A Sequence-Analysis Approach to the Study of the Transition to Adulthood in Low- and Middle-Income Countries

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This study investigates whether young people in low- and middle-income countries (LMICs) have experienced processes of destandardization of the life course similar to those observed in high-income societies. We provide two contributions to the relevant literature. First, we use data from 263 Demographic and Health Surveys (DHS) across 69 LMICs, offering the richest comparative account to date of women's transition to adulthood (TTA) patterns in the developing world. In so doing, we adopt sequence analysis and shift the focus from individual life-course events—namely first sexual intercourse, first union, and first birth—to a visually appealing approach that allows us to describe interrelations among events. By focusing on the analysis of trajectories rather than the occurrence of single events, the study provides an in-depth focus on the timing of events, time intervals between events, and how experiencing (or not) one event might have consequences for subsequent markers in the TTA in cross-national comparative perspective. Second, we identify clusters of TTA and explore their changes across cohorts by region and household location of residence (rural vs. urban). We document significant differences by macro-regions, yet relative stability across cohorts. We interpret the latter as suggestive of cultural specificities that make the TTA resistant to change and slow to converge across regions, if converging at all. Also, we find that much of the difference across cluster typologies ensues from variation related to when *the transition begins (early vs. late), rather than from the duration between events, which tends to be uniformly quick across three out of four clusters.*

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Introduction

Adolescence and early adulthood are critical periods of human development that set young people on trajectories that shape their future roles as adults (National Research Council and Institute of Medicine 2005). During adolescence, important decisions are made relating to transitions out of school, into work, into sexual relations, marriage, and parenthood. Although these transitions are not homogeneous across contexts, it is indisputable that they shape the subsequent life course and—in an intergenerational perspective—the context in which children are born and raised (Bongaarts, Mensch, and Blanc 2017).

Over the past century, there have been significant changes in the prevalence, timing, and complexity of transitions to adulthood (TTA) in the United States and Europe. These have been extensively documented, with the majority of studies providing evidence of increasing "destandardization" (or disorder) of family-formation trajectories (e.g., Rindfuss, Swicegood, and Rosenfeld 1987; Shanahan 2000; Billari and Liefbroer 2010). Family-life trajectories of young adults in high-income countries (HICs) seem to have become less similar to one another, and the variation in the types of family trajectories to have increased (Elzinga and Liefbroer 2007; Van Winkle 2018). Some other evidence suggests that, although no convergence of trends is observed yet, these diversified pathways to adulthood are changing in the same direction across most parts of Europe towards a later, longer, and complex TTA (Billari and Liefbroer 2010). In part, the seeming contradiction between destandardization and the uniformity resulting in later and longer transitions has occurred in virtually all countries with advanced economies. Historical, cultural, and institutional differences create distinctive expressions in the way that economic and technological change plays out at a regional or country level (Breen and Buchmann 2002; Cook and Furstenberg 2002; Buchmann and Kriesi 2011). For the same reasons, we anticipate that a similar process might occur in low- and middle-income countries (LMICs).

In LMICs, the literature on the TTA is still in its infancy, yet interest has been growing steadily in light of the significant socioeconomic and demographic transformations these countries have been undergoing (Juárez and Gayet 2014; Pesando and Global Family Change [GFC] Team 2019). Inserted within a framework of rooted poverty and persistent economic and social inequalities, factors such as massive educational expansion, technological change, changes in family forms and behaviors, high unemployment rates, multiple health vulnerabilities owing to climate change and natural disasters,[1] and shifting cultural preferences regarding marriage types are likely to manifest in a world in which fewer certainties lead to new ways of experiencing the TTA (Beguy et al. 2011). Drawing also on the idea that individual life courses are strongly

standardized by institutional demands—and the presence and nature of institutions in LMICs is heterogeneous and often lacking—existing (mostly single-country) research in LMICs has demonstrated a vast diversity of situations in different regions of the world, alongside TTA occurring at different ages and modalities within the same society (National Research Council and Institute of Medicine 2005; Juárez and Gayet 2014).

This study seeks to contribute knowledge on the nature of the TTA in LMICs by summarizing a large volume of information using a visually powerful methodological approach building on sequences of events and time intervals between them. We provide two contributions to the relevant literature. First, we offer—to the best of our knowledge—the first comparative account of women's TTA patterns in LMICs using data from 263 Demographic and Health Surveys (DHS) across 69 countries. In so doing, we shift the focus from the study of individual events in the TTA towards an approach that describes the life course as a combination of interdependent events where not only timing matters but also duration between events and the type of sequencing.

The literature on the TTA is currently organized along three lines. First are studies that describe the complexity of life-course transitions focusing on one or two countries only. Examples from HICs are Aassve, Billari, and Piccarreta (2007) on the UK; Oris and Ritschard (2014) on Belgium; Ravanera, Rajulton, and Burch (1998) on Canada; Robette (2010) on France; Salmela-Aro et al. (2011) on Finland; Sironi, Barban, and Impicciatore (2015) on Italy and the United States; etc. Conversely, examples from LMICs are Goldberg (2013) on South Africa; Echarri Cánovas and Pérez Amador (2007) and Fussell (2005) on Mexico; Beguy et al. (2011) on Kenya; Mensch et al. (2014) on Malawi; and Tian (2016) on China. Second are cross-national comparative analyses focused on industrialized societies, such as Billari and Liefbroer (2010), Elzinga and Liefbroer (2007), Schwanitz (2017), and Van Winkle (2018) covering, respectively, 26, 19, eight, and 14 countries and the institutional differences (e.g., welfare state regimes) prevailing. Third are cross-national comparative studies focused on LMICs, such as Lloyd and Mensch (2008), Bongaarts, Mensch, and Blanc (2017), and Pesando and GFC Team (2019). These provide good bases for the understanding of the TTA in LMICs, yet they describe transitions such as entering first marriage or first birth as independent—rather than interrelated—events.

Building on a similar observation that analyses of TTA in less developed countries largely focus on one or two transitions in isolation, this paper is closest in aim and ambition to Grant and Furstenberg (2007), who examined whether increases in female school participation, the timing of marriage, and socioeconomic changes in Africa and Latin America influenced the timing and pattern of the TTA using DHS data from six countries. We here capitalize on their work by enriching their analyses in three

directions. First and most importantly, we do not only rely on one combined index of heterogeneity to describe the complexity of the life course. Rather, we compute the timing of events, time intervals between events, and how experiencing (or not) one event might have consequences for subsequent markers in the TTA. Second, we provide updated estimates drawing on all surveys collected up until the year 2016. Third, we expand the geographical coverage from six to 69 countries, looking at cross-regional heterogeneity and changes across cohorts, subregions, and rural and urban areas.

Our second contribution is methodological. We use sequence analysis to describe the life-course complexity through detailed sequences of events defined by first sexual intercourse, first union, and first birth. To maximize the number of survey waves and countries covered, we focus on women only and restrict to events occurring up to age 30. The latter decision, together with our focus on first birth—rather than the whole fertility history—reflects an explicit choice to characterize the early part of the life course and highlight as much heterogeneity as possible "independently" of higher-order fertility, which would be a dominant and driving feature, for example, in sub-Saharan Africa (SSA). This has been shown, for instance, by extensive work that identifies the space between first and second births as one of the most important location intervals for understanding distinct patterns of demographic behavior between and within groups in African societies (Randall and LeGrand 2003; Johnson-Hanks 2004).[2] Drawing on information from the sequences, we group individuals into clusters of TTA and explore their changes overtime by region and urban/rural location of residence.

Conceptually, our choice of sequence analysis rests on the idea that increases in women's mean or median ages at key life-course events (e.g., median age at first marriage) are by now well-documented in LMICs (see, for instance, Bongaarts et al. 2017). Through this methodological approach, we are able to understand how transitions to first sex, first union, and first birth are interrelated and influence each other—and we intend to convey that background forces such as educational expansion, urbanization, and cultural, societal, and institutional changes do exert an influence not only on mean ages, but on the whole "package" of TTA status combinations that young adults undergo. In the context of LMICs, sequence analysis has been employed for single-country cases to study family planning trajectories in Malawi (Furnas 2016), relationship quality and well-being in Malawi (Frye and Trinitapoli 2015), and the use of time among the elderly in South Africa (Grapsa and Posel 2016).

This is among the first studies to use sequence analysis to study the TTA using large-scale comparative data from LMICs. By adopting this approach, we in no way claim that this technique is superior relative to the study of life-course events taken independently, yet we believe that our

study offers an alternative way of looking into the complexities and interdependencies of events which well adapts to the comparative nature of our data and might help corroborate existing findings obtained through more traditional methodologies.

Background: The TTA in LMICs

Like those in more industrialized societies, individuals in low-income societies have been witnessing a transfer of responsibility from family to other social agents and emerging new institutions with the potential to alter the timetable for growing up in nations where significant educational expansion has occurred. Yet the extent to which the dynamics and the contexts in which youth make TTA in low-income countries resemble those of more advanced economies is still an open question. Focusing on independent transitions, Behrman and Sengupta (2005) undertook an investigation of this kind, finding that low-income countries have converged—with East Asia and the Pacific converging the most and SSA converging the least—towards characteristics of high-income countries in a number of respects, such as the higher dependence on markets rather than family enterprises, formal schooling rather than working, more awareness of options and lifestyles from contexts broader than the local community, smaller gender gaps favoring males, and much more mobility in several dimensions. Conversely, more recent scholarly reviews (Juárez and Gayet 2014) point towards a vast diversity of situations in different regions of the world, with tensions arising from globalization leading to imitation of Western lifestyles in some respects, and circumstances of social inequality, poverty, and exclusion unique to the low-income world influencing the timeframe in which transitions occur, in other respects. Although globalization could have contributed to a homogenization of the transitions on a global scale, it seems to have resulted instead in even greater diversification of life paths—some of which are fully unique to LMICs.

As the expansion of universal school attendance to the secondary level is a key force in standardizing the ages at which young people begin the TTA —and in some (mostly) sub-Saharan African countries universal primary enrolment has not been achieved yet (Hewett and Lloyd 2005; Psaki, McCarthy, and Mensch 2018)—there is reason to expect widespread heterogeneity in the experience of early life-course transitions, and life paths that are relatively unstandardized in late adolescence. This line of thought would suggest that as education expands further, we might observe increasing standardization of life-course events over time across contexts. However, a recent systematic review of 35 studies in LMICs suggests that increased educational attainment has little to no effect on age at marriage, age at first sex, and age at first birth, while it has a small (negative) impact on total achieved fertility (Psaki et al. 2019). This line of inquiry would thus

suggest that even significant educational expansion would not be enough to standardize the ages at which young people make key life-course transitions, thus indicating that other sociocultural forces might be stronger determinants of processes of standardization (e.g., changes in norms and values, technological change, more immediate exchange of information through social media, etc.).

Given the weak role of institutions and the wide variation in institutional contexts across countries—both by region and by level of economic development—we anticipate marked differences across regions. As for changes overtime, our expectations are less clear-cut, yet recent studies on global family change have provided evidence of slow changes in family domains in LMICs (Cherlin 2016; Castro et al. 2019; Pesando and GFC Team 2019). Marriage, union formation, divorce, and union dissolution practices have proven less responsive to socioeconomic changes in LMICs because they are tied to elements of the social structure that are harder to change. These structural features of societies include religious beliefs, marriage-related laws and prohibitions, inheritance rights, shortages in the housing market, and persistent disparities in gender roles and dynamics (Coontz 2014). This inertia overtime would be consistent with what was observed by Fussell (2005) in Mexico and by Grant and Furstenberg (2007) who—putting aside concerns related to the validity of a single heterogeneity index for summarizing large volumes of information—observed relatively small changes in the age-specific index of heterogeneity from the first to the most recent survey in each country.

Yet, whether the TTA in LMICs is (un)structured or (dis)ordered and whether it resembles the TTA in HICs is ultimately an empirical question. Our analysis employs a new methodology that is well adapted to comparative data, providing a powerful descriptive tool for summarizing large volumes of information in a concise and visually appealing manner. In what follows, we turn to a more detailed description of our data, methodological approach, and empirical analyses. In the conclusions, we return to the future task of "explaining" the broad trends identified by our analysis.

Data and methods

Data

We use data from 69 LMICs drawing upon 263 DHS waves. Each survey is representative of the national population of women aged 15–49 and includes information on key variables of interest, that is, age at first sexual intercourse, age at first marriage, and fertility histories. Information from DHS data used in this study has been collected between 1985 and 2016. We keep all respondents (women) with complete information on age at first

sexual intercourse, first union, and first birth. Although DHS data are also collected for men in some countries, we here focus on women only to maximize the number of countries covered and survey waves included—future studies should focus on analogous analyses for men. Due to the complexity of disentangling formal and informal marriages, despite recognizing that what constitutes a marriage or a union varies widely across the world, we refer to unions as the combination of marriage and cohabitation (coded as "living together" in the survey), as typically done in studies of this kind (Casterline, Williams, and McDonald 1986; Clark and Brauner-Otto 2015; Pesando 2021). The number of survey waves and the availability of data for a specific year vary by country. Middle Eastern and North-African (MENA) countries—except for Egypt—are excluded from the investigation due to missing information on age at first sex, typically not asked for reasons of cultural appropriateness. This is an important omission, yet an essential one given that first sexual intercourse constitutes one of the three key events in this study, and we need data on all three for each country. To avoid providing biased trends for the MENA region, we thus exclude it altogether (i.e., we also exclude Egypt). Also, selected surveys from Asia were omitted because the DHS only interviews ever-married women, thus impairing our ability to observe early life-course transitions. This produces a more serious issue: our results for Asia tend to be more strongly driven by countries with complete samples (i.e., without ever-married samples). We will thus interpret Asian trends with caution. In general, we acknowledge that by relying on high-quality surveys that provide comparable measures for a well-defined universe of countries—such as the DHS—we face an obvious trade-off between country coverage and data quality. This results in the exclusion of important LMICs for which no DHS is available. This is indeed is a limitation of our study (also discussed in Pesando and GFC Team, 2019, in the same journal), and we aim to extend similar analyses to China and other excluded LMICs in future research. DHS sampling weights have been used in the analysis throughout.

As we conducted analyses at the regional level, countries were grouped in the following four macro-regions following the classification used in previous studies of global family change (e.g., Pesando and GFC Team 2019): Americas, Asia, former Union of Soviet Socialist Republics (USSR), and SSA. Among these, we relied on a further classification by 11 subregions, namely Americas Central, Americas South, Asia Southeast, Asia South, Asia Central, Asia West, Eastern Europe, Africa East, Africa West, Africa Central, and Africa South. Table 1 shows the regional and subregional classifications adopted in the analysis, and the sample size of women with complete sequences by subregion. For the number of waves per region, and the detailed regional and subregional classification of countries included in the analysis, see Online Appendix Table A1 and Figure A1.

TABLE 1 Regional and sub-regional classification adopted in the analysis, and sample of women with complete sequences

Region	Subregion	Observations
Americas	Americas Central	101,272
	Americas South	218,590
Asia	Asia Southeast	201,643
	Asia South	80,543
Former USSR	Asia Central	15,979
	Asia West	17,556
	Eastern Europe	12,151
SSA	Africa East	265,390
	Africa West	217,405
	Africa Central	65,492
	Africa South	28,575

NOTES: USSR: Union of Soviet Socialist Republics; SSA: Sub-Saharan Africa. Regional classification borrowed from Pesando and GFC Team (2019).
SOURCE: Demographic and Health Surveys.

Methods

This analysis looks at a combination of family life-course events that are closely interrelated, namely first sexual intercourse, first union, and first birth. As already mentioned above, we focus on first births only—rather than the whole fertility history—to better characterize the early part of the life course and highlight as much heterogeneity as possible "independently" of higher-order fertility. Rather than analyzing the median ages at different life-course events (e.g., age at marriage and children progression), we use sequence analysis to describe TTA trajectories. By focusing on the analysis of trajectories rather than the occurrence of single events (as done, for instance, in Bongaarts et al. 2017), sequence analysis explores the occurrence and the timing of events together with the duration between events (Barban and Sironi 2019). We are not just interested in the timing of events, but also in the time intervals between events, and how experiencing (or not) one event might have consequences for subsequent markers in the TTA. By adopting sequence analysis, we aim in this study to summarize a high volume of information and identify interdependencies between events using a flexible methodology that has not been previously adapted to the context of LMICs (and DHS) comparatively.

In sequence analysis, each life-course trajectory is represented by a string of characters, with each character denoting one particular state that describes a specific family role or status. Hence, every trajectory is made up of a number of values that corresponds to the number of years (or months) each individual is observed.

Sequence analysis is associated with a family of algorithms used to quantify dissimilarities between life-course trajectories. *Optimal Matching*

algorithm (OM) is the most known technique that has been applied to social science.[3] OM expresses distances between sequences in terms of the minimal amount of "effort," measured in terms of edit operations (insertion, deletion, and substitution), that is required to change two sequences such that they become identical. Sequence analysis algorithms identify differences in trajectories due to changes in *timing* (when events happen), *quantum* (what and how many transitions), and *ordering* (in what order) of life-course events (Billari and Piccarreta 2005; Billari, Fürnkranz, and Prskawetz 2006). We construct trajectories using a state-space composed of five different states: "no sexual intercourse—not in a union," "sexual intercourse—not in a union," "no sexual intercourse—in a union," "sexual intercourse—in a union, no children," and "sexual intercourse—in a union, one child or more."[4]

After constructing sequences of events, we obtain a series of descriptive statistics computed directly from the sequences themselves, such as the *mean age at specific events*—specifically, age at first sexual intercourse, first union, and first child—and the *time between events*—specifically, sex to first union, sex to first child, and union to first child. All summary measures are computed conditional on the event occurring by age 30.

After building partnership and fertility trajectories and computing summary measures from the sequences, we build clusters to identify patterns in the data and highlight "typical" life-course trajectories (Abbott and Tsay 2000; Aisenbrey and Fasang 2010; Barban and Billari 2012; Barban 2013). In this study, we identify clusters using a clustering algorithm (*Agglomerative Hierarchical Clustering*) based on a training sample of 20,000 randomly selected individuals, in a spirit similar to Studer (2013).[5] A complete description of the classification procedure and the underlying rationale is included in the Online Appendix, alongside Tables A2 and A3 which provide different indices to identify the optimal number of cluster solutions (Table A2) and sensitivity analyses comparing summary statistics for the subsample and for the whole sample (Table A3).

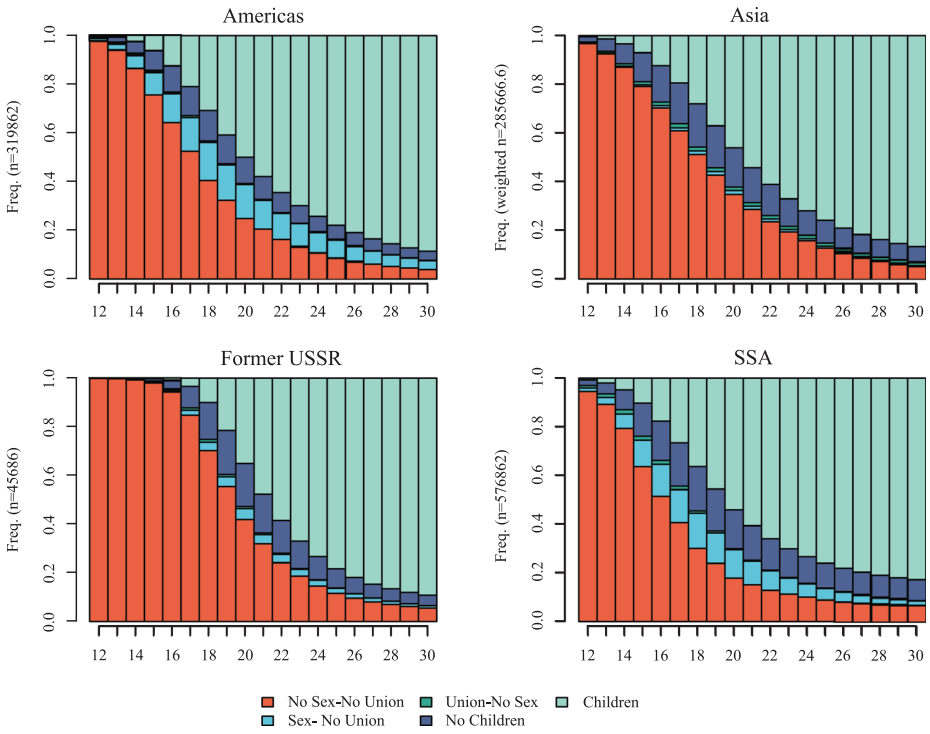
Once we classify individuals into typologies, we are able to explore cluster distributions by regions, subregions, and birth cohorts, in order to ascertain differences and changes in typical transitions over time. Moreover, to understand potential drivers of the TTA over time and across countries, we investigate differences between urban and rural settings.

Findings

Sequences

Figure 1 presents the distribution of states across the four macro-regions—Americas, Asia, former USSR, and SSA —between ages 12 and 30. The

FIGURE 1 Distribution of states across macroregions



NOTES: Groups are mutually exclusive and are derived from individual information on age at first sexual intercourse, age at first union, and age at childbearing. Unfortunately, we cannot distinguish from the data women who had children before entering a form of union and assume that childbearing always occurs within a union. The group "sex, no union" therefore includes always women without children. The category "No children," instead, includes women who are in a union, have had sex, but no children.
SOURCES: Demographic and Health Surveys.

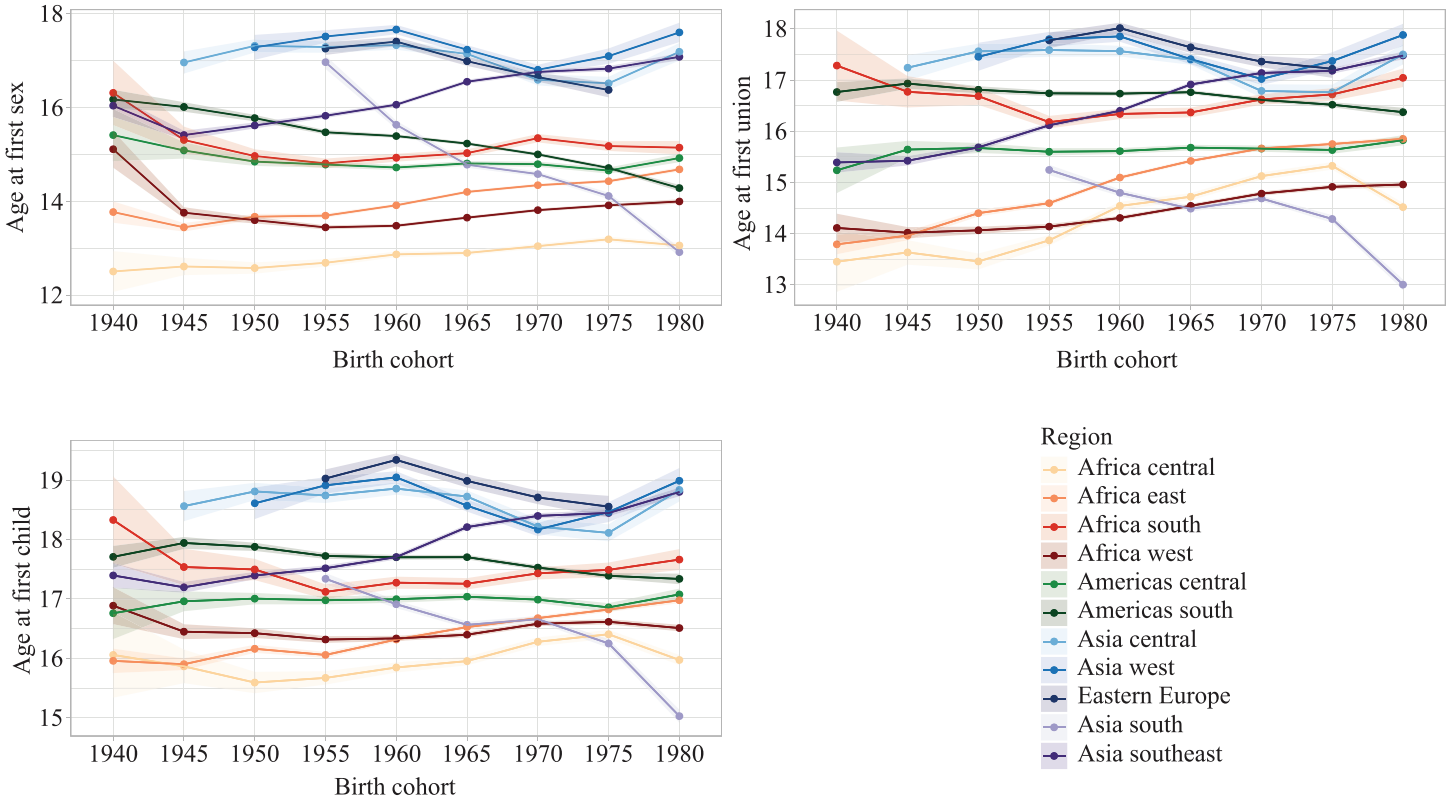
four panels show an important degree of heterogeneity across areas. First, women in SSA and the Americas experience transitions to the first event earlier than in the former USSR and Asia. As a matter of fact, in South and Central America, half of the women in the sample experienced their first event in the TTA, that is, first sexual intercourse, by age 19, and in SSA by age 18. The median age is higher in Asia and former USSR, 20 and 21 years of age, respectively. Also, the state '"sex-no union" is very distinct in the Americas and SSA, it is less widespread in the former USSR, and almost nonexistent in Asia, suggesting a closer connection between first sexual intercourse and being in a union in the latter regions. Lastly, the transition from "sexual intercourse—in a union (no children)" to having at least one child—is fastest in the Americas and slowest in the former USSR. By age 30, more than 80 percent of women in all macro-regions have completed the transition to motherhood, but slightly more so in Americas South and Central and Former USSR, relative to Asia and SSA.

Descriptive summary measures based on sequences

Extracting information directly from the sequences, we obtain some descriptive summary measures to provide a *prima facie* characterization of the cross-context heterogeneity. Mean ages at events and mean times between events are reported in Figures 2 and 3, respectively, with each line corresponding to a subregion. Starting from Figure 2, three trends are evident. First, the three variables—mean age at first sex, first union, and first child—follow very similar trends overtime in each subregion. Second, within each panel there is heterogeneity across regions both in terms of levels and—to a lesser extent—in terms of trends. In terms of levels, mean ages at first sex, union, and childbearing are lowest in Africa Central, East and West and highest in Asia West, Central, and Eastern Europe. The overall trend is one of delayed TTA with increasing mean ages at each event. For example, age at first sexual intercourse increased from 13.5 to 14 in Africa Central, from 14.7 to 15.6 in Africa East, from 17 to 18 in Asia Southeast across women born between 1940 and 1980. Age at first union increased in most regions as well: from 14.4 to 15.5 in Africa Central, from 15.1 to 15.9 in Africa West, from 14.7 to 16.8 in Africa East, from 16.2 to 16.8 in Americas Central, and from 16.4 to 18.5 in Asia Southeast. Age at first birth has increased the least over time across subregions out of the three events, but we can still observe an increase from 16.9 to 18 in Africa East, from 17.7 to 18.1 in Americas Central, from 19.5 to 19.9 in Asia Central, and from 18.4 to 19.8 in Asia Southeast.

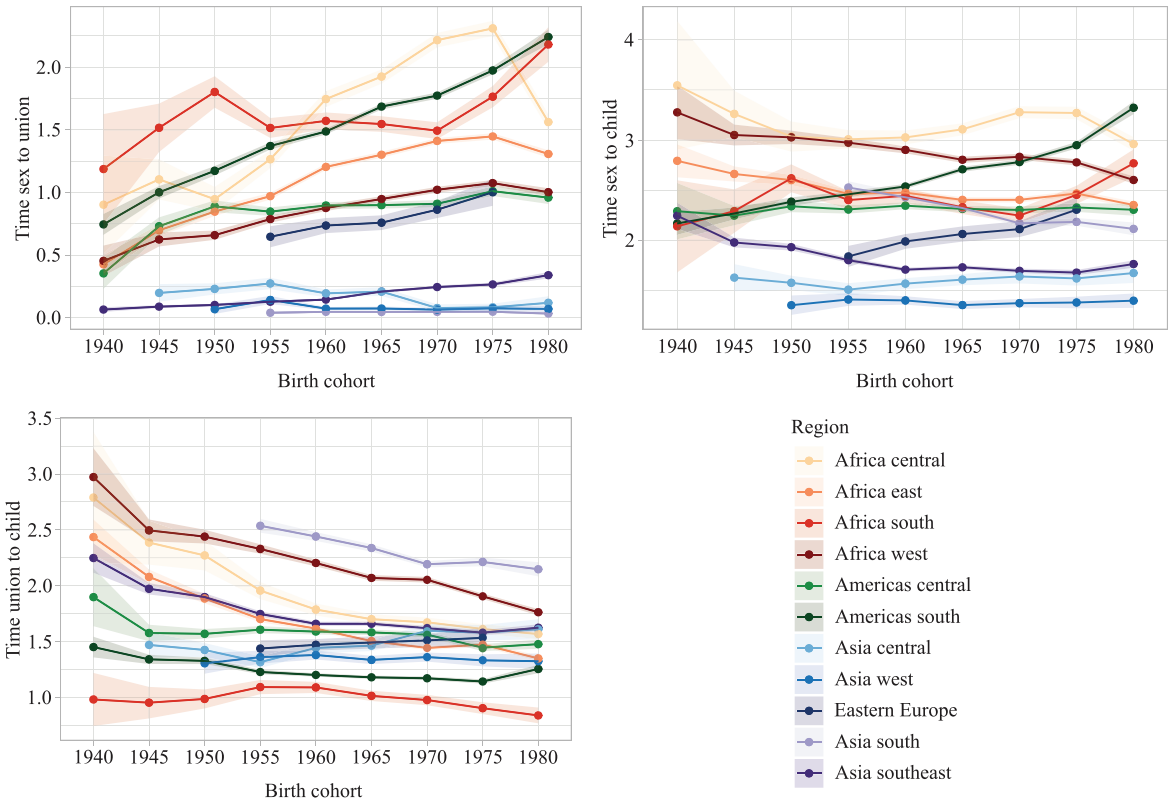
Despite this general trend, some subregions stand out as having experienced more marked—or different—changes overtime. Asia Southeast is among these, as it shows the steepest increases in the three variables over time (around a one-year increase in age at first sex, a two-year increase in age at first union, and a 1.5-year increase in age at first child).[6] This trend is almost a mirror image of one followed by South Asia—including countries such as India and Bangladesh—which shows the steepest declines in the three variables across cohorts, in line with the literature on the topic (Ram 2012; Ali et al. 2020). Also in line with the literature, Americas South stands out as one subregion exhibiting declining mean ages at events, particularly for sexual intercourse—in line with Bongaarts et al. (2017). In Americas South, age at first sexual intercourse declined from 17.1 among women born in the 1940s to 15.3 among those born in the 1980s. Age at first union declined approximately by half a year (from 17.8 to 17.4) and age at first birth from 18.7 to 18.4. Third, two panels—the one on age at first sex and the one on age at first child—suggest the emergence of two groups of subregions that seem to converge towards similar mean ages, namely Asia Central, Asia Southeast, Asia West, and Eastern Europe (group a), and

FIGURE 2 Mean age at specific events: first sexual intercourse (panel a, top left), first union (panel b, top right), and first child (panel c, bottom left)



SOURCES: Demographic and Health Surveys.

FIGURE 3 Time between specific events: sex to union (panel a, top left), sex to child (panel b, top right), union to child (panel c, bottom left)



SOURCES: Demographic and Health Surveys.

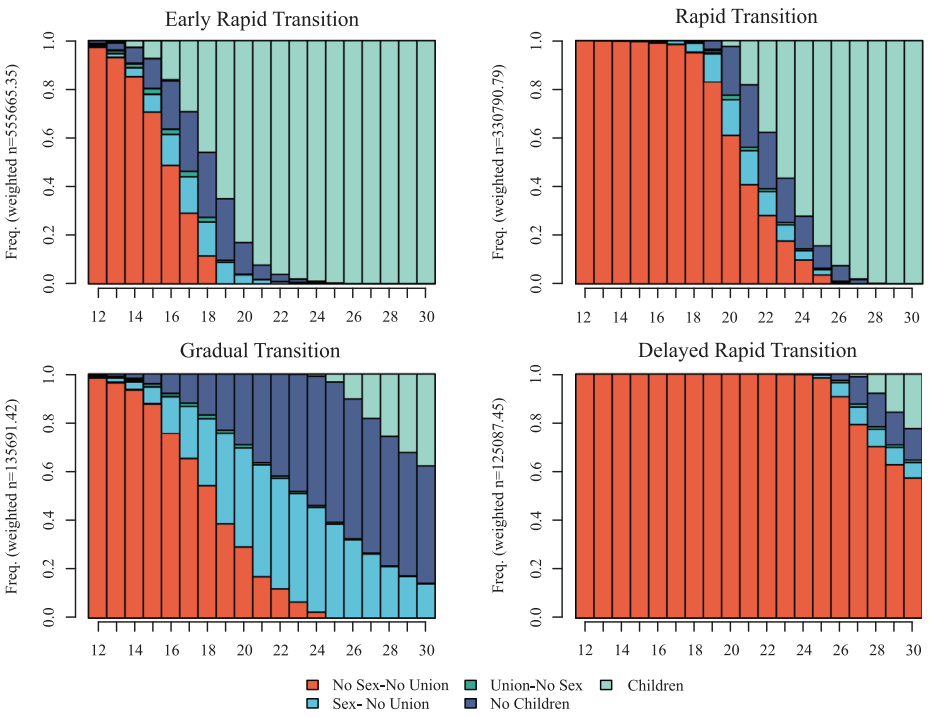
Americas Central, Americas South, Africa South, Africa West, Africa Central, Africa East, and Asia South (group b). This distinction reflects the "speed" of the TTA that is apparent also in Figure 1. Conversely, the panel on age at first union does not show a distinction of this kind.

In contrast to panels in Figure 2, panels in Figure 3 show more heterogeneous trends across variables, mostly increasing for "time sex to union" (panel a, top left), flat for "time sex to child" (panel b, top right) and decreasing for "time union to child" (panel c, bottom left)—a set of variables and findings which are, to the best of our knowledge, new in this literature and owing to our specific methodology extracting indicators directly from the sequences. Within each panel, subregional trends are also heterogeneous. For instance, in Americas South—one subregion with declining mean ages at first sexual intercourse—we observe the most marked increases in the intervals between first sexual intercourse and first union, suggesting delayed progressions to subsequent events: from nine months for women born in the 1940s to 27 months for women born in the 1980s. Despite mean ages at first sexual intercourse are also declining in South Asia, this is a finding that we do not document for the latter region. In the four subregions of SSA and in Americas Central, we also observe a large increase: from half a year to a year in Africa West, from four months to 16 months in Africa East, from 11 to 19 months in Africa Central, from 14 to 26 months in Africa South, and from four months to a year in Americas Central. The interval between first sexual intercourse and first union is instead relatively flat in Asia Central, Asia Southeast, Asia West, and Eastern Europe.

As far as "time sex to child" is concerned, most subregions show rather flat patterns, suggesting that, even if transitions to first sexual intercourse occur later, there is no evidence that childbearing is also shifted ahead once women have engaged in first sexual intercourse. In SSA (particularly in Africa West, East, and Central), we observe narrowing intervals between first sexual intercourse and childbearing: from 3.3 to 2.6 years, from 2.8 to 2.4 years, and from 3.6 to 3 years respectively. Americas South, also in this case, is the subregion that shows the largest increase, from 2.2 to 3.4 years.

When looking at the transition from first union to first child, we observe a general declining trend. SSA (except for Africa South) is the region where time from union to child has declined most rapidly across birth cohorts. The decline is evident in Africa West (from 3 to 1.75 years), East (from 2.8 to 1.7 years) and Central (from 2.5 to 1.3 years), and in Asia Southeast (from 2.25 to 1.7 years). The trend is flatter in other subregions. These results combined suggest that there is a general delay in entering into first union after experiencing first sexual intercourse, but that once women get married or start a coresidential union, the transition to motherhood is relatively quick.

FIGURE 4 Cluster analysis: features and typologies



SOURCES: Demographic and Health Surveys.

Clusters

The analysis proceeds by obtaining clusters to describe typologies of TTA. The cluster analysis suggests the emergence of four distinct groups, labeled for convenience and ease of reference according to their respective characteristics. Figure 4 describes the importance of the five states described above in differentiating the typologies of clusters.

Cluster 1, labeled the *"Early Rapid Transition"* cluster, is characterized by early transitions to first sexual intercourse outside of a union: by age 16, half of the women in this cluster have experienced this event, followed by a relatively short period in a union with no children, and then a quick transition to first birth. By age 17, all women in this cluster have experienced sexual intercourse, and by age 23 almost every woman had her first child. The average interval between sexual intercourse and first child is two years. The second cluster, labeled the *"Rapid Transition"* cluster, is also characterized by short interval times between transitions, but the timing is shifted forward by about four years. The main feature of this cluster is that once the transition starts (around age 18), most events happen in a very short span of time, on average less than two years. The third cluster, "*Gradual Transition*,"

TABLE 2 Sample sizes and labels of the four cluster solutions

Cluster	Label	Frequencies	% (weighted)
1	Early Rapid Transition	626,930	51.19
2	Rapid Transition	333,007	27.22
3	Gradual Transition	145,156	11.83
4	Delayed Rapid Transition	119,503	9.76

SOURCE: Demographic and Health Surveys.

shows a slower and more gradual transition to first sexual intercourse, as well as a slower transition into a union and into childbearing. The average age at transition to first sexual intercourse is 16, followed by an average interval of four years before entering a union and four additional years before childbearing. Also, 38 percent of women in this typology have not had children by age 30. The last cluster, *"Delayed Rapid Transition,"* is characterized by extremely delayed TTA patterns in which, until age 25, no one in the cluster has experienced childbearing and, by age 30, less than half of the sample has started the transition. In Table 2, we report the sample sizes—frequencies and weighted percentages—in each typology. The "Early Rapid Transition" cluster is the most frequent one, with 51.2 percent of women belonging to this group, followed by 27.2 percent in the "Rapid Transition" cluster, 11.8 percent in the "Gradual Transition" typology, and 9.8 percent in the "Delayed Rapid Transition" one.

Each typology of TTA has its distinctive features, further outlined in Table 3. In the "Early Rapid Transition" cluster, the mean age at each event is lower than 16. On average, women in this group start their TTA when they are just 12.5 years old and have their first child by age 15. Also, the time between events is relatively short: 6.6 months between first sex and first union, and 1.63 years between first union and first child. The "Rapid Transition" cluster is also characterized by short intervals between events (4.4 months between first sex and first union, and 1.49 years between first union and first child), but the TTA of these women starts later, given that they experience their first sexual intercourse when they are 18.1 years old and they have their first child when they are 19.9, on average. Women in the "Gradual Transition" typology start their TTA after those in the "Early Rapid Transition" group, but earlier than those in the "Rapid Transition" one, since the mean age at first sex is 14.4. The transition in this third cluster is also slower, since the mean age at first child is 22.4, and between 3 and 5 years elapse between first sex and first union and between first union and first child. Finally, the "Delayed Rapid Transition" cluster is characterized by a late start, with the mean age at first sexual intercourse being 24.6 and the mean age at motherhood being 25.9. Even though the beginning of the TTA is postponed, the transition from one event to the other is relatively quick: 3.7 months between first sex and first union, and 1.2 years between

TABLE 3 Mean age and time between events, by cluster and overall

		Early Rapid Transition	Rapid Transition	Gradual Transition	Delayed Rapid Transition	All sample
Age at first transition	Mean	12.49	18.02	14.04	24.28	14.80
	(SD)	(1.79)	(2.10)	(2.51)	(1.74)	(3.72)
Age at first sexual intercourse	Mean	12.66	18.12	14.40	24.60	14.81
	(SD)	(1.96)	(2.20)	(2.77)	(1.68)	(3.66)
Age at first union	Mean	13.04	18.39	18.75	24.65	15.71
	(SD)	(2.15)	(2.13)	(4.35)	(1.64)	(4.00)
Age at first child	Mean	14.68	19.88	22.42	25.91	17.09
	(SD)	(2.23)	(2.24)	(2.56)	(0.90)	(3.83)
Time between sex to union (yrs)	Mean	0.55	0.37	4.91	0.31	0.98
	(SD)	(1.12)	(0.80)	(3.79)	(0.86)	(2.13)
Time between sex to child (yrs)	Mean	2.06	1.79	8.38	1.43	2.42
	(SD)	(1.93)	(1.48)	(2.74)	(1.15)	(2.51)
Time between union to child (yrs)	Mean	1.63	1.49	2.63	1.17	1.65
	(SD)	(1.88)	(1.47)	(3.69)	(0.99)	(1.97)

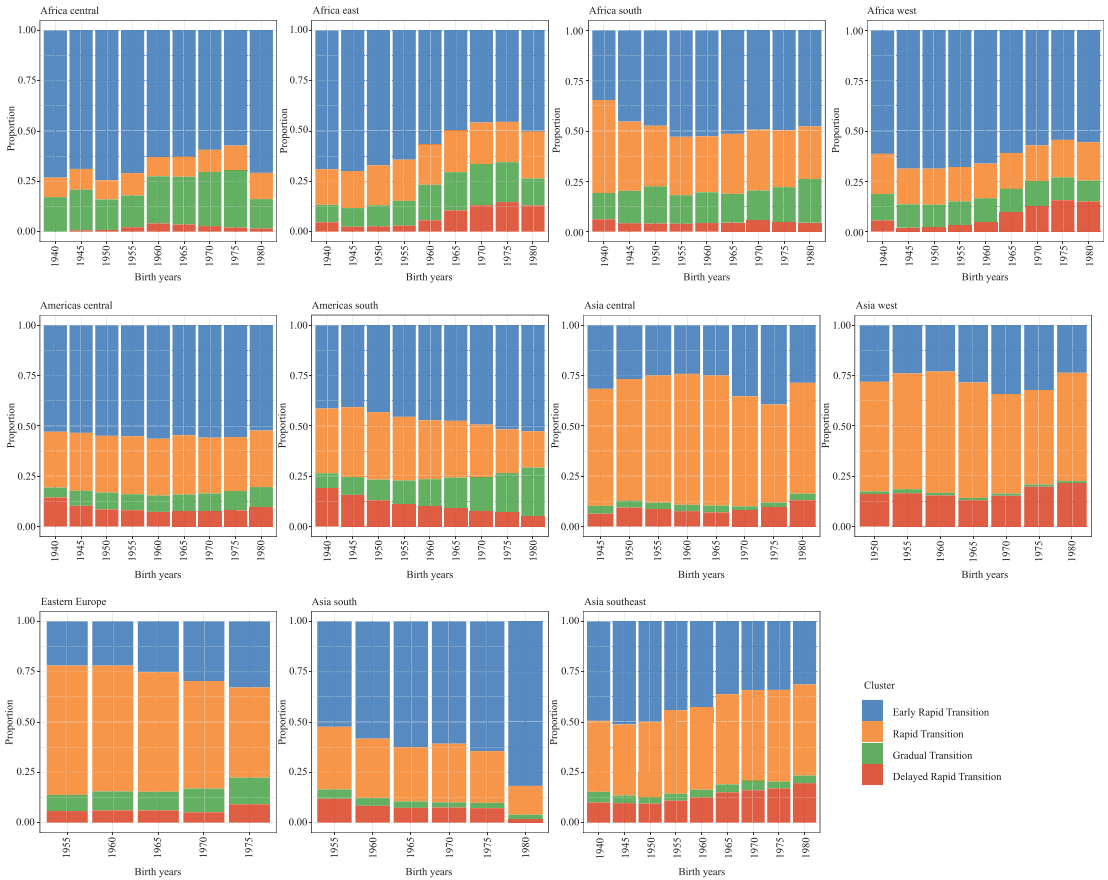
NOTES: SD: standard deviation; yrs: years. Regional classification borrowed from Pesando and GFC Team (2019).
SOURCE: Demographic and Health Surveys.

first union and first child. Figure A2 in the Online Appendix complements Table 3 by providing a graphical depiction of the average time spent in each state, by cluster of sequences.

Cluster trends over time and place

Figure 5 reports 11 panels and shows which clusters characterize each region, and the extent to which the prevalence of the clusters has changed over time by birth cohort within each subregion.[7] Each panel pertains to a subregion, and each bar within each panel corresponds to a birth cohort. Online Appendix Figure A3 reports the overall prevalence of each cluster in every country included in the analysis, while the most common cluster in each country by birth cohort is reported in Online Appendix Figure A4. At first glance, we observe that the "Early Rapid Transition" cluster is still the most prevalent in Africa, Americas South and Central, and Asia South, with between 40 and 70 percent of women in this cluster across all birth cohorts. The prevalence of this typology was also high in Asia Southeast, but the percentage of women in this group decreased from 47 percent for

FIGURE 5 Evolution over birth cohorts of cluster typologies for each subregion



SOURCES: Demographic and Health Surveys.

those born in 1940s to 29 percent for those born in 1980s. Conversely, in Asia South its prevalence increased from about 50 percent for those born in 1955s to 75 percent for those born in the 1980s. Moreover, this cluster is not as common in Asia Central, West, and Eastern Europe, with a prevalence of between 20 and 30 percent across cohorts.

In most subregions, the proportion of women belonging to this typology has not fluctuated substantially over time, with the exception of a decreasing trend in Africa East and Asia Southeast, and an increasing prevalence in Asia South and, to a smaller extent, Americas South. This may be suggestive of a process of demographic transition which is getting closer to completion in subregions where the cluster is far less prevalent (e.g., Asia Central, Asia West, and Eastern Europe), more advanced in subregions where the prevalence has narrowed across cohorts (e.g., Africa East and Asia Southeast), and still unfolding or stalling in subregions where the prevalence of an early transition is still very common and stable across cohorts (e.g., Africa Central and West) —yet data on complete fertility would be needed to fully evaluate these claims. The stable shares of women undergoing early transitions in Africa Central and West are also consistent with cultural specificities of these regions, such as rooted patriarchal norms, tighter control over age at marriage, wider age differences between spouses, and very high prevalence of child marriage (Tabutin and Schoumaker 2004; Odimegwu 2020). The second cluster, "Rapid Transition" does not show particular changes in trends over time. It has become slightly more prevalent in Asia Southeast, and less prevalent in Americas South and Asia South. This cluster is the most prevalent in Asia and Europe: more than half of women in Asia Central and Eastern Europe fall into this typology. Also, the "Gradual Transition" typology does not present substantial fluctuations by birth cohorts in most regions, except for a gradual increase across cohorts in Americas South and Africa East, from about 10–20 percent in both contexts. The "Delayed Rapid Transition" cluster is the least prevalent one in SSA, yet one that shows relevant changes over time in most contexts. There has been a substantial increase in its prevalence in Africa East and West, from almost nonexistent to between 10 and 15 percent, and a steady high prevalence in Asia Central, followed by Asia Southeast (while it is almost nonexistent in Asia South for the most recent birth cohorts). Although partly speculative and outside the scope of this descriptive paper, the increasing importance of the "Gradual Transition" and "Delayed Rapid Transition" typologies in contexts such as Asia and specific parts of SSA is a trend that well fits with the idea of emerging second demographic transition (SDT) pillars in some LMICs.

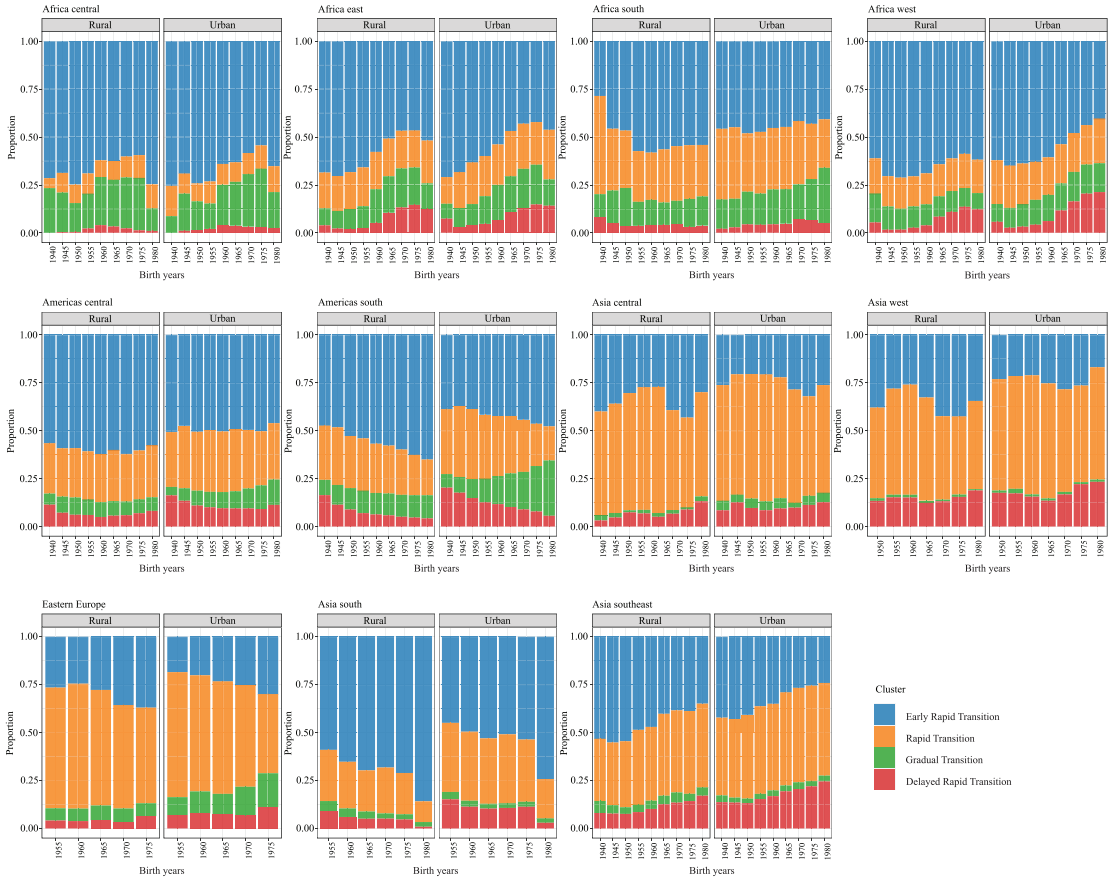
Overall, despite marked heterogeneities across regions, a clear message emerges from Figure 5. In many regions such as, for instance, Africa South, Americas Central, and Asia West, the prevalence of some clusters—especially the more "secularized" clusters—has changed relatively little

overtime, despite generalized knowledge that key demographic indicators such as the total fertility rate (TFR) have declined massively (see Online Appendix Figure A5 with trends in TFR by subregion over time). This raises the question, among others, of how changes in life-course indicators such as age at first birth relate to changes in complete, or higher-order fertility (not captured in the present study) or in the TFR more broadly. Let us focus, for instance, on Americas Central and Asia West. In both subregions, the "Delayed Rapid Transition" and "Rapid Transition" clusters have changed very little over time (suggesting that age at first birth has not moved much); nonetheless, the TFR of both subregions has declined by more than half over the past half century (Figure A5 in the Online Appendix). On one hand, this trend may suggest that the two variables are increasingly decoupled and some LMICs might be following a pattern of fertility transition similar to the one of Bangladesh, pairing low—and even declining (see Figure 2) —ages at first birth with low complete fertility. On the other hand, we speculate that more evident changes over time in the prevalence of clusters would be apparent if we extended our age range to women all ages and took into account also transitions to higher-order births—an analytic endeavor we undertake in a parallel study.

Differences by urban and rural settings

The data further allow us to distinguish between urban and rural settings. We exploit this information to indirectly get at whether changes in life-course trajectories vary by level of development and urbanization. We hence replicate Figure 5 having distinct panels for urban and rural locations within each subregion (Figure 6). Results show that, on the whole, there are no marked differences within subregions among those who live in urban versus rural areas. There are small differences in levels, but barely any difference in trends across birth cohorts—again, we acknowledge that we might observe more marked differences across areas should differences in completed fertility be taken into account. The only visible exceptions are Americas South and Asia South, where the "Early Rapid Transition" cluster became relatively more prevalent in rural areas compared to urban areas. For instance, in Americas South its prevalence increased from 35 to almost 45 percent in urban areas, while it increased from 45 to 65 percent in rural areas. Conversely, the "Gradual Transition" cluster became more common in urban areas (from 10 to almost 25 percent), but not in rural areas, where the prevalence remained between 10 and 15 percent across cohorts. Also, in Latin America (both South and Central), Africa West, and Asia (Southeast, Central, and South), the "Delayed Rapid Transition" cluster has expanded proportionally more in urban areas. The picture presented in Figure 6 is suggestive of the idea that urbanization is only one possible driver—and

FIGURE 6 Evolution over cohort of cluster typologies by subregion, by urban (right)/rural (left)



SOURCES: Demographic and Health Surveys.

even a rather minor one—underlying changes in the TTA in some of the subregions considered.

Conclusions and discussion

This study has provided a rich account of women's TTA patterns across 69 LMICs using most available DHS. In so doing, we contributed to the relevant literature in two directions. First, we proposed an alternative methodology that shifted the focus from the study of independent life-course transitions towards a characterization of the life course as an interrelated combination of events, thus reflecting the idea that background forces—such as educational expansion, urbanization, and cultural, societal, and institutional changes—exert an influence on the whole "package" of TTA status combinations that young adults go through, rather than a succession of single events. Methodologically, we built partnership and fertility trajectories using sequence analysis; we computed novel summary measures on the timing of events and the time intervals between events extracted directly from the sequences, and we identified clusters of typical life-course trajectories using a robust clustering algorithm (*Agglomerative Hierarchical Clustering*) based on optimal-matching distances of sequences.

In line with other studies focusing on independent life-course transitions in LMICs (e.g., Bongaarts et al. 2017; Pesando and GFC Team 2019), we found that—on the whole—the TTA has been delayed in LMICs. However, our analyses reveal a high degree of cross-regional idiosyncrasies such as declining mean ages at first sexual intercourse in Americas South and Asia South, declining time intervals between first sexual intercourse and first child across Africa East and West, and declining time intervals between first union and first child across all subregions considered, but particularly so across Africa West and Central. These results combined suggest that there is a general delay in entering into first union after experiencing first sexual intercourse, but that once women get married or start a coresidential union, the transition to motherhood is relatively quick. These are simple findings, yet some that add nuances to the somehow "unidirectional" idea that the TTA has simply been delayed, and also some that—to the best of our knowledge—have not yet been documented using analogous measures drawn directly from sequences and analogous visual approaches.

We then identified clusters of TTA in an innovative data-driven manner and summarized the ensuing heterogeneity through four cluster solutions, labeled "Early Rapid Transition," "Rapid Transition," "Gradual Transition," and "Delayed Rapid Transition." At first glance, these are four rather distinct typologies that concisely summarize the high volume of existing heterogeneity. "Early Rapid Transition" —characterized by quick transitions to first sexual intercourse outside of union, followed by a short period in a union with no children, and then a quick transition to first birth—remains

the most common typology for all LMICs combined, with more than 50 percent of women belonging to it (especially across SSA) and significant declines across cohorts in Africa East and Asia Southeast, while less so in Africa South, where prevalence of this typology was lower to start with. Conversely, the opposite cluster typology, "Delayed Rapid Transition"—characterized by a late start, with a mean age at first sexual intercourse around 25 and a relatively quick transition to motherhood—is the least common typology for all LMICs combined, yet still about 10 percent of women belong to it. This typology is the least prevalent in SSA, yet one that has shown relevant changes over time in most contexts. For instance, there has been a substantial increase in its prevalence in Africa East and West, from almost nonexistent to between 10 and 15 percent, and a steady high prevalence in Asia Central, followed by Asia Southeast and, to a lesser extent, Asia South. We believe the existence of such a TTA cluster is a demographic phenomenon that went quite unnoticed in the family literature to date. While its prevalence sounds less surprising in the Asian context, its existence and significant increase across cohorts in Africa East and West is a novel finding which will deserve an in-depth analysis of its own. We hypothesize that this group might be composed of professionally oriented women in some societies who are "forced out" of the marriage market by their educational pursuits, yet this is only one hypothesis that would require more detailed data on work and occupation which we lack in the current context. Overall, our results point to differences across subregions and "novel" cluster typologies, thus underscoring the importance of investigating cross-regional differences in partnership and fertility trajectories looking at the interrelation among different events in a holistic way.

Upon a deeper interpretation, however, our results also suggest that these cluster typologies share important commonalities. For instance, in three out of the four clusters, transitions are very quick for most groups (hence the adjective "rapid" in the labels), suggesting that the observed heterogeneity very much owes to *when* the transition begins (early vs. late) rather than to the speed of events or duration between events. In this respect, the "Gradual Transition" cluster is the only one emerging from our analysis that features longer and more gradual time intervals between events. This is key from a policy perspective, as it suggests that the most effective policies might be precisely those that seek to delay the first transition (rather than, for instance, delaying first birth once a girl has already entered a union), such as, for instance, investing in longer education and/or discouraging child marriage (Psaki et al. 2019).

Focusing specifically on changes over time, when looking at all LMICs combined, we did not observe drastic changes across cohorts. Rather, there seems to be relative stability of cluster typologies over time. Indeed, specific subregions such as Africa East and Asia Southeast underwent more apparent changes away from an "Early Rapid Transition" and towards a

"Gradual-" and "Delayed Rapid Transition," yet in other regions stability has been the norm. Examples are Africa Central (with high and stable prevalence of "Early Rapid Transition'), Asia West (with high and stable prevalence of "Rapid-" and "Delayed Rapid Transition'), and Eastern Europe (with high and stable prevalence of 'Rapid-" and "Gradual Transition"). Although not much literature exists on changes in the TTA in LMICs, these findings align with recent studies that have provided evidence of slow changes and little convergence in family domains in LMICs (Cherlin 2016; Castro et al. 2019; Pesando and GFC Team 2019). In this sense, our findings confirm the idea that union formation and fertility practices might be less responsive to socioeconomic changes in LMICs because they are tied to elements of the social structure that are more resistant to change. These structural features of societies include religious beliefs, marriage-related laws and prohibitions, inheritance rights, shortages in the housing market, and persistent disparities in gender roles and dynamics (Cook and Furstenberg 2002; Coontz 2014).

Although the analysis was not set up to test explicitly for cross-regional convergence in TTA overtime, our results are suggestive of a reality that is far from convergence and likely supportive of persistent differences across regions. Going back to the specific literature that inspired this study, our results align with findings from Grant and Furstenberg (2007), who observed relatively small changes—or high inertia—in the age-specific index of heterogeneity from the first to the most recent survey in each country. We see this high level of consistency as valuable given the far broader country coverage of our study, the larger sample sizes, and the different and varied methodological approaches. Exploring why and how these novel clusters appear in some subregions remains an exciting task for future research, requiring a more explicit examination of the historical and cultural differences that produce distinctive adaptions of economic and technological change as discussed in the introduction.

Our analyses by rural/urban location of residence represent a preliminary attempt to identify underlying drivers of conditions that moderate economic and technological change. Except for Americas South (and, to a lesser extent, Asia Central and Asia Southeast), where differences between rural and urban areas were apparent due a more marked increase in the "Gradual Transition" typology and higher levels of the "Delayed Rapid Transition" typology in urban areas, differences were quite minor elsewhere. We took this evidence as pointing towards the idea that urbanization was only one minor driver of changes in the TTA in LMICs. This lack of explanatory power of household location of residence calls for the need to look for additional factors that might explain the heterogeneity in the TTA across LMICs, possibly the expansion of education, cultural and institutional variables, or information on different socioeconomic strata within countries. As a matter of fact, albeit indirectly, our results point towards a reality whereby

homogeneity in TTA patterns seems higher within regions than across them, suggesting that cultural factors may well be at work.

Returning to the original puzzle in this study, the question of whether young people in LMICs have experienced processes of destandardization of the life course similar to those observed in high-income societies does not lend itself to a unique answer. In contrast to what Billari and Liefbroer documented in Europe (2010), pathways to adulthood have not changed in the same direction across all LMICs towards a late, protracted, and complex TTA. To the contrary, excepting a few generalized and common trends, each subregion seems to have followed very diversified pathways.

Our data-driven methodological approach delivers four clearly distinct typologies which, in some respect, impose order and structure to the existing heterogeneity and high volume of information—a finding which would suggest that the TTA in LMICs is instead ordered and structured. If we took our clusters as a starting point, we could summarize this whole scenario by stating that the TTA in LMICs is ordered and structured, yet it has changed in ways that do not necessarily resemble changes observed in high-income societies. Ultimately, an assessment of this kind hinges upon theoretical perspectives that have been adopted to understand changes in families across the world with socioeconomic development. The reader might have noticed that we explicitly shied away from dealing with the applicability of the SDT in this study, given the heated debates surrounding it (Zaidi and Morgan 2017). We did so because we could not explicitly test for it in great detail. We will simply state that the emergence of the "Gradual Transition" cluster—and the "Delayed Rapid Transition" cluster, to a lesser extent—resembles some of the pillars of the SDT. The fact that these clusters are more apparent in Asia Southeast, Asia West, and Eastern Europe would also support the idea that some SDT forces are at play. Yet our findings combined seem most supportive of a scenario in which the SDT has limited applicability to selected subregions, rather than to all LMICs combined.

The study has limitations that lay the ground for subsequent research. First, our analysis only focuses on women, mostly to prioritize breadth and country coverage. An alternative study using DHS could be conducted focusing on the same life-course transitions for men, though sample size would be significantly reduced. We nonetheless see this as a fruitful avenue for future research. Second, although not a limitation per se, we focus on first child rather than the whole fertility history to better characterize heterogeneity in the earlier part of the life course. This choice may in part be responsible for the limited changes over time or the little variations between rural and urban areas that we document. Third, although we look at changes over time for groups of countries (rather than countries individually), when evaluating changes across cohorts we run the risk that some trends might be masked by the different composition of countries by birth cohorts—a serious limitation which calls for complementary studies

at subnational/subregional variation. Fourth, although it would be ideal to predict the four cluster solutions as a function of multiple country-specific characteristics, our analyses by birth cohort—with women born as early as the 1930s—are such that it is challenging to obtain time series for variables such as the Human Development Index or Gender Inequality Indicators that date back to such a period. This said, we acknowledge that the scope and ambition of this study remains predominantly descriptive.

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Notes

1 Plenty of work suggests that climate change and natural disasters are important determinants of life-course events of young adults (particularly girls), and more so across low- and middle-income countries.

2 We are currently undertaking two related projects adopting a similar methodological approach yet also (i) focusing on men and (ii) focusing on complete fertility histories with attention to sex composition of births.

3 The development of OM started in the seventies and the technique has been described in detail by . adapted OM to social sciences assigning to three elementary operations different costs, based on the "social" differences between states (Lesnard 2006). The choice of the operations' costs determines the matching procedure and influences the results obtained.

4 Note that groups are mutually exclusive and are derived from individual information on age at first sexual intercourse, age at first union, and age at childbearing. Unfortunately, we cannot distinguish from the data women who had children before entering a form of union and assume that childbearing always occurs within a union. The group "sex, no union" therefore includes always women without children. The category "No children," by contrast, includes women

who are in a union, have had sex, but no children.

5 Differently from other studies that use the entire dissimilarity matrix to classify observations in different groups representing typologies of trajectories, we used a subsample of the data to estimate a classification of respondents in different groups, and we assigned the remaining sample to a cluster based on their similarity to a representative sequence of each cluster. This method is appropriate for large samples, for instance, when it is computationally impractical to estimate a complete pairwise dissimilarity matrix.

6 As mentioned above, trends for Asia Southeast need to be interpreted with caution as some countries had to be removed due to only having samples of ever-married women.

7 We acknowledge that in this analysis some trends might be partly masked by the different composition of countries by birth cohorts. By looking at groups of countries (subregions), these compositional effects partly net out, yet we acknowledge that this is a serious limitation of our approach to be further addressed in future studies focusing on subnational and/or subregional variation.

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