982	1976	5.8	2006	5.6	1991	1998	2004	2011							
	Chad	1996	1981	6.2	2009	7.3	1996	2004	2014								
	Congo Dem.Rep.	1995	1992	6.3	2008	6.4	2007	2013									
	Congo-Brazzaville	1975	1990	4.5	2006	5.3	2005	2011									
	Gabon	1982	1985	5.7	2007	4.6	2000	2012									
Southern Africa	Lesotho	1970	1989	4.5	2009	3.6	2004	2009	2014								
	Namibia	1975	1977	5.9	2008	3.6	1992	2000	2006	2013							
	South Africa	1955	1983	3.9	2011	2.7	1998	2016									
	Zimbabwe	1970	1984	5.7	2005	4.3	1999	2005	2010								

Table A-1: (Continued)

Region	Country	Onset of transition	Period of observation and total fertility				Survey waves										
			Start	TF start	End	TF end	1st	2nd	3rd	4th	5th	6th	7th	8th	9th	10th	11th
Western Africa	Benin	1981	1966	5.7	2012	5.8	1981	1996	2001	2006	2011	2017					
	Burkina Faso	1982	1977	6.5	2005	6.7	1992	1998	2003	2010							
	Côte d'Ivoire	1971	1965	6.5	2006	5.8	1980	1994	1998	2011							
	Ghana	1967	1964	6.1	2009	5.2	1979	1988	1993	1998	2003	2008	2014				
	Liberia	1981	1971	5.9	2008	6.4	1986	2006	2013								
	Mali	1990	1972	6.4	2007	6.6	1987	1995	2001	2006	2012						
	Niger	1982	1977	6.6	2007	7.5	1992	1998	2006	2012							
	Nigeria	1978	1975	6.2	2008	6.1	1990	2003	2008	2013							
	Senegal	1980	1963	6.2	2012	5.7	1978	1986	1992	1997	1999	2005	2010	2012	2014	2015	2017
	Togo	1976	1973	6.4	2008	5.8	1988	1998	2013								
All	All		1962	6.1*	2012	5.6*											

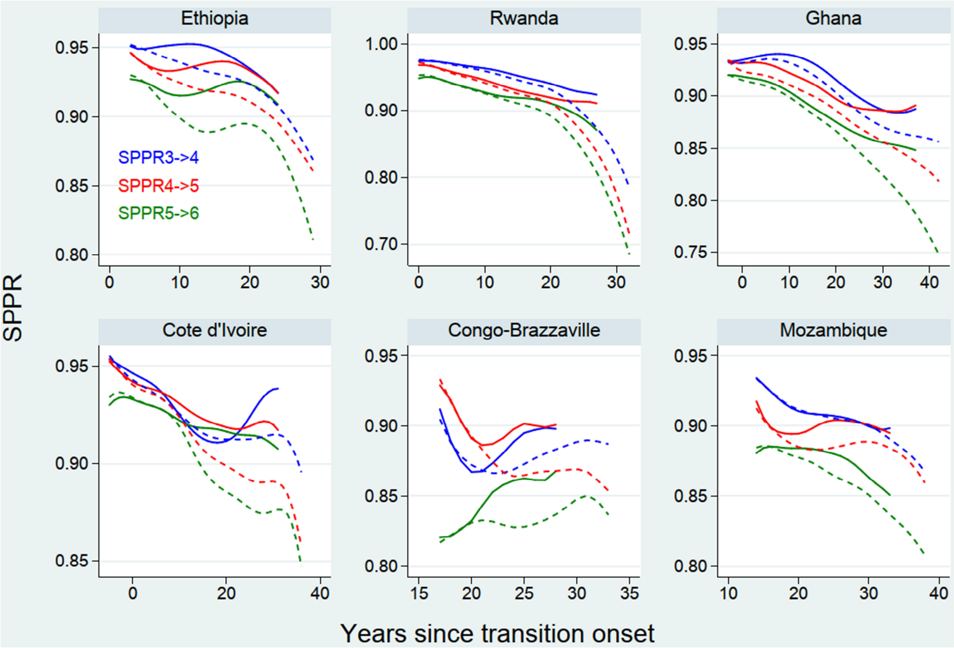
Sources: WFS and DHS.
Note: * unweighted average.

Figure A-1: Average over target parities in the absolute inter-survey differences in the synthetic parity progression ratio estimates, sub-Saharan Africa, 1962–2012



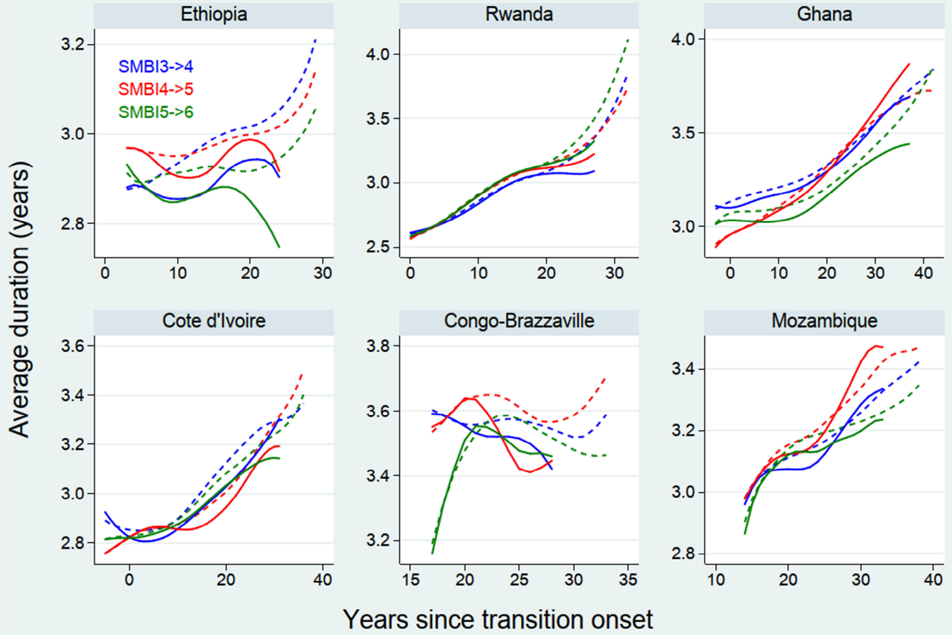
Sources: WFS and DHS.

Figure A-2: Smooth trends in synthetic parity progression ratios when the data for the 5-year period immediately preceding each survey is included (dashed lines) vs. excluded (solid lines), Congo-Brazzaville, Côte d'Ivoire, Ethiopia, Ghana, Mozambique, Rwanda 1962–2012



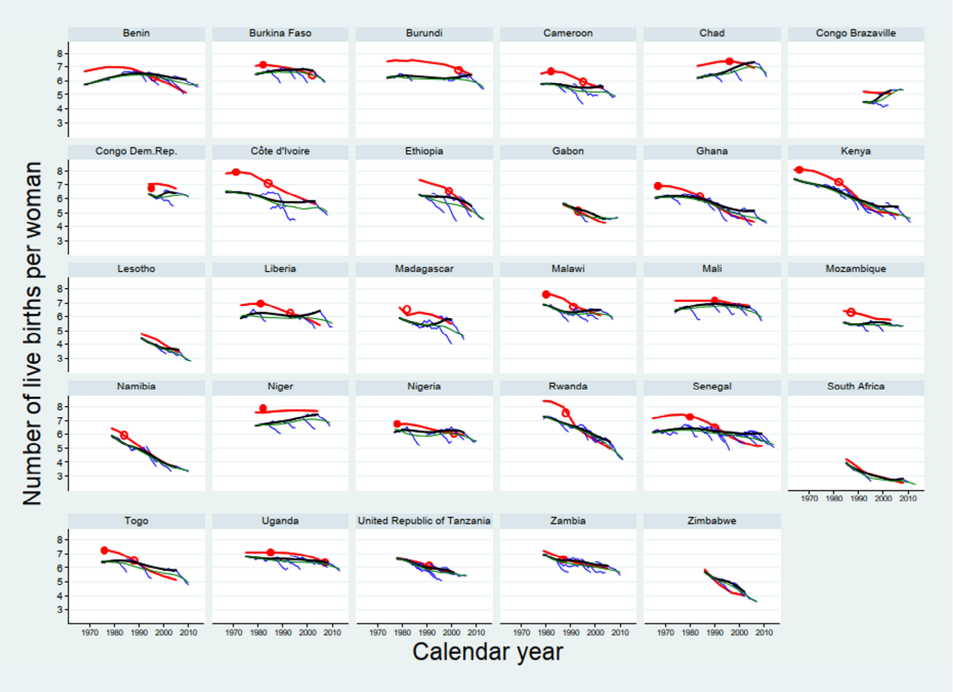
Sources: WFS and DHS.

Figure A-3: Smooth trends in the singulate mean birth intervals when the data for the 5-year period immediately preceding each survey are included (dashed lines) vs. excluded (solid lines), Congo-Brazzaville, Côte d'Ivoire, Ethiopia, Ghana, Mozambique, Rwanda 1962–2012



Sources: WFS and DHS.

Figure A-4: Total fertility according to UN estimates (in red), survey-specific estimates (in blue), and the averaged and smoothed survey trend (in black), sub-Saharan Africa, 1962–2012



Sources: WFS and DHS.

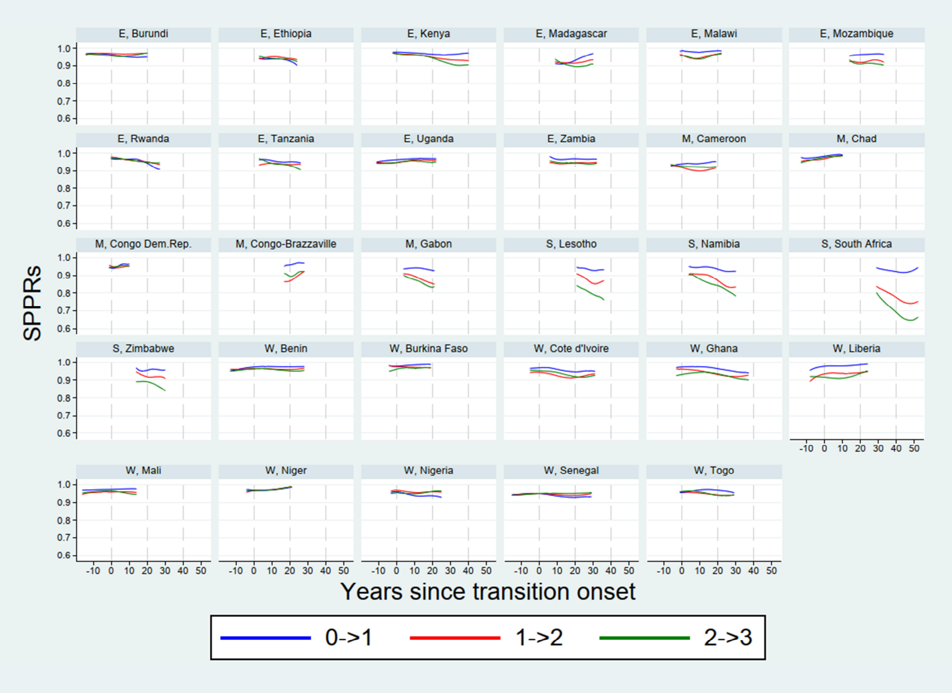
Notes: The red line corresponds to the UN TFR estimates with the full and empty red dots indicating, respectively, the years when the UN TFR peaked and when it dropped by 10% from the peak; the blue and black lines give the survey-specific and the average smooth estimates (without the data for the 5-year period before each survey), respectively; the green lines indicate the average smooth estimates that include the data for the 5-year period before each survey; calendar years refer to 5-year synthetic cohorts indexed by the central year.

Figure A-5: Synthetic parity progression ratios to the 4th, 5th, and 6th birth over the course of national fertility transitions, sub-Saharan Africa, 1962–2012

Sources: WFS and DHS.

Notes: The estimates refer to 5-year synthetic cohorts indexed by the central year; E=Eastern Africa, M=Middle Africa, S=Southern Africa, W=Western Africa.

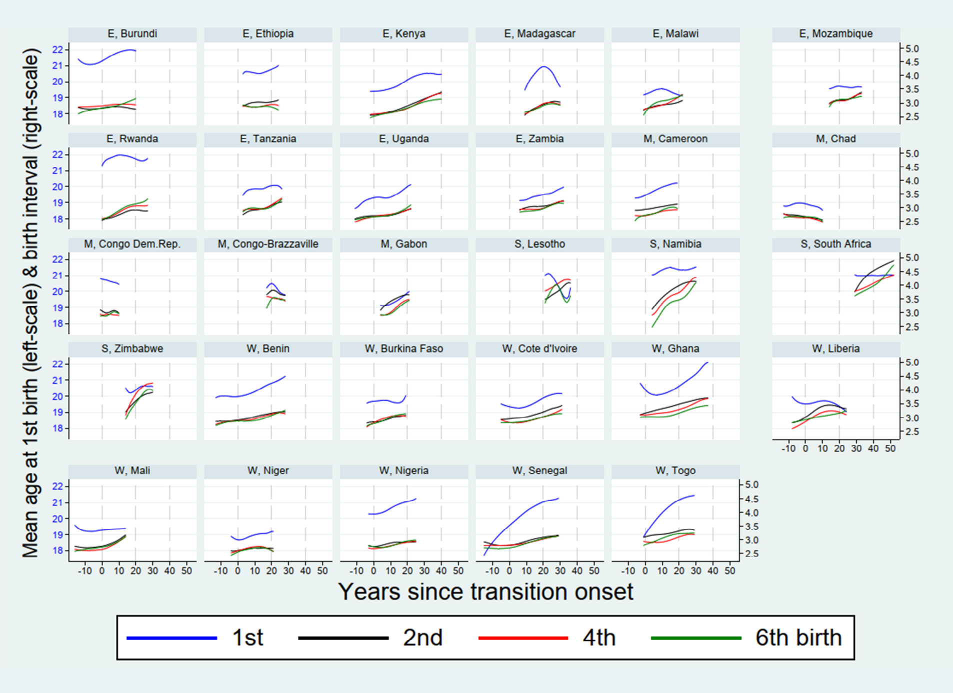
Figure A-6: Synthetic parity progression ratios to the 1st, 2nd, and 3rd birth over the course of national fertility transitions, sub-Saharan Africa, 1962–2012



Sources: WFS and DHS.

Note: The estimates refer to 5-year synthetic cohorts indexed by the central year; E=Eastern Africa, M=Middle Africa, S=Southern Africa, W=Western Africa.

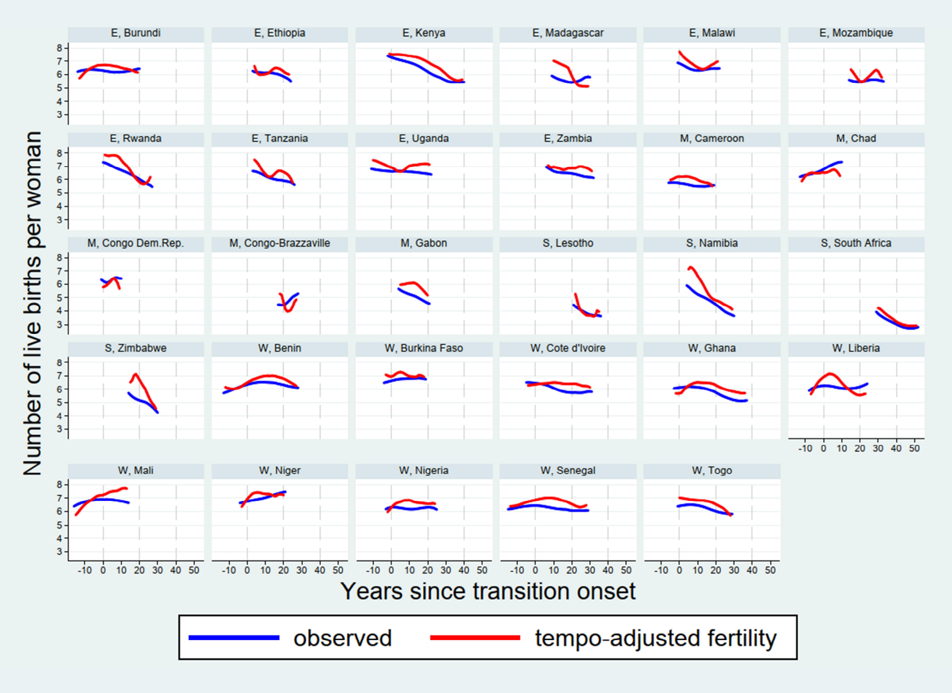
Figure A-7: Singulate mean age at 1st birth and mean birth intervals over the course of national fertility transitions, sub-Saharan Africa, 1962–2012



Sources: WFS and DHS.

Notes: The estimates refer to 5-year synthetic cohorts indexed by the central year; E=Eastern Africa, M=Middle Africa, S=Southern Africa, W=Western Africa.

Figure A-8: Observed and tempo-adjusted level of total fertility over national fertility transitions, sub-Sahara Africa, 1962–2012



Sources: WFS & DHS.

Notes: The estimates refer to 5-year synthetic cohorts indexed by the central year; E=Eastern Africa, M=Middle Africa, S=Southern Africa, W=Western Africa.