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The Emergence and Diffusion of Birth Limitation in Urban Areas of Developing Countries

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Abstract

The rising heterogeneity of women in terms of family size over the course of the fertility transition challenges the classic hypothesis about the diffusion of birth limiting behaviors across parities, known as family limitation. We evaluate whether birth limitation diffused sequentially from upper to lower parities during the onset and unfolding of the urban fertility transition in 27 developing countries. Relying on multiple surveys and censuses, we decompose long-term declines in cohort fertility into the parity-specific contributions, and propose two new summary indicators for international comparison. The results challenge the hypothesis of family limitation. We find a significant international variation in the parities at which birth limitation initially emerges, in the direction of its subsequent diffusion to other parities, as well as in the extent to which the limiting behavior is generalized across all parity groups. We finally discuss the international heterogeneity in the patterns of emergence and diffusion of birth limitation, and draw theoretical conclusions and societal implications.

Introduction

Fertility decline has brought major opportunities for developing countries. The shrinking number of children leads to a temporary concentration of the population in young working ages, while the share of non-active inhabitants to be supported decreases. Resources can instead be invested in economic production, savings and the improvement of the quality rather than the quantity of social services, including health and education (Bloom et al. 2003). Past research provided information mainly about the trends in average fertility. One of the universal consequences of fertility decline, however, has been neglected: inequality in family size increases among women because some groups start to limit their fertility earlier and at a faster pace than others (Lutz 1989; Shkolnikov et al. 2007; Giroux et al. 2008; Hruschka and Burger 2016). This has implications for the distribution of the socioeconomic gains from the fertility transition. Women with fewer births have increased freedom to work outside of the household and to invest in the quality of their children's education. Women with large families, by contrast, face difficulties in exploiting the opportunities brought about by the demographic dividend. Heterogeneity in women's family size tends to decelerate development (de la Croix and Doepke 2003) and to trigger (or reproduce) socioeconomic inequalities in the process (Bloom et al. 2012; Eloundou-Enyegue et al. 2017). In this paper, we study how fertility heterogeneity comes about by investigating the demographic diffusion of birth limiting behavior during the onset and unfolding of the fertility transition.

Diffusion processes arise when innovative attitudes and behaviors that were previously very rare or absent in a population subsequently spread from some subgroup to all the others (Rogers 1983; Casterline 2001, p. 6). As the decision to have another birth is related to the number of children a women already has, a parity perspective of fertility is the most appropriate to study the diffusion of birth limiting behavior (Henry 1952). According to the classic hypothesis, women stop childbearing once they attained the desired family size (Henry 1952, 1961; Coale 1973; Knodel and van de Walle 1979). Family size norms shrink gradually with the structural and ideational transformations that accompany modern development, including "the growing importance of the individual rather than the family, and particularly the extended family group; the development of a rational and secular point of view; the growing awareness of the world and modern techniques through popular education; improved health; and the appearance of alternatives to early marriage and childbearing as a means of livelihood and prestige of women" (Notestein 1953: 18). The point here is that the new birth limiting behavior is expected to diffuse progressively from upper to lower parity groups over time (Henry 1961) – a process referred to hereafter as family limitation.

In other words, the average level of fertility should drop because the share of (larger than) average-sized families declines in the population. This would lead to a limited heterogeneity in women's family size. Hence, the expectations based on the classic model of family limitation are in conflict with the empirical evidence on the rising fertility inequality over the course of the transition. We aim at shedding new light on this paradox.

National-level analyses of fertility trends by parity or age (as a proxy for parity) confirmed a role for family limitation across Asia, Latin America, as well as in contemporary high fertility contexts in Europe (Knodel 1977; Hobcraft 1985; Feeney 1991; Juarez and Llera 1996; Rodriguez 1996; Hosseini-Chavoshi et al. 2006; Spoorenberg 2009; Spoorenberg and Dommaraju 2012; Lerch 2013; Spoorenberg 2013; McDonald et al. 2015; Timæus and Moultrie 2020). Yet there are notable exceptions. Instead of spreading gradually from upper to lower parities, birth limiting behaviors were initiated among several different parities at the onset of the fertility transitions in Costa Rica and Colombia (Hobcraft 1985; Juarez and Llera 1996). Sub-Saharan Africa also follows an "exceptional" pathway of slow fertility decline (Bongaarts 2017), which is driven by a distinct pattern of birth spacing at all parities (Johnson-Hanks 2007; Timaeus and Moultrie 2008; Moultrie et al. 2012). Women only recently started to limit their family size in the countries that are most advanced in the fertility transition (Lerch and Spoorenberg accepted).

National-level trends in parity-specific fertility actually mask considerable variation between population subgroups, as these reach different stages of the fertility transition. According to the demographic transition model, the above mentioned transformations in values and socioeconomic structures that motivate smaller family ideals emerge and diffuse at a particularly fast pace in urban environments (Notestein 1953). Cross-sectional research confirms a lower fertility in urban than in rural areas at all parities in the developing world (Lutz 1984; Mboup and Saha 1998). The rural-to-urban fertility gap first widens and then shrinks over the course of the fertility transition, although a residual rural excess level remains even at very advanced stages

(Lerch 2019a). A longitudinal analysis of the diffusion of parity-specific fertility decline across the levels of China's urban hierarchy concluded that "it is [..] tempting to conceptualize the fertility transition as a sequence of overlapping [urban-to-rural] diffusion waves of innovative stopping behaviors (first with the sixth birth, then the fifth, then the fourth, etc.)" (Feeney and Yu 1987; Skinner et al. 2000: 645). Therefore, fertility change at the national level may not provide useful information about the demographic diffusion of birth limiting behavior, as the observed pattern is confounded by a geographic diffusion.

In this study, we focus on the emergence and diffusion of fertility decline within urban populations. Urban areas concentrate more than half of the population in the global South and the bulk of its demographic dividend (United Nations 2017). Patterns of fertility decline in cities are particularly relevant for our understanding of the rising inequality among women in terms of family size. The focus on urban areas further enables us to widen the geographical coverage of this study by including the trajectories of fertility decline in sub-Saharan Africa, where progress in rural areas was limited so far (Lerch 2019b). We evaluate whether the urban fertility transition has followed the model of family limitation, with birth limiting behaviors diffusing progressively from upper to lower parities over time. We contribute to the literature by decomposing fertility trends in the global South into their parity-specific contributions over the long term (i.e. more than 50 years), covering all major developing regions. Two new summary indicators are also proposed to test the hypothesis of family limitation in a comparative perspective.

In the next section we present the research strategy, data and methods used. We then define two descriptive measures that capture the direction and generalization of the diffusion of birth limiting behavior across parities, and apply these to the time series in urban populations of 27 developing countries for which our data cover early to advanced stages of the fertility transition. The role of rural-to-urban migration in the diffusion of fertility limitation is also assessed. The last section discusses the international heterogeneity in the diffusion of birth limitation, and draws theoretical conclusions and societal implications.

Research strategy, data and methods

To analyze the demographic diffusion of birth limiting behavior within urban societies, we estimate parity progression ratios (PPRs), which measure "the proportion of women who have already had a certain number of children and go on to have an additional one" (Hinde 1998, p. 109). These measures are then used to analyze the parity-specific contributions to fertility decline over the course of fertility transition. We adopt a cohort perspective for different reasons.

A cohort perspective of birth limitation

Period indicators of fertility fluctuate a lot in times of significant spacing or postponement of births, which constitute two mechanisms women rely on to temporarily (rather than definitively) limit their number of children (see Timæus and Moultrie 2020). Cohort measures, by contrast, smooth out short-term variations and are therefore better suited to gauge long-term trends in birth limitation.

In theory, the practice of birth spacing or postponement may also leave women with an insufficient number of reproductive years to attain large completed family sizes. Reasons for this include infecundity at older ages or changes in personal circumstances (such as marital disruption). In this case, women do not stop childbearing. They curtail reproduction for motives that are not related to the attainment of a target parity – a widespread mechanism of birth limitation in sub-Saharan Africa according to Timaeus and Moultrie (2020). However, the average age at first birth has remained below 25 years in developing regions (Bongaarts et al. 2017), and remarriage is often accepted. We therefore argue that women have enough time to bear at least five children on average (assuming an average birth interval of four years over a 20-year reproductive period following the first birth).

When compared to stopping behaviors, the spacing (or postponement) of births had a comparatively limited impact on the decline of completed fertility outside of sub-Saharan Africa according to Knodel and van de Walle (1979) and Timaeus and Moultrie (2020). Yet Hruschka's et al. (2018) modeling exercise found the inverse. It should be stressed here that disentangling the motivations for birth limitation is empirically difficult (i.e. whether it is temporary or definitive, and dependent on the attainment of a target parity or not). In many countries, women often relied on a combination of limiting and spacing behaviors (Timaeus and Moultrie 2020). As the target number of children declines, women have more room to postpone their births in their reproductive life span. Moreover, distinct sub-populations may have different normative family size ideals and, thus, stop at varying parities. The resulting aggregate pattern of parity progression ratios may then be wrongly interpreted as a curtailment (rather than stopping) of fertility according to Timaeus and Moultrie's (2020) criteria. In this study, we focus on the parity at which women terminated childbearing at the end of their reproductive life. We leave for future research the question of the complex mix of birth limiting behaviors women relied on over the life course to implement their fertility goals.

A cohort perspective of fertility also avoids the problems with conventional period measures – such as the total fertility rate (TFR) – in the context of important migration flows (as between rural and urban areas). This is especially the case when the decisions to move and have children are endogenous. In order to facilitate geographic relocation, migrants tend to postpone (or bring forward) births, which are then recuperated (or followed by a pause) at the destination. As the TFR at destination only measures the behavior after migration, it tends to overestimate (or underestimate) the intensity of childbearing in times of comparatively larger migration flows (Toulemon 2004). Unfortunately, half of the surveys used for this study (see below) do not provide information on women's duration of residence in urban areas, which would have allowed us to control for the tempo effects of migration on period fertility measures. Completed fertility of cohorts, by contrast, is not affected by tempo biases.

Data

The analysis covers urban areas of 27 developing countries. It is based on data from 151 World Fertility Surveys (WFS) and Demographic and Health Surveys (DHS), as well as Multiple Indicators Cluster Surveys (MICS) and public use samples of population Censuses (IPUMS; these supplementary data were relied upon where the WFS and DHS do not cover the early or the late stages of the fertility transition). While the WFS and DHS collect information on the number of children ever born and women's birth histories, the MICS and IPUMS provide only summary information on fertility. We thus reconstructed recent birth histories by applying the own-children method (Cho et al. 1986) to the data about children and women of reproductive age, as listed in the household questionnaire.

Given our interest in long-term fertility trends, we selected 19 countries in which our data cover the onset up to the advanced stages of the urban fertility transition (i.e. starting with an average cohort fertility of more than 5.5 and ending with less than 3.5 children per woman). We additionally selected eight countries in which the transition onset is not observed, but in which urban fertility of the first cohort is situated between 5 and 5.5. Surveys which only interviewed ever-married women are also included in order to increase the geographical and temporal coverage of this study. At the ages at which we measure fertility (30 years and more; see below), the majority of women are ever married in our sample of countries. A-Table 1 in the Appendix lists the countries considered in this study. The sample is composed of six Asian populations (only mid- to final transition stages are covered in India; standardized surveys for China are not available), seven populations from Latin America, three populations from Northern Africa, and 11 sub-Saharan African countries.

Although many surveys do not provide definitions of the urban populations, the vast majority (most probably) followed national standards at the time of data collection. We can rule out potential biases in our fertility estimates due to the changing definition and delineation of urban zones over time (i.e. the reclassification of populations from rural to urban): survey-specific estimates for overlapping years in a given country are indeed congruent to each other (see A-Figure 1 in Appendix). However, inter-country differences in the urban definition constitute a major challenge for comparative research. Fertility levels are likely to be underestimated when slum dwellers are not included in the official definition of urban populations, while the measures may be overestimated when including populations in the cities' near vicinities with predominantly rural livelihoods. As we are unable to control for this unobserved heterogeneity in the definitions of urban areas, we compare the general pattern of diffusion of birth limiting behavior rather than the fertility levels per se.

Estimation method

The decomposition of fertility change into its parity-specific contributions is based on cohort parity-progression ratios (PPR). We estimate survey-specific series of PPR by five-year age cohorts to increase the robustness of the results. For those cohorts that had reached the end of their childbearing career at the time of the interview (i.e., aged 40-44 and 45 and above), completed PPR are computed directly based on the distribution of women according to the stated parity. In order to fill inter-cohort gaps and extend the survey-specific series of estimates with more recent cohorts, we also projected completed PPRs based on the truncated estimates for the cohorts aged 30-34 and 35-39 at the survey dates.

We applied the Brass and Juarez paired cohort comparison method to project the PPRs (Brass and Juarez 1983). The younger cohorts' completed PPRs (i.e. at age 40-44) are obtained by projection of the older cohorts' level into the future, taking into account the fertility differences between each pair of adjacent cohorts in the period immediately preceding the collection of the data (see Appendix). These cohort differences are estimated at equivalent ages and parity in order to control for the truncation of the fertility career and the selection of more fertile women in higher parity groups among younger cohorts. The method assumes that fertility differences between two adjacent cohorts remain constant and are not distorted by differential tempo of childbearing after age 30. This assumption is reasonable in the set of countries under study.

We are confident about the quality of the older women's reporting of achieved parity, as well as about the accuracy of the projections of PPRs for younger women: survey-specific estimates and projections of PPRs for overlapping cohorts are indeed congruent to each other in a given country (see A-Figure 1 in Appendix). Therefore, we averaged the survey-specific PPRs for overlapping cohorts, annually and linearly interpolated the figures and applied the locally weighted least squares technique to smooth the trend (with a bandwidth of 0.75).

Total fertility (*TF*) is then calculated as a weighted average of the parities attained in the cohort, with the weights being constituted by the parity distribution of women as implied by the PPRs. We used the PPRs from nulliparous to the first births (PPR0->1) through the progression from the fifth to the sixth birth (PPR5->6), and estimated the average parity among women with at least six births based on the surveys (see Appendix). Our external validation of national-level estimates of fertility (based on the above method) against United Nations statistics confirmed a high quality of the data – even in countries where only ever-married women have been interviewed (see A-Figure 2 in Appendix). Our estimates cover the cohorts born between 1906 and 1982. Urban fertility declined continuously at a fast pace in all countries (with an average decline of 0.08 birth per woman and cohort), even in sub-Saharan Africa (see A-Table 1).

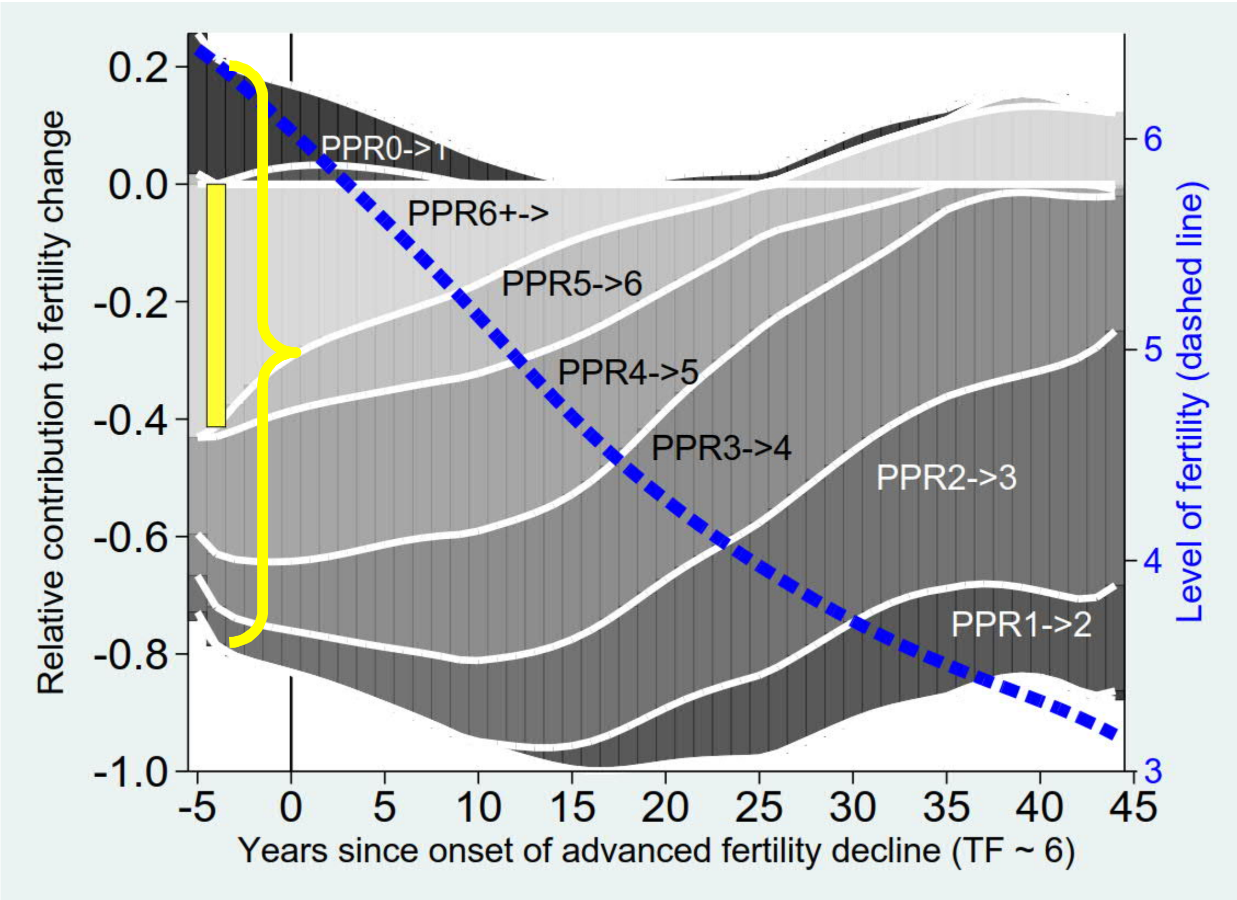
Although our cohort estimation approach eliminates the tempo effects of migration on the measurement of urban fertility trends, the inclusion of in-migrants may still bias the observed pattern of diffusion of birth limitation. Fertility trends by current urban residence do not necessarily reflect the pattern of childbearing of women who continuously lived in urban areas, as a large share of women moved to cities at adult ages. As a robustness test of our result, we therefore replicated the analysis on the non-migrant urban population only (for the countries providing information on migration in successive surveys), and compared the results with those referring to all women interviewed in urban areas.

Two summary indicators of the pattern of diffusion of birth limiting behaviors

Classic theory emphasizes a role for family limitation in the process of fertility decline (Henry 1952, 1961; Coale 1973). To evaluate the extent to which birth limiting behaviors diffused progressively from higher to lower parities over time, we decomposed cohort fertility decline into the contributions by parity using the general algorithm of stepwise replacement (see Appendix; Andreev et al. 2002; Zeman et al. 2018). We computed the contributions which are attributable to behavioral changes among women with none, one, two, three and up to six or more previous children ever born. The method accounts not only for the direct impact of declining progression ratios, but also for the indirect impact that operates through the transformation of the distribution of women by parity (e.g. the changes in the population at risk of progressing to higher parities).

Figure 1 illustrates the results of the parity-specific decomposition of the fertility decline in urban Kenya, starting from an average of 6.4 children per woman born in 1928 to 3.1 among the 1981 cohort (see the thick dashed blue line, which refers to the y-axis on the right-hand side). The vertically stacked bars represent the relative contributions of each parity group to the decline in total fertility (y-axis on left-hand side) in successive cohorts (plotted on the x-axis). In the first cohorts, total fertility declined mainly because of lower birth rates among women with at least six previous children born. Childlessness, however, decreased in this early stage of the transition (e.g. nulliparous women contributed to increasing fertility). This can be related to the decline in the extent of primary sterility in the early process of modernization (Dyson and Murphy 1985). In more advanced stages of the transition, fertility decline was dominated successively by birth limitation among women with four, then three and finally among those with only two previous births. Although birth rates at upper parities slightly rebounded in the last stage of the transition, this example generally conforms to the family limitation model.

Figure 1: Relative parity-specific contributions to the change in total fertility over the course of the fertility transition, urban cohorts 1928-1981, Kenya.



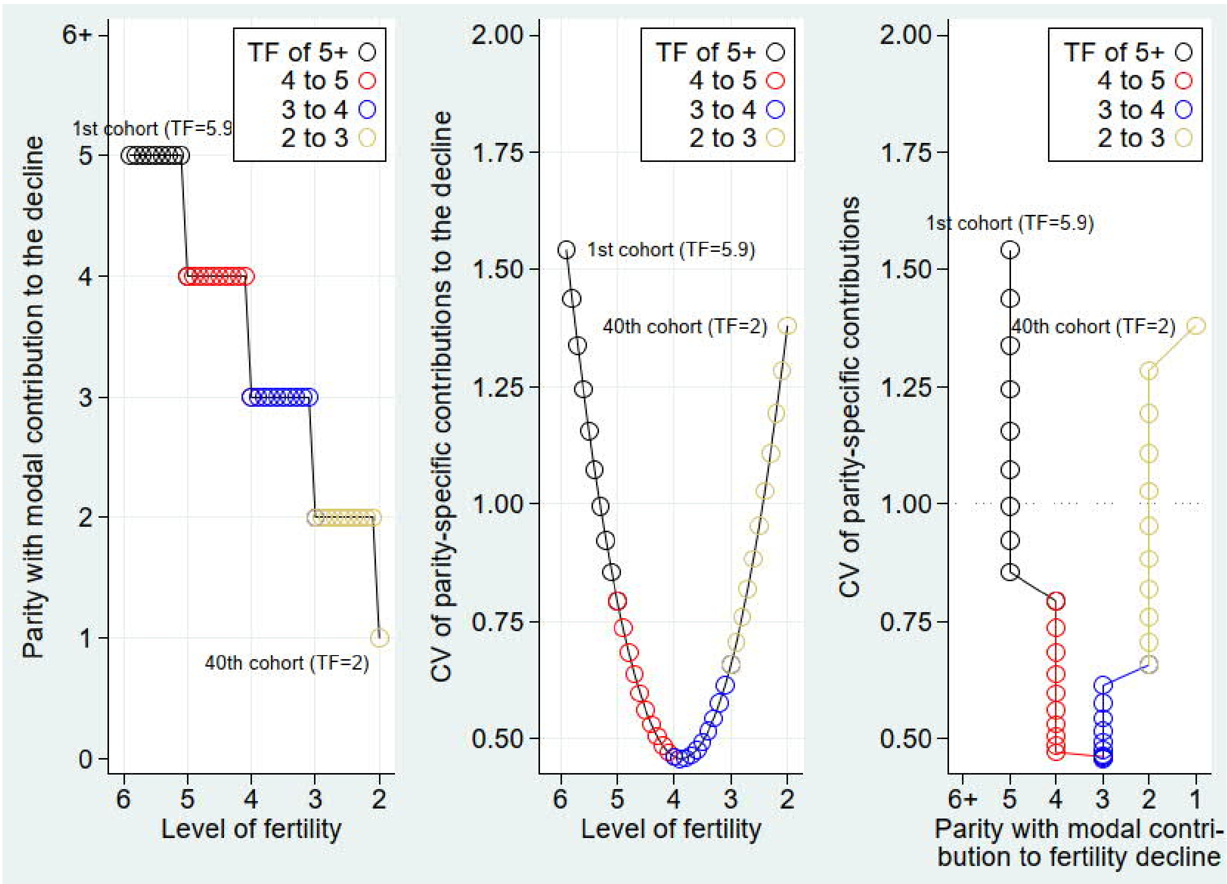
Source: WFS & DHS.

Note: each vertically stacked bar represents the impact of a change in a given PPR on the variation in total fertility between two adjacent cohorts; the yellow bar highlights the modal contribution to fertility change between the cohort born five years prior to the onset of advanced decline and the immediately following cohort; the yellow brace indicates the parity-specific contributions that are considered when calculating the coefficient of variation of the contributions to the decline (see text).

To compare the detailed patterns of fertility decline across the 27 urban populations, we define two summary indicators. The first indicator indicates the direction of diffusion of birth limitation across parities. We track over time the parity group with *the modal contribution to the inter-cohort fertility decline* (e.g. the parity associated to the largest vertically stacked bar in a given cohort, as highlighted in yellow in Figure 1). The left-hand side panel of Figure 2 illustrates the trend in this first indicator (on the y-axis) over the course of a stylized fertility transition, as indexed by the average level of fertility in successive cohorts (see the labels on the x-axis and the different colors of the dots). Birth years and average levels of fertility are also given for the first and last cohorts. In the model of family limitation, the direction of diffusion of birth limiting behavior is downward: the drop in fertility in every cohort is mainly driven by a declining rate of parity progression among women who already have had a number of previous births which is immediately below or equal to the average fertility level of the previous cohort.

The second indicator measures the generalization of the birth limiting behavior across parities. The classic model of family limitation conjectures a sequential diffusion process as constituted by two distinct dynamics (Rodriguez 1996). At the onset of the fertility transition, the new limiting behavior first spreads from the innovators to the other members of the uppermost parity group through social interaction. As soon as the number of adopters reaches a critical threshold, the innovative behavior trickles down to the immediately lower parity group, and so on. This sequential diffusion of birth limiting behavior implies a concentration of fertility decline in the parity group with the modal contribution. Our second indicator measures the extent to which this is the case: we calculated for each cohort the coefficient of variation (CV) of all parity-specific contributions to the fertility decline (i.e. the standardized variance of the stacked vertical bars in Figure 2, as indicated by the yellow brace). In the case of a positive contribution by a particular parity group (i.e. an increase in its fertility), we set this value equal to zero. A high CV indicates a strong *concentration of fertility decline* among the parity group with the modal contribution. A low CV, by contrast, corresponds to a situation of *generalized fertility decline*: several parities contribute more or less equally to the progress in the fertility transition.

Figure 2: Evolution in the two indicators that capture the direction (left-hand panel) and generalization (middle panel) of fertility decline across parities over the course of a stylized fertility transition (the right-hand panel combines the two indicators in a three-dimensional plot)



Source: Simulated data.

Notes: CV = coefficient of variation, TF = total cohort fertility.

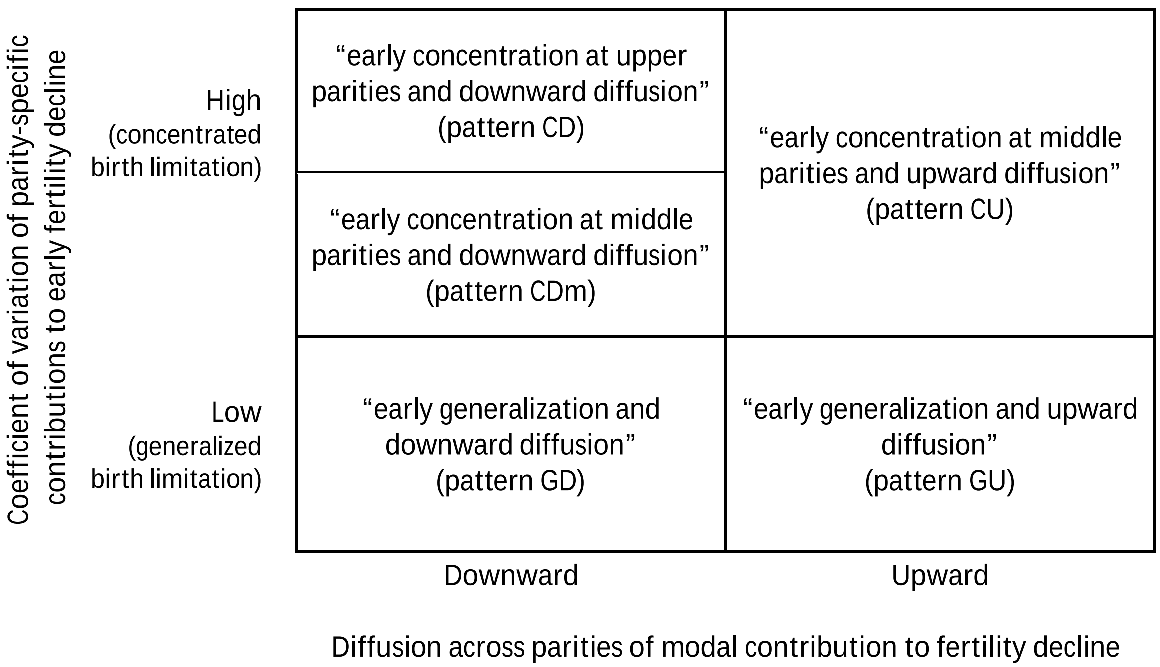
The middle panel of Figure 2 illustrates the trend in the parity-specific generalization of fertility decline over the course of a stylized transition. At its start, the new birth limiting behavior is highly concentrated (among the uppermost parity, as shown in the left-hand side panel). As the behavior diffuses to middle and low parities over time, the fertility decline becomes less concentrated. This is because upper parity groups continue to limit childbearing, even though their contribution to the decline in total fertility becomes secondary (because their intensity of childbearing is already low). In the middle of the transition, when the average fertility level is between three and four children per woman, fertility decline arises from rather similar contributions of several different parities (i.e. generalized fertility decline). In the advanced stages of the transition, by contrast, the variation in the parity-specific contributions increases again. This is because women in upper parity groups will not contribute any more to further reduction in total fertility, once birth limitation is entirely diffused within these groups. Progress in the transition is driven more and more by behavioral changes which are concentrated among lower parity women (i.e. with three or two previous births, and finally those with only one previous child). This U-shaped trend in the generalization of the adoption of birth limiting behaviors is typical for social diffusion processes (Rogers 1983).

Although the CV of the parity-specific contributions to fertility decline is a global measure of variation, its demographic interpretation is not straightforward. The indicator may be compared with a more intuitive measure: the number of parity groups which cumulatively contribute to at least 60% of the inter-cohort decline in total fertility. This partial measure of variation is strongly and linearly associated with the CV (with a statistically significant correlation coefficient of 0.77 across all countries and cohorts in our sample). A CV of 0.30 corresponds to a situation in which four different parity groups are responsible for at least 60% of the fertility decline, while coefficients of variation of 1.0 and 1.5 correspond to a situation in which respectively two and only one parities dominate the decline.

In sum, the hypothesis of family limitation conjectures a step-wise drop in the parity with the modal contribution to fertility decline, and a U-shaped trend in the variation of all parity-specific contributions (concentration, generalization, and resumed concentration). The right-hand panel of Figure 2 plots the stylized cohort series (i.e. the empty dots of different colors for the stage of the fertility transition) according to the two new indicators: the direction of diffusion of birth limitation on the x-axis, and the generalization of fertility decline on the y-axis. The trend follows a step-wise U-shaped evolution in the concentration-generalization-concentration of fertility decline during its diffusion from upper to lower parities over cohorts. Birth limiting behaviors are most generalized in the middle of the fertility transition, when average fertility reaches about four to three children per woman. This stylized pattern constitutes the reference for the international comparison in the next section.

However, other patterns of the emergence and diffusion of birth limiting behaviors may exist. We defined four distinct groups, using two main rules. On the one hand, we distinguished the populations in which the initial birth limitation is concentrated in a few parities at the onset of the transition and those characterized by an early generalized fertility decline (y-axis of Figure 3). The first group of series starts with a CV of parity-specific contributions above unity, the second group with a CV below (or equal to) unity. On the other hand, we differentiate those populations in which the limiting behavior diffused downward across parities from those which experienced an upward diffusion over the unfolding of the fertility transition (y-axis of Figure 3).

Figure 3: Schematic patterns of the emergence and diffusion of birth limitation across parities during the onset and unfolding of the fertility transition.



Combining these two criteria gives four distinct patterns of parity-specific fertility declines:

- the classic and conjectured pattern of “early concentration and downward diffusion” of birth limitation (which can be additionally differentiated between early concentrations among upper versus middle parities; CD versus CDm),
- the “early concentration and upward diffusion” pattern (CU),
- the “early generalization and downward diffusion” pattern (GD)
- the “early generalization and upward diffusion” pattern (GU).

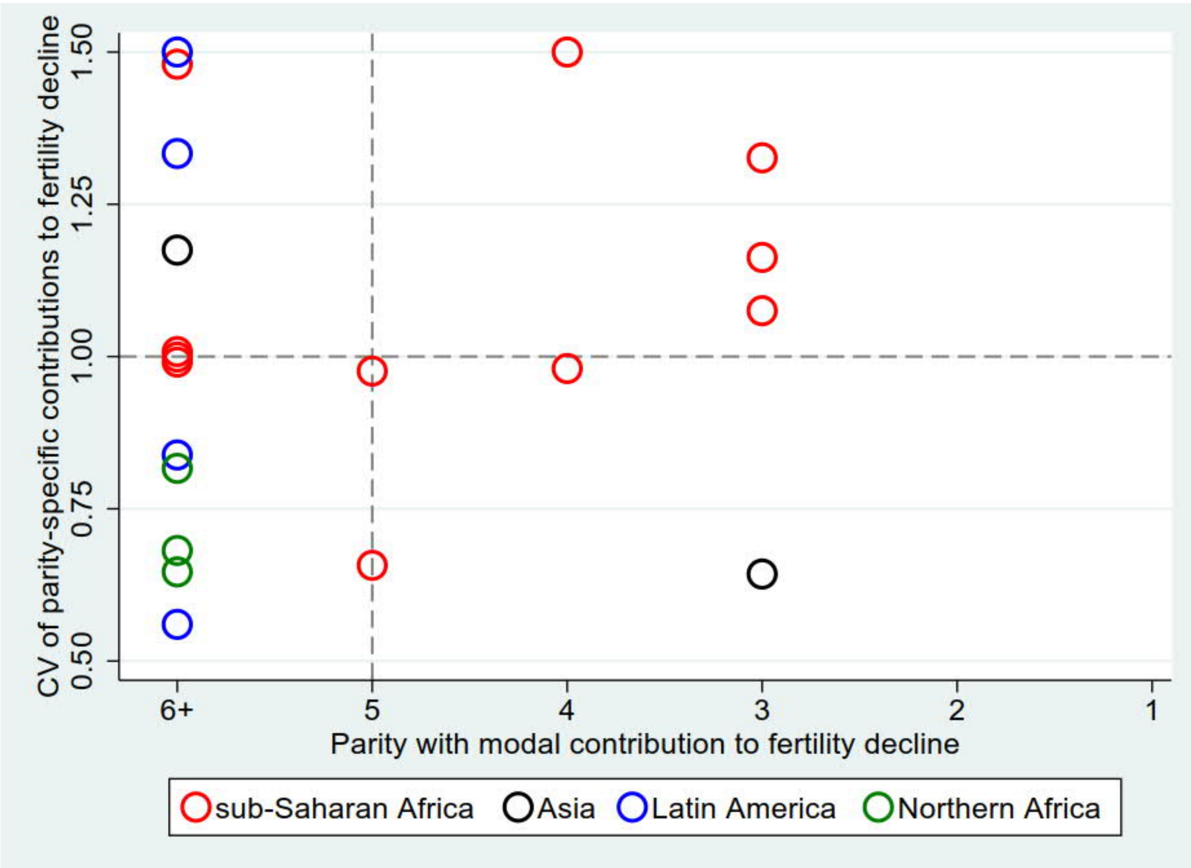
This classification is used to differentiate the 27 urban populations according to the emergence and diffusion pattern of birth limitation.

Results

The emergence of birth limiting behavior

In Figure 4, the urban populations in 19 developing countries are plotted according to the pattern of birth limitation at the onset of the fertility transition (i.e. between the two oldest cohorts with more than 5.5 children per woman on average). The parity that dominates the early fertility decline is shown on the x-axis, and the extent to which the behavioral change is concentrated in that parity is given on the y-axis. Each empty dot refers to a single urban population and is colored according to the world region it belongs to.

Figure 4: Starting pattern of birth limitation (between the first two observed cohorts with average fertility above 5.5) in 19 developing countries, urban cohorts 1926-1982



Source: WFS & DHS, MICS, IPUMS. Notes: CV = coefficient of variation.

The results reveal a significant international heterogeneity in the parities at which birth limiting emerges. The majority of populations are situated on the left of the dashed vertical line in Figure 4, meaning that upper parities dominated the early fertility decline. Although every major world region is represented, all countries in Latin America and Northern Africa are situated in this left-hand side of Figure 1. The four urban areas situated in the upper-left corner conform to the classic onset of family limitation: fertility decline was indeed concentrated in those upper parities. In the remaining populations in the lower-left corner, however, birth limiting behavior has emerged concurrently among different parities. The early fertility decline was generalized, even though women with at least six previous births slightly dominated the trend. All three Northern African countries in our sample fall in this group.

Of the remaining eight urban populations situated on the right-hand side of the dashed vertical line, all but one are located in sub-Saharan Africa. Their onset patterns of fertility decline clearly challenge the classic model. In four of these populations, the initial drop in urban fertility was strongly concentrated among middle or lower – rather than upper – parity groups (see upper-right corner). In the other four populations (lower-right corner), fertility started to decline due to similar contributions of several different parities. Middle or low parities dominated but only slightly.

The diffusion of birth limiting behavior

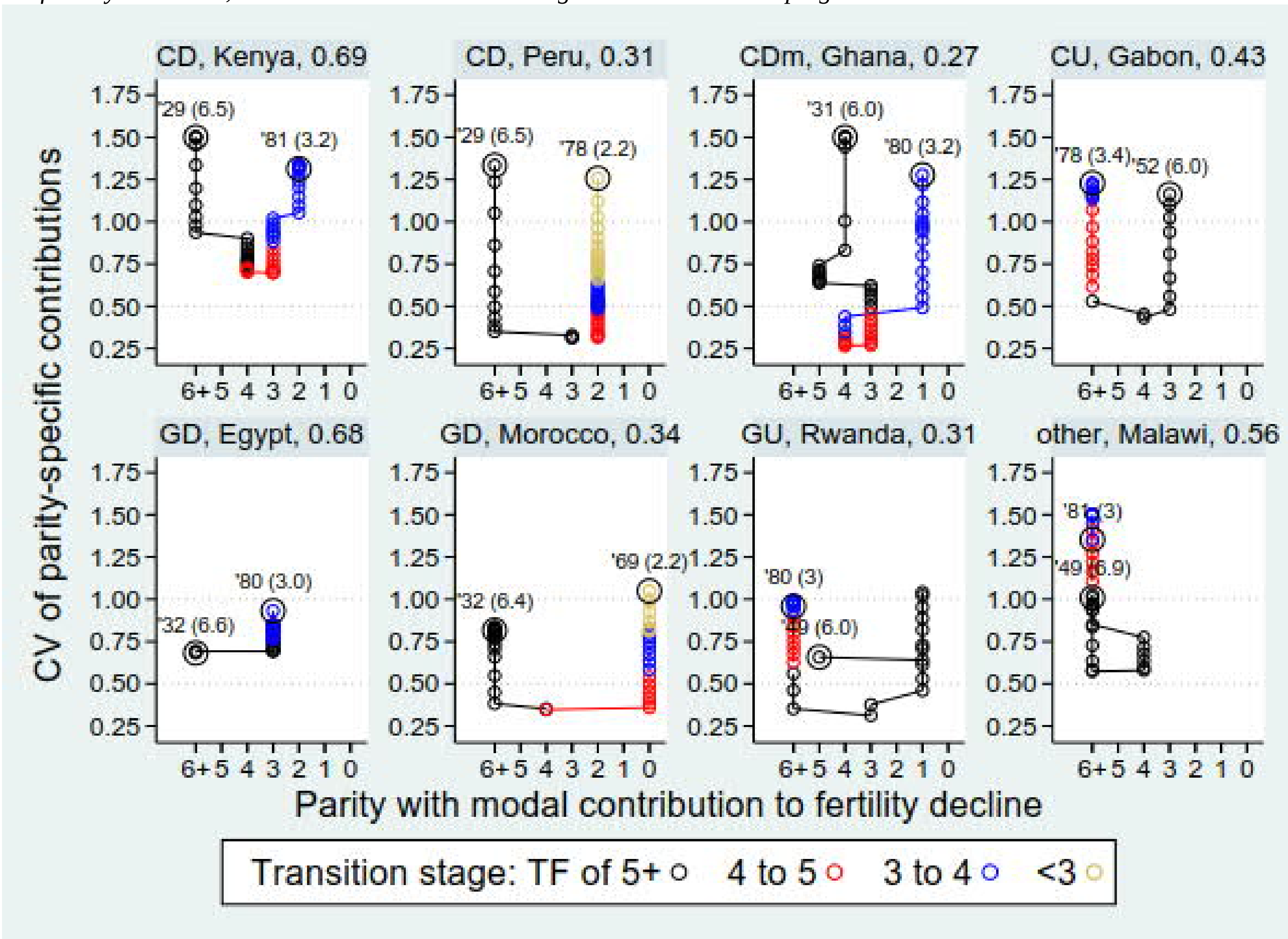
All 27 populations experienced a general cohort trend of initial concentration, subsequent generalization and a later resumed concentration of fertility decline by parity: the coefficient of variation of the parity-specific contributions generally follows a U-shaped trend over the cohorts (see Figure 5, and A-Figure 3 in the Appendix). However, we find significant variation not only in the emergence of birth limiting behavior (as discussed above), but also in its later diffusion across parities. Each of the five distinct patterns of parity-specific fertility transition (as introduced in the Method section) can be observed in at least one urban population. Within each group, there is also significant heterogeneity in the maximal extent of generalization of birth limiting behavior over the course of the transition. We also observe some special patterns.

In Figure 5, the cohort series of fertility are given by the dots which are colored according to the average number of children ever born. We map these fertility transitions of eight illustrative urban populations in our two-dimensional indicator space: the parity with the modal contribution to the inter-cohort fertility decline on the x-axis (i.e. the indicator of the direction of diffusion of birth limitation), and the importance of this parity's impact, relative to other parities, for the total decline in intercohort fertility on the y-axis (i.e. the CV as an indicator of the concentration/generalization of fertility decline). The panels of Figure 5 are labeled with the acronyms for the pattern of fertility decline they represent, the name of the illustrative country, and the trough in the CV of the parity-specific contributions over the course of the transition. In addition, Table 1 lists all the 27 urban populations according to the pattern of fertility decline. The entire set of cohort series is shown by world region in the A-Figure 3 in the Appendix.

The classic pattern of family limitation "early concentration and later downward spread of fertility decline" (CD) is exemplified by urban Kenya and Peru. Both cohort series reveal a sequential top-down diffusion of birth limitation across parities. Furthermore, Kenya's trend follows the congectured stepwise U-shaped evolution in the generalization-concentration of fertility decline. Note that birth limitation never totally generalized (among all parity groups within a given cohort): the trough in the CV of parity-specific contributions remains above 0.5. This confirms the sequential nature of the diffusion of the new behavior from upper to lower parities. But the trough in the CV is reached early on in the course of the fertility transition – when average fertility crossed the 5-children bar. While this classic diffusion of birth limiting behaviors is widespread only in Asia (where the data, however, do not cover the onset of fertility decline in all countries), it constitutes the exception in other developing regions (see A-Figure 3).

Although the fertility decline in Peru also unfolded according to the classic model, the new birth limiting behavior generalized at a faster pace across parities, when compared to the fertility transitions in Asia and Kenya. While the uppermost parity clearly dominated the onset, almost all parities contributed to a similar extent before average fertility crossed the 5-children-bar: the trough in the CV of parity-specific contributions was well below 0.5. This challenges the hypothesis of the sequential nature of behavioral diffusion across parities. Mexico and Nicaragua followed a similar version of the classic pattern. Here, the resumed concentration of fertility decline by parity in the final transition stages is very timid. Several parities continued to contribute to a similar extent.

Figure 4: The direction (x-axis) and generalization (y-axis) of diffusion of birth limiting behaviors across parities over the course of the fertility transition, urban cohorts 1926-1982 in eight illustrative developing countries.



Sources: WFS, DHS, MICS, IPUMS.

Notes: each empty dot represents a cohort; the first and last cohorts are indicated by an empty, larger and black dot, and is indexed with its year of birth and average level of fertility; values next to the country name refer to the trough in the CV of parity-specific contributions to the fertility decline over the entire course of the transition; CV = coefficient of variation; TF = total fertility; CD = “early concentration among an upper parity and subsequent downward diffusion of fertility decline by parity”; CD = “early concentration among an upper parity and subsequent downward diffusion of fertility decline by parity”; CDm = “early concentration among middle parities and downward diffusion”, CU = “early concentration and upward diffusion”; GD = “early generalization and later downward diffusion”; GU = “early generalization and later upward diffusion”.

Table 1: Populations ranked according to the pattern of diffusion of birth limitation and the trough in the CV of the parity-specific contributions to the fertility decline over the course of the transition, urban cohorts 1906-1982 in 27 developing countries.

Pattern	Trough in CV	Country	Pattern	Trough in CV	Country
CD	0,28	Nicaragua	CU	0,43	Gabon
	0,31	Peru			
	0,50	Mexico			
	0,54	Bangladesh			
	0,57	Sri Lanka			
	0,68	Thailand			
	0,69	Kenya			
	0,74	Indonesia	other		
	0.92	India		0,23	Philippines
CDm	0,27	Ghana		0,30	Senegal
	0,46	Ethiopia		0,56	Malawi
GD	0,34	Morocco		0,72	Brazil
	0,47	Ecuador			
	0,47	Togo	GU	0,25	Côte d'Ivoire
	0,49	Tanzania		0,31	Rwanda
	0,54	Bolivia			
	0,55	Colombia			
	0,58	Madagascar			
	0,60	Tunisia			
	0,68	Egypt			

Sources: WFS, DHS, MICS, IPUMS.

Notes : CD = “early concentration among an upper parity and subsequent downward diffusion of fertility decline by parity”; CDm = “early concentration among middle parities and downward diffusion”, CU = “early concentration and upward diffusion”; GD = “early generalization and later downward diffusion”; GU = “early generalization and later upward diffusion”; CV = coefficient of variation of parity-specific contribution to cohort fertility decline.

Urban Ghana stands for a pattern of fertility decline which is characterized by an atypical onset and a fast but classic generalization/concentration across parities (CDm). Congruent to the classic model, birth limitation was initially concentrated and later diffused to lower parities. However, the early fertility decline was concentrated among a middle, rather than upper, parity. Birth limitation then diffused concurrently to almost all parities at a fast pace – with a trough in the CV of the parity-specific contributions to the overall fertility decline of 0.27. In advanced stages of the transition, the fertility decline in urban Ghana concentrated among lower parities: as expected, the CV of parity-specific contributions increased again to levels above unity. Although the urban populations of Ethiopia experienced a pattern similar to the Ghanaian one, the CV of parity-specific contributions remained below unity until the last cohort observed. Fertility decline remained generalized across parities throughout the entire course of the transition.

Gabon represents the pattern of early concentration and later upward diffusion of fertility across parities (CU). Similarly to the case of Ghana, initial fertility decline was concentrated among a middle (rather than an upper) parity and generalized to other parities at a fast pace (with a trough in the CV of 0.48 before average fertility crossed the 5-children-bar). Although this was followed by a renewed concentration in later stages, which is consistent with the case of Ghana, advanced fertility decline was more and more dominated by upper (rather than lower) parities. Middle and lower parity groups resist the diffusion of birth control in the advanced transitional stages. These patterns CDm and CU are only observed in sub-Saharan Africa.

Compared to this first group of patterns, in which the onset of fertility decline was concentrated among a given parity, the remaining types of fertility transitions are characterized by a generalized onset of birth limitation among several parities (with a CV of parity-specific contributions to the initial inter-cohort fertility decline equal to or below unity). Egypt and Morocco illustrate the most frequent pattern of early generalization and later downward diffusion of fertility decline (GD). In Egypt, fertility decline remained generalized among several parities over the entire course of the transition. However, the trough in the CV of parity-specific contribution to the decline remained above 0.5, which reveals a limited extent of generalization. In Morocco, by contrast, the already generalized fertility decline at the transition onset generalized even more to all parities at a fast pace. The trough in the CV of parity-specific contributions of 0.26 was reached before average fertility fell below five. Birth limitation among childless women then started to dominate more and more the subsequent fertility decline, leading to a resumed increase in its concentration by parity. Similar patterns are also found in Tunisia, as well as in Latin America (Colombia, Bolivia, Ecuador) and two sub-Sahara African countries (Togo, Madagascar). When compared to Morocco, however, either the extent of generalization of the fertility decline to all parities, or the resumed concentration at later transitional stages, was less marked.

The urban population of Rwanda stands for the pattern which is characterized by an early generalization and upward diffusion (GU) of birth limiting behavior across parities. While the spread of behavioral changes from middle to upper parities is similar to the one found in Gabon, the fertility decline was more generalized across parities starting from the very onset of the transition until advanced stages. Low parities did contribute to the advanced fertility decline, but their contribution was not the most important. A similar pattern can be found in Cote d'Ivoire. In the "other" a-typical pattern, portrayed by Malawi, the stopping behavior also emerged among several parities at the transition onset, with only a slight dominance of middle parities. Later on, however, fertility decline was increasingly concentrated among the uppermost parities (rather than generalized). This again points to significant resistances to further fertility decline among women with fewer previous births. Urban Senegal is characterized by similar resistances to the intensification of birth limiting behaviors among lower parity women during the unfolding of the fertility transition.

The Philippines constitute another special case (see A-Figure 3). Birth limitation was widespread at the onset of fertility decline and throughout the transition, with women having three and only two previous births slightly leading the process. The fertility transition in Brazil was similarly driven by middle parities. However, these parity groups dominated the process to a larger extent when compared to the pattern found in the Philippines.

In sum, the classic pattern of diffusion of birth limiting behaviors across parities is the norm only in Asia. The generalized fertility decline among several parities throughout the entire course of the transition tends to be more prevalent in the Northern Africa and in Latin America. The initiation of birth limitation among middle parities, however, is often observed in sub-Saharan Africa. Here, the new behavior is also frequently not diffused to lower parities in advanced stages of the fertility transition.

Discussion & conclusion

The pattern of diffusion of birth limiting behavior matters for the heterogeneity of women in terms of family size. This has implications for the inequalities in their freedom to take advantage of the new socioeconomic opportunities brought about by fertility decline (such as the demographic dividend). Yet the empirical evidence about the parity-specific diffusion of fertility decline is scarce. It mainly refers to national-level populations in which the demographic and geographic spreads of behavioral innovation are confounded by each other. Focusing on urban populations spanning all regions of the global South, we introduced an innovative way to look at the parity-dependent reproductive changes in a comparative and long-term perspective. We tested whether the emergence and diffusion of birth limiting behaviors during the onset and unfolding of the fertility transition was congruent to the classic model of family limitation.

The two new indicators enabled us to succinctly monitor and compare the parity-specific direction and generalization of the diffusion of birth limitation over time. The results confirmed a general trend characterized by an initial concentration of fertility decline among a given parity, a subsequent generalization and then by a resumed concentration among another parity group at later stages of the transition. This is consistent with the process of social diffusion of a behavioral innovation. However, there is significant international heterogeneity in the parity at which birth limitation emerged, in the direction of diffusion of the new behavior to other parities, and in the extent of its generalization across all parity groups. The classic model of progressive family limitation over time was confirmed in only one third of urban populations studied (in 9 out of 27), and was the norm only in Asia. In the four confirmed cases outside of Asia, the birth limiting behaviors tended to generalize sooner than expected – as soon as average fertility was approaching the five-children-bar. In the other urban populations that did not follow the classic pattern, birth limiting behaviors emerged either concurrently among a heterogeneous group of parities or essentially among middle (rather than upper) parities. In sub-Saharan Africa, middle and lower parities also resisted advanced fertility decline. The robustness tests in the Appendix reveals that the inclusion of rural-to-urban migrants in the samples did not significantly alter the observed patterns of diffusion of birth limiting behaviors.

This diversity in the patterns of fertility decline is not confined to the developing world. Zeman et al. (2018) also found contrasting parity-specific pathways towards below-replacement fertility levels in OECD countries. The diversity in the parity groups which are simultaneously involved in the fertility decline in developing countries clearly contradicts the classic hypothesis of family limitation. Cultural differences do not seem to matter. In particular, the generalized birth limitation among several different parity groups in urban sub-Saharan Africa challenges the argument of an African "exceptionalism" of slow fertility decline driven by the spacing of births, as derived from national level observations (Moultrie, et al. 2012; Bongaarts 2017; Timæus and Moultrie 2020).

The socioeconomic differentiation of urban societies may be the key explanation for the observed differences in the transition patterns. The progressive family limitation found in Asia can be related to a comparatively low level of inequality and a stronger commitment of governments to impose the small family ideal in society, when compared to other developing regions (UN-Habitat 2008; Véron 2008; Attané and Barbieri 2009). In such a context, there may indeed be one single normative target family size which gradually shrinks over time. The atypical parity-specific patterns of fertility decline, by contrast, are predominantly observed in Latin America, Northern Africa, and sub-Saharan Africa, where income inequality is more pronounced. The early generalization of birth limitation to different parity groups may be related to heterogeneity in the motives for fertility decline and, thus, the presence of concurrent normative family size ideals. One may distinguish between an opportunity-seeking limitation of childbearing at low parities among higher educated and affluent groups versus a poverty-driven termination of fertility at middle or upper parities among disadvantaged women (Basu 1986; Cosio-Zavala 1995). These different types of fertility transition may unfold simultaneously not only within distinct social strata of urban society, but also within distinct neighborhoods. This presumably led to the strong spatial heterogeneity in fertility in African cities (Weeks et al. 2010).

Furthermore, the emergence of birth limitation among middle (rather than upper) parities may be related to an initiation of the fertility transition by a specific subpopulation which may be engaged more intensively in social interactions with other countries that are more advanced in the transition (Bongaarts and Watkins 1996). This specific onset pattern of fertility decline is indeed predominantly observed in the more recent transitions in sub-Saharan African cities, as well as in countries with large European minorities (i.e. Brazil) which probably imported behavioral changes from their country of origin.

To better understand the atypical patterns of fertility transition, future research may analyze their contextual determinants (such as income inequality and cultural diversity), as well as the differences in the emergence and diffusion of birth limitation within distinct socioeconomic or ethnic groups. The mix of reproductive behaviors women rely on to limit their completed fertility may also be studied in depth for each of the transition patterns identified in this study. Furthermore, the rate of unwanted births typically rises over the course of the fertility transition because of increased unmet needs for modern means of contraception (Bongaarts and Casterline 2018). Our trends in cohort parity progression ratios thus result from the inter-cohort differences in both, fertility desires (i.e. target parties) and unwanted fertility, and we are unable to differentiate between the two. Comparative analysis of desired and actual parity progression would provide useful information on the respective roles played by behavioral intentions and the constraints to realize fertility plans. A particular focus should be directed towards the middle and lower parity groups that resist the diffusion of birth limiting behaviors at advanced stages of the transitions in sub-Sahara Africa, where unmet need for contraception is particularly high. This will help to better focus family planning programs on those women who have been left behind or face special barriers. More generally, subsequent studies should include a larger number of countries outside of sub-Saharan Africa, which are underrepresented here because of the lack of harmonized public-use survey data that cover the early through late stages of the fertility transition.

The rejection of the classic hypothesis of family limitation has implications for our understanding of the rising heterogeneity of women in terms of their family size over the course of the fertility transition (Lutz 1989). Transitions initiated by middle (rather than upper) parities, or by several parities simultaneously, leads to a particularly strong heterogeneity in terms of family size within cohorts: while some women stop after two children, others terminate childbearing only after the fourth, fifth or sixth birth. In such contexts, only a minority of less fertile women are able to take advantage of the new socioeconomic opportunities brought about by the demographic dividend that accompanies the drop in average fertility. In other words, the generalized patterns of urban fertility decline and the resulting heterogeneity in women’s family size may constitute the root causes of the persistence of socioeconomic inequalities in developing countries' cities (UN-Habitat 2008), which may in turn reproduce fertility inequality over generations.

Appendix

Sample of countries and survey/census waves

A-Table 1: Country-specific levels of urbanization, number and dates of fertility surveys, observed urban cohorts and their level of fertility in 27 African, Asian and Latin American countries.

	Country		% urban		Survey (census) years												Observed urban cohorts & corresponding fertility			
	(abbr. & name)		1950	2000	1st	2nd	3rd	4th	5th	6th	7th	8th	9th	10th	11th	12th	First	TF	Last	TF
ASIA	BD	Bangladesh	4	24	1975	1993	1996	1999	2000	2004	2007	2011	2014				1926	7.2	1980	2.6
	IA	India	17	28	1992	1999	2000	2005									1928	4.1	1971	2.7
	ID	Indonesia	12	42	1976	1987	1991	1994	1997	2002	2007	2012					1927	5.3	1978	2.2
	PH	Philippines	27	48	1978	1993	1998	2003	2008	2013							1929	6.4	1979	2.6
	LK	Sri Lanka	15	18	1975	1987											1926	5.5	1953	2.9
	TH	Thailand	16	31	1970	1980	1987	2000	2005	2012							1906	5.0	1971	2.7
LA	BO	Bolivia	34	62	1976	1989	1993	1998	2003	2008							1912	5.2	1974	3.0
	BR	Brazil	36	81	1970	1980	1986	1996	2000	2010							1906	5.0	1976	2.9
	CO	Colombia	33	72	1976	1986	1990	1995	2000	2004	2009						1927	6.4	1975	2.2
	EC	Ecuador	28	60	1979	1987	2001	2010									1930	5.9	1976	3.4
	MX	Mexico	43	75	1976	1987	2015										1927	7.0	1966	2.6
	NC	Nicaragua	35	55	1997	2001											1948	5.1	1967	3.1
	PE	Peru	41	73	1977	1986	1991	1996	2000	2004	2007	2009-2012					1928	6.6	1978	2.2
NA	EG	Egypt	32	43	1980	1988	1992	1995	2000	2003	2005	2008	2014				1931	6.7	1980	3.1
	MA	Morocco	26	53	1980	1987	1992	2003									1931	6.4	1969	2.2
	TN	Tunisia	32	63	1978	1988	2012										1929	7.0	1978	2.6
SSA	CI	Côte d'Ivoire	10	44	1980	1994	1998	2005	2011								1931	6.6	1977	3.5
	ET	Ethiopia	5	15	2000	2005	2011										1951	5.7	1977	3.0
	GA	Gabon	11	80	2000	2012											1951	6.1	1978	3.4
	GH	Ghana	15	44	1979	1988	1993	1998	2003	2008	2014						1930	6.0	1980	3.2
	KE	Kenya	6	20	1977	1988	1993	1998	2003	2008	2014	2015					1928	6.5	1981	3.1
	MD	Madagascar	8	27	1992	1997	2003	2008	2011	2013	2016						1943	5.9	1982	3.1
	MW	Malawi	4	15	1992	2000	2004	2010	2012	2014	2015						1948	6.9	1981	3.0
	RW	Rwanda	2	15	1992	2000	2005	2007	2010	2013	2014						1948	6.1	1980	2.9
	SN	Senegal	17	40	1978	1986	1992	1997	1999	2005	2006	2008	2010	2012	2014	2015	1929	6.8	1981	3.3
	TG	Togo	4	33	1988	1998	2013										1939	6.1	1979	3.4
	TZ	Tanzania	3	22	1991	1996	1999	2004	2007	2009	2011	2015					1942	6.5	1981	3.4

Sources: WHS & DHS, MICS, IPUMS, UN World Urbanization Prospects 2015. Notes: LA = Latin America, NA = Northern Africa, SSA = sub-Saharan Africa, TF = total cohort fertility.

Projection of cohort parity progression ratios and estimation of total fertility

To project the completed PPRs for the cohorts aged 30-34 and 35-39 at the survey dates, the Brass-Juarez paired-cohort comparison procedure was applied (Brass and Juarez 1983; Moultrie, et al. 2012). The truncated PPRs for the younger cohorts are projected forward in time by multiplying the completed PPR of the cohort aged 40-44 at the survey date *t* (*PPR(40-44, t)* in Equation 1) by that cohort's fertility differential with the immediately younger cohort and by the latter cohort's fertility differential with the subsequent cohort (second right-hand term in the Equation below). In other words, the completed PPRs are multiplied with the downward-cumulated fertility change ratios between successive pairs of adjacent cohorts.

$$PPR(30-34,\ t+10) = PPR(40-44,\ t) * \prod_{c=35-39}^{40-44} \frac{PPR(c-5,t)}{PPR(c,t-5)} \qquad (1)$$

The innovative idea of the Brass-Juarez method is to estimate the inter-cohort fertility change ratios at equivalent ages and parities in order to control for the truncation of the fertility career and the selection of more fertile women in higher parity groups among younger cohorts. For the older women in each pair of cohorts, the number of births that occurred in the five-year period immediately preceding the survey (as reported in the birth histories) is subtracted from the stated parity at the survey date *t*. Thus, the older cohort's PPR as of five years before the survey (*PPR(c, t-5)*) is truncated and affected by selection to the same extent as the younger cohort's PPR at the time of the survey (*PPR(c-5, t)*).

Total cohort fertility (*TF*) can be obtained as a weighted average of the parities attained in the cohort, with the weights constituted by the parity distribution of women (i.e. the proportion having given birth to one, two, etc. children; p*i*):

$$TF = 1 * p1 + 2 * p2 + 3 * p3 + 4 * p4 + 5 * p5 + avCEBP6 * p6 \qquad (2)$$

The average number of children ever born among women in the last open ended parity group (six children or more), *avCEBP6,* was estimated at the survey dates; inter-survey estimates have been linearly interpolated, pre-survey estimates extrapolated, and the trend smoothed.

The parity distribution of women (p*i*) is implied by the chaining of the progression ratio of nulliparous women to the first birth (*PPR0->1*) through the ratio of progression from the fifth to the sixth birth (*PPR5->6*):

$$pi = \left[\prod_{k=1}^{i} PPR_{(k-1)\to k}\right] * \left[1 - PPR_{i\to(i+1)}\right] \quad (3)$$

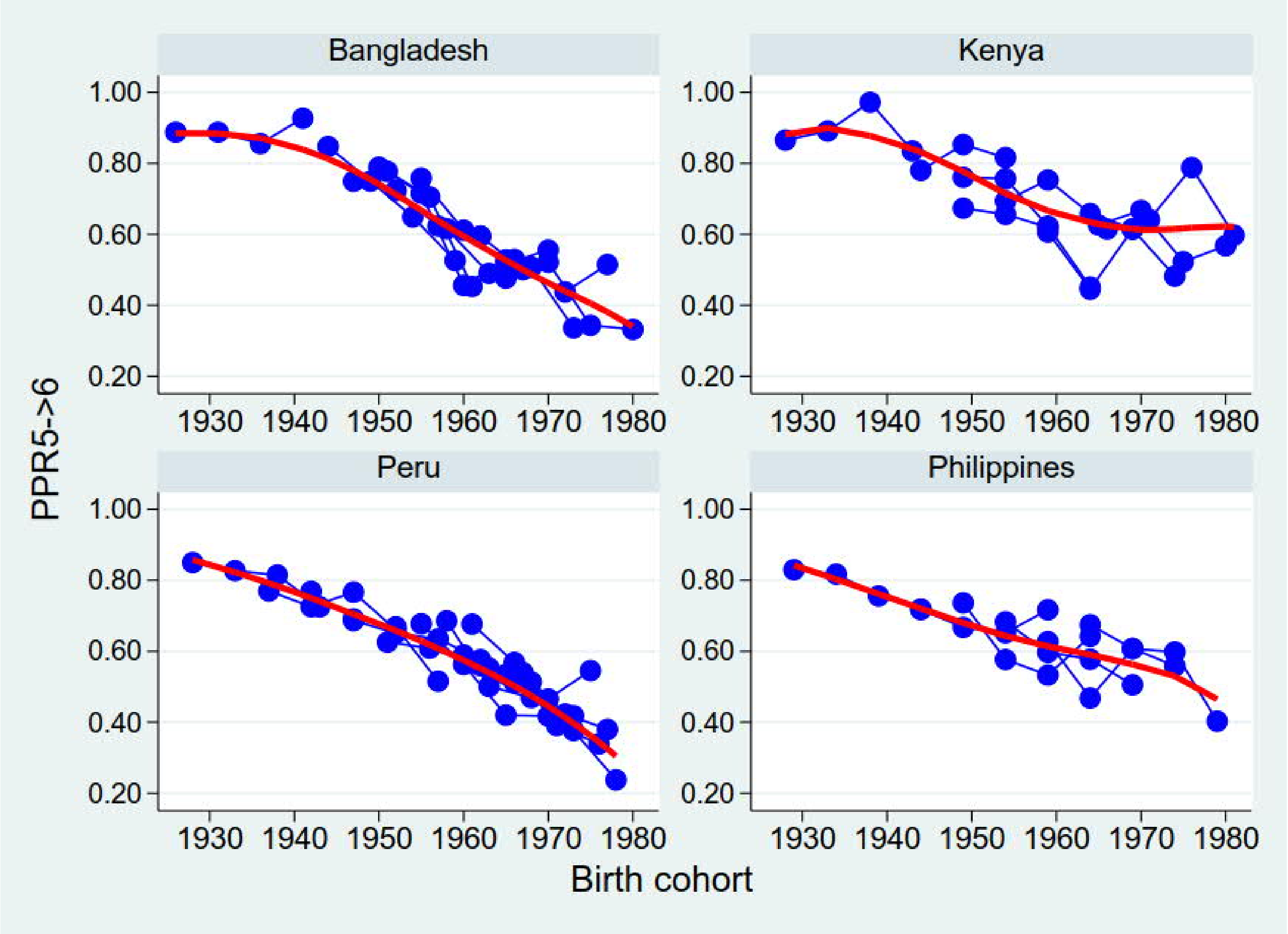
Cross-validating and smoothing of the estimates

We performed two quality tests of our estimations series. The first is based only on the survey/census-samples. To assess the quality of the reporting of women's parity, on the one hand, and the accuracy of our projections for younger cohorts, on the other hand, we cross-validated the observed and projected values of completed PPRs for overlapping cohorts as obtained respectively from two successive surveys. This internal plausibility test of our data revealed a higher agreement between observed and projected PPRs at lower parities, which can be explained by larger samples of women. A-Figure 1 shows the most problematic crude series of observed and projected progression ratios as obtained from successive surveys: the transition from the fifth to the sixth birth (PPR6). Countries are purposively selected to illustrate the range of data quality. On each individual blue line, the last two points designate projected values, whereas prior points represent estimates. The averaged and smoothed trend (see below) is also plotted in red.

Overall, we can conclude that the quality of our series of completed PPRs is good. We smoothed the trend by, first, averaging survey-specific data points for overlapping cohorts, linearly interpolating the estimates, and then applying a running line function (see thick lines in A-Fig. 1).

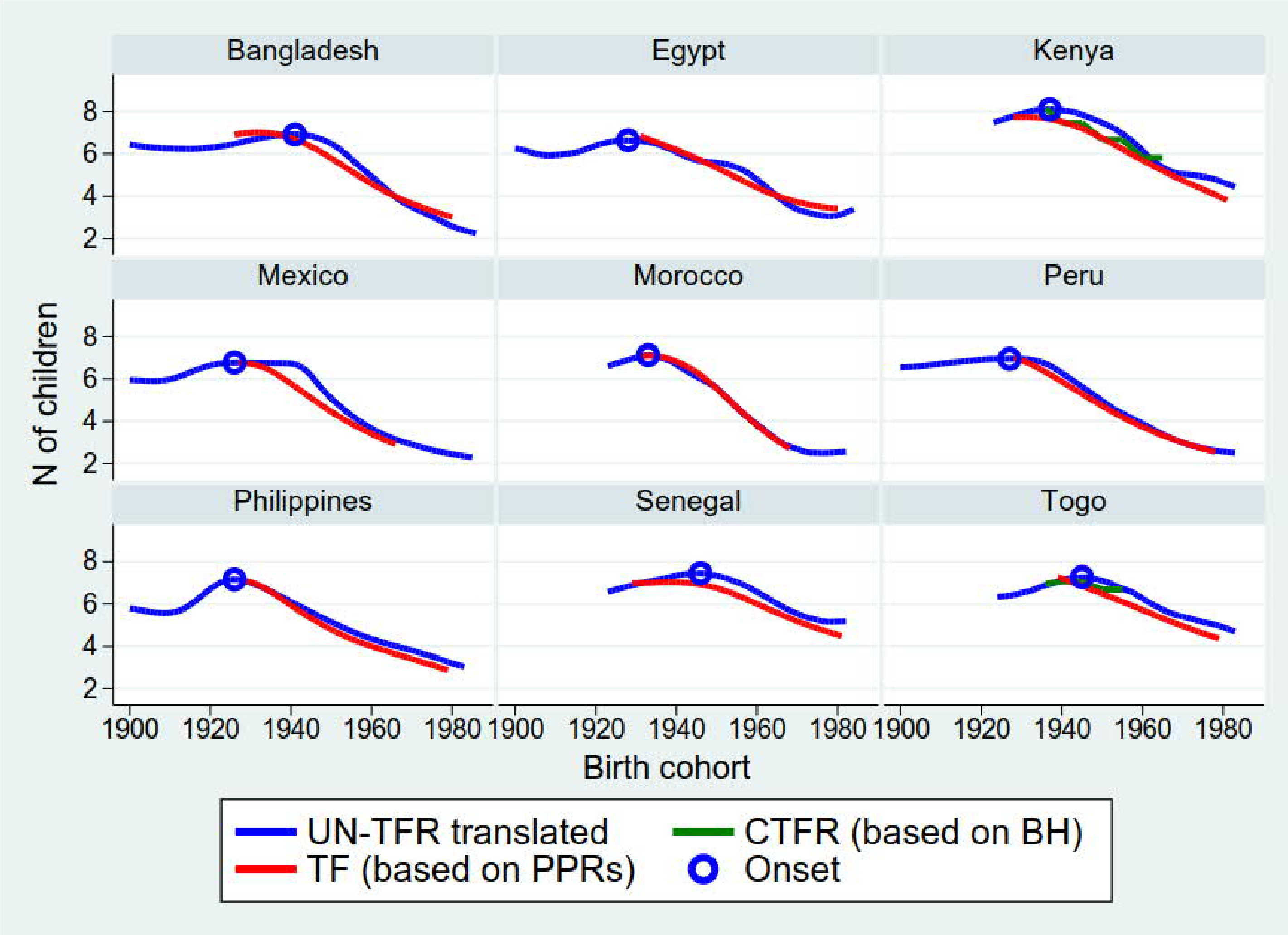
As a second external plausibility test, we estimated national-level total cohort fertility (TF) based on the PPRs (which are primarily based on parity data) and compared the trends with two external estimates: the United Nations' period TFR series which have been back-translated by the average age at childbearing to get a cohort indicator, and Sneeringer's (2009) estimates of the total cohort fertility rates (CTFR; i.e. the sum of age-specific rates) based on the pooled birth histories from successive DHS in Africa. As shown in A-Figure 2, our estimates fit the two other series well – even in countries where only ever-married women have been interviewed (such as in Bangladesh, Egypt and Morocco).

A-Figure 1: Survey-specific estimates and projections of transition ratios from the fifth to the sixth birth (in blue; PPR5->6) and the smoothed trend (in red), urban cohorts 1926-1982 in selected developing countries.



Sources: WHS & DHS, MICS, IPUMS.

A-Figure 2: Three estimates of the national-level total cohort fertility trends, as implied by the chaining of cohort PPRs, by cohort age-specific fertility rates, and by the back-translation of period TFRs (by the mean age at birth), national cohorts 1900-1985 in selected developing countries



Sources: WHS & DHS, MICS, IPUMS, United Nations (2017)

Decomposition of cohort fertility decline by parity

We decomposed cohort fertility decline into the contributions by parity using the general algorithm of stepwise replacement (Andreev, et al. 2002; Zeman, et al. 2018). The contributions are given by the differences between a set of simulations of total fertility as implied by the chained PPRs which are measured for two adjacent cohorts and step-wise replaced for each other. Using equation 2 and 3 (above), the first simulation starts with the chaining of all PPRs of the older cohort and provides the baseline level of fertility. The second simulation of total fertility is obtained by substituting only the PPR0->1 of the younger cohort for the value referring to the older cohort. Comparing the two simulations provides us with the contribution of the inter-cohort change in the PPR0->1 to the inter-cohort decline in total fertility. In subsequent simulations, we step-wise substitute an additional PPR of the younger cohort for the estimate of the older cohort (moving upward across parities), and compare the successively simulated values of total fertility.

Based on this decomposition exercise, A-Figure 3 shows the direction and generalization of the diffusion of birth limiting behavior for the urban areas in all 27 countries. Countries are ranked according to the pattern observed and the trough in the coefficient of variation of the parity-specific contribution to the inter-cohort fertility decline.

The impact of urban in-migrants on the pattern of diffusion of birth limiting behaviors

The inclusion of in-migrants in the estimates of urban fertility may bias the observed pattern of diffusion of birth limitation. Urban in-migrants have been socialized to rural fertility standards and did not spend their whole reproductive period in the city. The process of adaptation to urban fertility standards is generally completed only among the migrants' descendants, who have been socialized in cities (Goldstein and Goldstein 1981; Brockerhoff 1998; White et al. 2005). Consequently, urban in-migrants may stop childbearing at higher parities when compared to non-migrant urban dwellers. Alternatively, migrants may be selected among women with low fertility preferences and may therefore stop childbearing at lower parities, when compared to non-migrants.

In order to evaluate the impact of migration on the results presented above, we compared these with another set of estimates based exclusively on the non-migrant populations in urban areas. Non-migrants are defined as those women who have been socialized (until age 15) *and* interviewed in an urban area. We identified these women based on the information about the childhood or previous type of residence location as reported in a sub-set of WFS and DHS surveys. The cohort series for the non-migrants are shorter than those for the total urban population (and inter-cohort gaps have been linearly interpolated). This is because several (more recent) surveys do not provide any information on migration. The pattern of diffusion of birth limitation among non-migrants is shown by a gray line in the A-Figure 3 for comparison with the results for the total urban population.

When compared to the results for the entire urban population, the robustness tests among non-migrants reveal more erratic cohort trends in the two-dimensional indicator space due to the sampling biases which stem from the lower numbers of observations. In general, the direction of diffusion of fertility decline across parities and the trough in the variation of parity-specific contributions are not affected by the inclusion of migrants in the estimates. However, when compared to the total population, the birth limiting behaviors among non-migrants tends to be more concentrated in the upper-most and lowest parities at, respectively, the onset and advanced stages of the fertility transition.

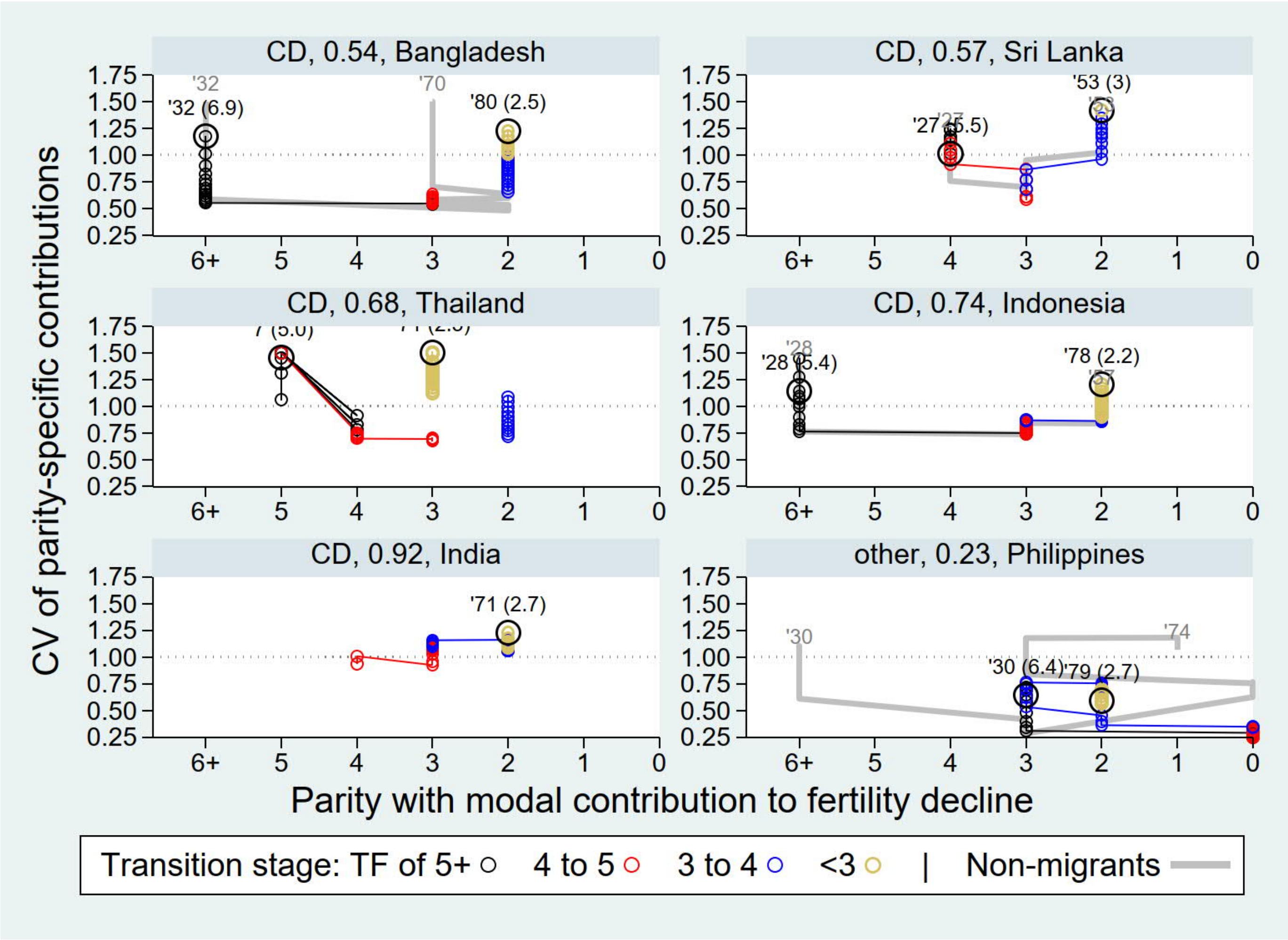
At the onset of the transition, migrants tend to be selected among less fertile women who stopped childbearing at lower parities when compared to non-migrants. This diversifies the parities that contribute to the onset of fertility decline in the total urban population (such as in Bangladesh, Morocco, Madagascar, Tunisia and the Philippines). In late stages of the transition, the inverse is often observed: urban in-migration increases the share of higher fertile women in cities, which leads to a more pronounced generalization of birth limiting behaviors across parities in the total urban population, when compared to the non-migrant sub-group (such as in Mexico, Bangladesh, Morocco, Madagascar, Philippines). The arrival of less fertile in-migrants in early transitional stages and the arrival of more fertile in-migrants in the advanced stages are congruent with migration theory. While migrants are initially selected among the most progressive social group at origin, the opportunities to move diffuse within society as the risks and uncertainty of the mobility project diminish with the institutionalization of the migration flow, through the growth of a network of migrants who assist new migration candidates.

At the transition onset in Gabon, Kenya, and Togo, however, the emergence of birth limiting behavior in the total urban population is concentrated among an upper parity, while it is rather generalized among non-migrants – with often a slight predominance of a lower parity group. In-migration increases the share of more fertile women to the extent that birth limitation at higher parities dominates the early urban fertility decline. For similar reasons, the advanced stages of the transition are dominated to a greater extent by birth limitation at higher parities in the total when compared to the non-migrant population (in Ecuador, Kenya, Rwanda, and particularly Senegal and Malawi).

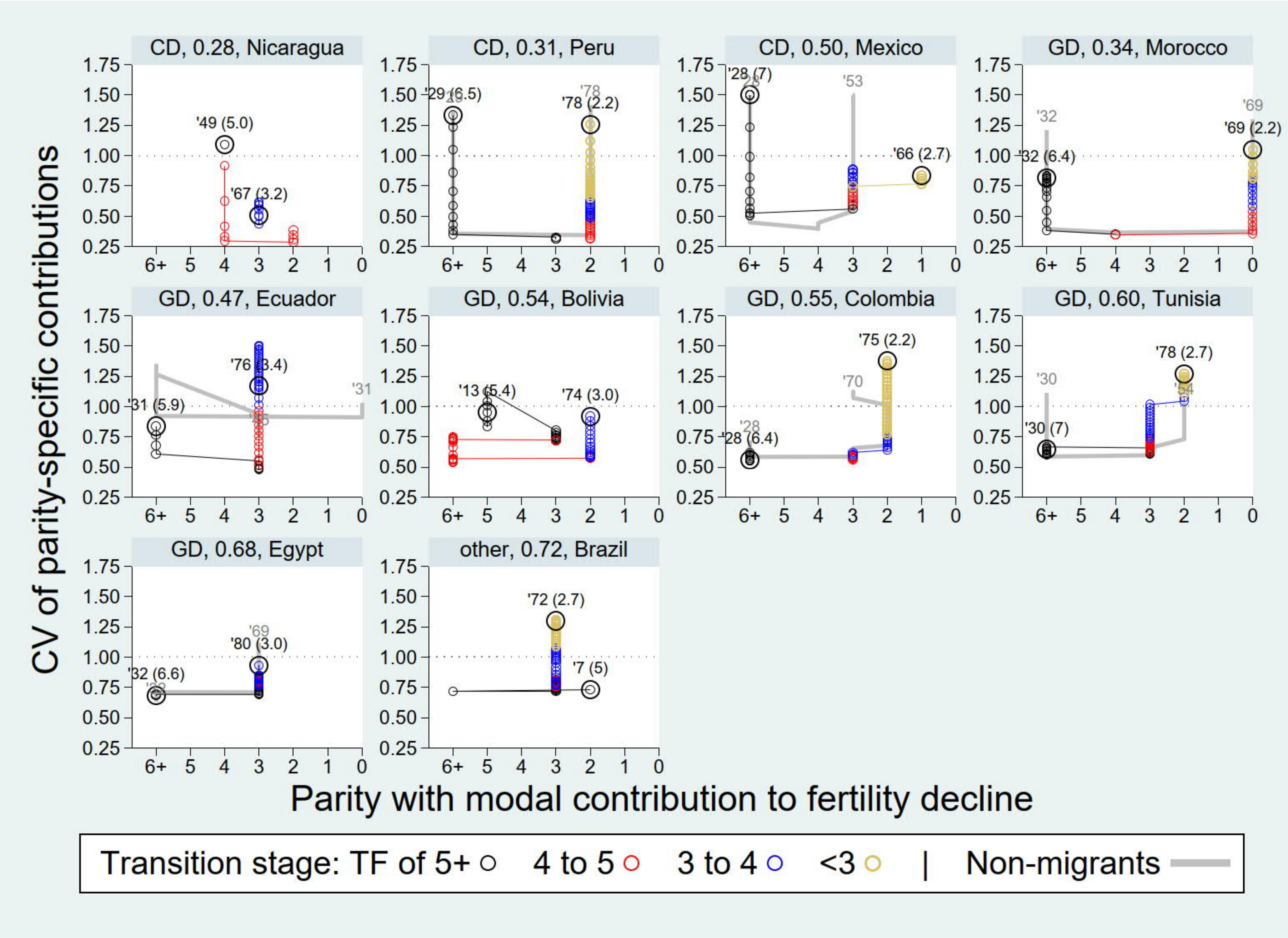
We can conclude that the general pattern of diffusion of birth limiting behavior across parities is not strongly affected by the inclusion of in-migrants in the estimates for the majority of urban populations. The countries in which migrants make a significant difference are either small and predominantly urban, or characterized by a low level of urbanization. As in these contexts in-migrants represent a large share of the urban population, and we lack information on the migrants' duration of residence in many surveys, their exclusion from the analysis would be questionable.

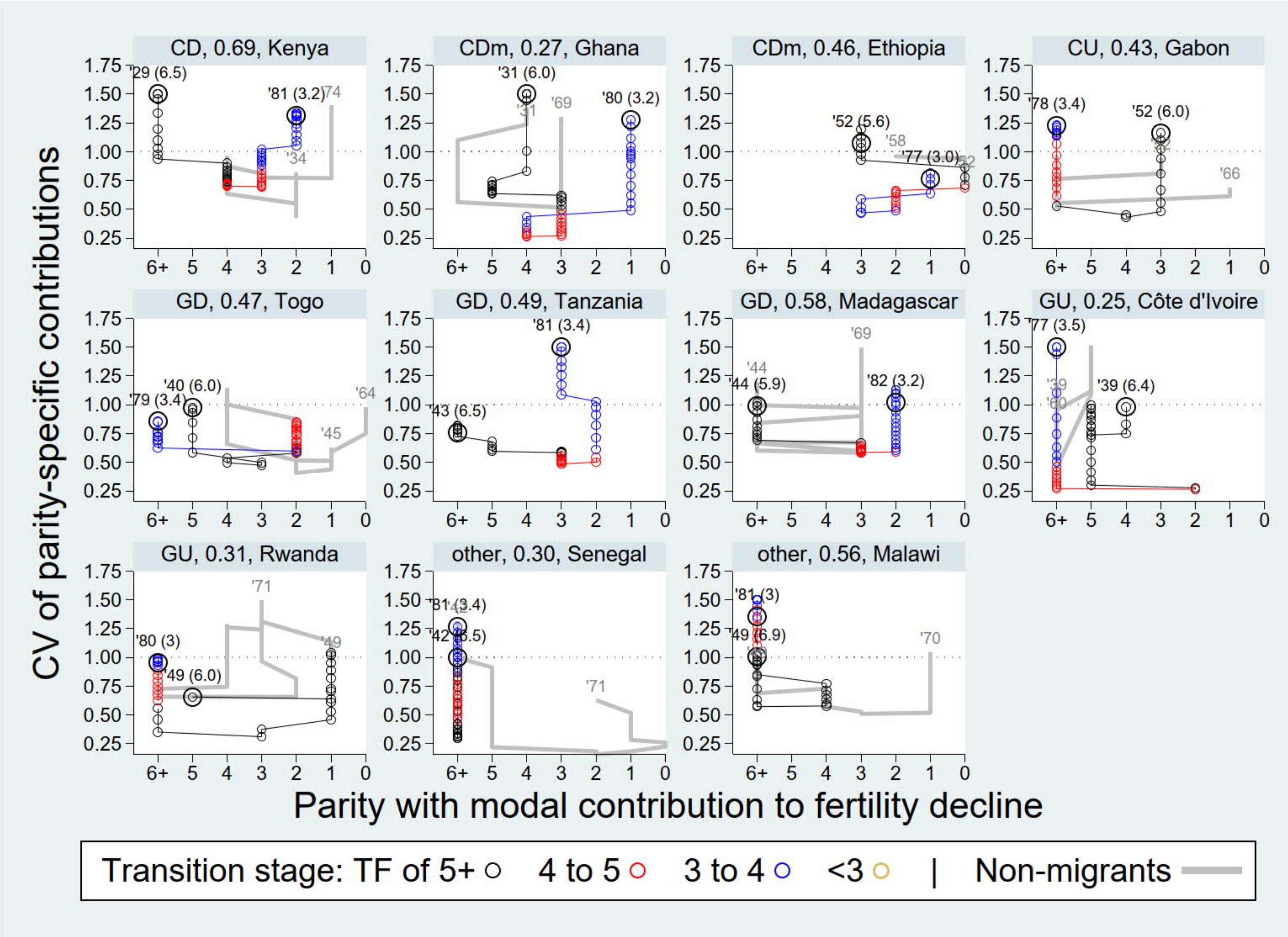
A-Figure 3: Direction (x-axis) and generalization (y-axis) of birth limiting behavior across parities over the course of the fertility transition, total and non-migrant populations in 27 developing countries, urban cohorts 1906-1982.

ASIA



LATIN AMERICA AND NORTHERN AFRICA




CD, 0.69, Kenya
CDm, 0.27, Ghana
CDm, 0.46, Ethiopia
CU, 0.43, Gabon
GD, 0.47, Togo
GD, 0.49, Tanzania
GD, 0.58, Madagascar
GU, 0.25, Côte d'Ivoire
GU, 0.31, Rwanda
other, 0.30, Senegal
other, 0.56, Malawi
CV of parity-specific contributions
Parity with modal contribution to fertility decline
Transition stage: TF of 5+
4 to 5
3 to 4
<3
Non-migrants

Sources: WHS & DHS, MICS, IPUMS.

Notes: within each developing region, the populations are ranked according to the pattern of fertility decline and the trough in the CV of the parity-specific contributions; the first and last cohort is indicated by a larger black dot and indexed with its year of birth and average level of fertility; values next to the country name refer to the trough in the CV of parity-specific contributions to the fertility decline over the entire course of the transition, CV = coefficient of variation, TF = total fertility, CD = early concentration among upper parities and subsequent downward diffusion of fertility decline by parity, CDm = early concentration among middle parities and downward diffusion, CU = early concentration and upward diffusion, GD = early generalization and downward diffusion, GU = early generalization and upward diffusion.

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