MAX PLANCK INSTITUTE
FOR DEMOGRAPHIC RESEARCH

Konrad-Zuse-Strasse 1 · D-18057 Rostock · Germany · Tel +49 (0) 3 81 20 81 - 0 · Fax +49 (0) 3 81 20 81 - 202 · www.demogr.mpg.de

MPIDR Working Paper WP 2021-009 I May 2021
Revised September 2021
https://doi.org/10.4054/MPIDR-WP-2021-009

Income inequality and increasing dispersion of the transition to first birth in the Global South

Andres Castro I castro@demogr.mpg.de
Ewa Batyra I batyra@demogr.mpg.de
Mikko Myrskylä I office-myrskyla@demogr.mpg.de

© **Copyright is held by the authors.**

Working papers of the Max Planck Institute for Demographic Research receive only limited review. Views or opinions expressed in working papers are attributable to the authors and do not necessarily reflect those of the Institute.

Income inequality and increasing dispersion of the transition to first birth in the Global South.

Abstract

The relationship between levels of social and economic inequality and demographic changes remains poorly documented, particularly for fertility. Covering a period from 1986 to 2018, this paper documents a positive country-level association between income inequality and the dispersion of first birth schedules among women from 88 countries of the Global South. This association is driven by a dual dynamic of the decreasing mean age at first birth among a shrinking group of women who transition to motherhood early, and the increasing mean age at first birth and rising heterogeneity in the timing of childbearing among a group of first birth delayers. We show that this association is strongest in countries where the total fertility rate (TFR) is below 2.5 children per woman. We argue that differential opportunities for accessing quality education, formal labor markets, and migration are potential drivers of the rising heterogeneity in the ages at which women transition to childbearing. These results highlight the importance of examining societal and demographic processes jointly, and clearly indicate that more and better-quality data on social and economic inequality are needed.

Introduction

Macro-level analyses of fertility variation have primarily focused on the question of how national mean levels of fertility are associated with development and income measures, and thus have advanced a narrative of development-driven demographic change (Luci-Greulich and Thévenon 2014; Myrskylä, Kohler, and Billari 2009; Pesando and GFC-team 2019). Notable exceptions have explored sub-national variation, but have still focused on central measures of fertility and development (e.g., Fox, Klüsener, and Myrskylä 2019). Less attention has been paid to the variability in reproductive behavior, and to how it relates to the unequal distribution of social and economic resources. This lack of attention is unfortunate because there is a close connection between economic development and increasing social and economic inequality (Pikkety 2019). The question of how social and economic inequality influence the variability of reproductive patterns within and across countries remains poorly examined, especially for countries of the Global South. We use the term Global South as an economic and geopolitical category that groups countries and populations with interconnected histories of colonialism, neocolonialism, economic dependency and geopolitical subordination vis-a-vis wealthier/richer countries (Chant and Mcllwaine 2009). Under this broader conceptualization, the Global South includes countries of Latin America and the Caribbean, Sub-Saharan Africa, North Africa and the Middle-East, low- and middle-income countries in Asia, and former Soviet states.

If socioeconomic inequality is indeed accompanied by increasing disparities in reproductive behavior, then previous studies have overlooked an important aspect of the relationship between development and fertility change: namely, the unequal pattern of fertility decline across subpopulations. Moreover, if the variability in reproductive behavior is better explained by distributional than by mean levels of development and income, then a complementary narrative of demographic change based not only on the levels, but also on the distribution of the fruits of development becomes necessary. In other words, if distributional indicators of development correlate strongly with reproduction, there is plenty of room for an alternative perspective of demographic change that calls into question our current "*anchored narratives*" of fertility change (van de Kaa 1996). This new perspective could affect both our understanding of historical demographic transitions and our predictions about future demographic change.

In countries of the Global South, where welfare states are weak and the lack of opportunities and poverty are pervasive, the link between socioeconomic and reproductive inequality is clear: inequality in opportunity structures – i.e., the set of social, economic, and cultural resources available to individuals – during the transition to adulthood translates into multiple (potentially divergent) family formation schedules (Juarez and Gayet 2014). As societies modernize and become more diverse in terms of the educational and occupational profiles of their populations, family formation trajectories are expected to become less standardized; i.e., they are more likely to deviate in multiple ways from long-lasting societal templates regarding the timing and ordering of family formation events (Grant and Furstenberg 2007).

In addition, if the distribution of social and economic resources is very unequal, we can expect the reproductive behavior to be polarized. Moreover, there is often a two-way relationship between this polarization and economic inequality (Amato et al. 2015; Furstenberg 2010; McLanahan and Percheski 2008). For example, in contexts in which lower and later fertility are positively associated with socially desirable outcomes for parents and children (e.g., more time spent in educational systems,), higher rates of early parenthood among vulnerable populations can contribute to the reproduction of socioeconomic inequalities. While the existence of this two-way relationship has been acknowledged by previous research, a large-scale empirical test for it is lacking.

The aim of this paper is to augment our understanding of the relationship between socioeconomic inequality on the variability of reproductive schedules. In particular, we focus on the country-level associations between income inequality and the dispersion of first births over age in countries of the Global South. We extend the findings of previous studies on the topic in three directions. *First*, we show that previous studies that focused on either central tendency measures (e.g., mean national levels) or single indicators to characterize the shape of age-specific first birth risks were limited. *Second*, we provide an innovative set of indicators to characterize the shape of first birth risks. *Third*, we assess the strength and the robustness of the association between these indicators and national-level measures of income inequality and income concentration using 288 surveys covering 88 countries that were conducted between 1985 and 2018. Compared to previous studies on this topic, our analysis has a wider temporal scope and a more international perspective, as we have been able to include a very diverse set of countries with varying levels of fertility, fertility timing, and socioeconomic characteristics. This sample of countries allows us to document the key role of low fertility in the relationship between inequality and the age pattern of first birth.

Previous studies

We distinguish between papers that followed non-parametric and parametric approaches, and between those that relied on the visual assessment of plots to identify bimodal or bifurcated fertility schedules. Most of these studies concentrated on the timing of the first birth, although some examined all birth orders. To develop our hypotheses about how the dispersion of reproductive schedules is associated with socioeconomic inequality, we review studies of fertility inequality in countries of the Global South.

Measures and approaches to first birth dispersion across the world

The distributional aspects of fertility have long interested demographers (Lutz 1989). Greater variability in the age at childbearing has been associated with the increasing diversification of women’s life courses, particularly after 1980, when the post-war societal norms regarding the timing of family formation began to erode in industrialized societies (Coontz 2014). Ni Bhrolcháin (1995, chap. 12) documented a declining trend in the variability of the age at childbearing from 1951 to 1980 in Austria, Belgium, Denmark, France, the Federal Republic of Germany, the Netherlands, Norway, Sweden, Switzerland, and England and Wales. The author also found, however, that between 1980 and 1991 in England and Wales (the only countries for which data were available), the dispersion of the age at childbearing increased sharply, driven by the rising variability in the age at first birth. Similar increasing trends during the 1980s were documented for Spain (Castro Martín 1992) and the US (Bloom and Trussell 1984).

A more detailed picture of the variability of fertility schedules in the US was provided by Sullivan (2005). Her work proposed two indicators for measuring the presence of two humps in the age-specific first birth rates – a pattern she referred to as bimodality – and the strength of this bimodal pattern, when present. Both indicators rely on the geometrical features of smoothed age-specific first birth rates: i.e., the depth of the valley and the distance between the humps. According to these indicators, the first birth schedules in the US were bimodal for about 10 years between 1990 and 2000, a period of rising socioeconomic inequality. Furthermore, her work showed that this pattern emerged from educational and racial/ethnic differences in the timing of the first birth.

The bifurcation of first birth schedules across cohorts in the US and several other high-income countries has also been documented by Rendall et al. (2009; Michael Rendall et al. 2010). Reproductive polarization is more pronounced in countries with so-called liberal family policy regimes, such as the US and the United Kingdom, than in countries with more universalistic family policy regimes, such as France and Denmark. The authors also extended this result to Southern European countries, where the trend toward reproductive polarization is the strongest.

Inequality in women's options for combining family and work emerged as a key contributor to the reproductive polarization in the latter set of countries.

Following a descriptive approach, Burkimsher (2017) documented the evolution of the age-specific first birth rates of women born between 1968 and 1980 in 22 high-income nations in the Americas, Europe, and Asia. In addition to having a wider geographical and temporal scope than previous studies, this study proposed that there is a bimodal pattern of first birth rates across cohorts in several of the 22 countries. This study relied on the visual assessment of contour plots that show that there were two different trajectories of change in the age at first birth across cohorts. For some countries, fertility peaks moved from early to late ages across cohorts, with no signal of simultaneous humps; while for others, the risk of first birth is shown to be relatively high at early (19 years) and late ages (29 years). The author suggested that migration status could be a factor in these bimodal patterns.

Chandola et al. (1999; 2002) studied the heterogeneity of the timing of fertility in Europe and across several English-speaking countries. The authors fitted mixture and non-mixture parametric models to the empirical densities of the age at first birth. The finding that the mixture models had a better goodness of fit than the non-mixture models was taken as evidence of a bifurcation of fertility schedules in the English-speaking countries of Australia, Canada, Ireland, New Zealand, and the United Kingdom; but not in Austria, Denmark, France, Switzerland, and the Netherlands. The authors noted that in the English-speaking countries, non-marital fertility had been generating a small distortion in fertility patterns at early ages.

Despite the methodological differences across all these previous studies, all of them relied on the assumption that there is a bifurcation of age-specific first birth schedules stemming from the existence of distinct subpopulations. Thus, all of these studies sought to identify categorically defined groups who differ in terms of socioeconomic status (married vs.

unmarried, educated vs. non-educated, foreign-born vs. native-born), and who therefore display divergent patterns in the age at first birth.

Fertility decline, first birth dispersion, and socioeconomic inequality in the Global South

The literature on fertility change in low- and middle-income countries has highlighted the relationships between development, fertility decline, and fertility inequality (Eloundou-Enyegue, Giroux, and Tenikue 2017). Several studies have pointed out that fertility decline has been accompanied by increasing heterogeneity in the age patterns of fertility (Lerch 2019; Pantazis and Clark 2018), as well as by a widening of fertility differentials across subpopulations, particularly in Latin American and Caribbean countries (Adserà and Menendez 2011).

As countries develop, fertility decline tends to occur more rapidly than fertility postponement, which implies that there is a higher variability in the timing of first births than in the total fertility rate (TFR). For example, according to Pesando et al. (2019; Figure 4), the country-level standardized relationship between the Human Development Index (HDI) and the TFR was almost twice as strong as the association between the HDI and the singulate mean age at first firth (approx. -0.65 vs. -0.35, respectively). These relationships mean that the tempo of fertility is less responsive to development (as measured by the HDI) than the quantum of fertility.

Juarez and Gayet (2014) suggested that the lower responsiveness of the timing than of the quantum fertility indicators is related to the increases in socioeconomic inequality that are inherent in development. In unequal societies, the opportunity structures of women differ substantially across socioeconomic status (SES) groups, and these differences affect the timing of women’s life course transitions, such as finishing school (or dropping out), entering a union/marriage, migrating, moving out of the parental home, pursuing higher education, and joining the labor force – all of which are related to the initiation of childbearing. Therefore, we can expect to observe that in societies with high levels of socioeconomic inequality, the timing of the first birth varies significantly across groups who are affected by these inequalities.

Divergent patterns in the timing of childbearing have recently been documented in some Latin American and Caribbean countries, including in Brazil, Chile, Costa Rica, and Uruguay; i.e., in countries with above-average levels of development within the region (Lima et al. 2018; Rios-Neto, Miranda-Ribeiro, and Miranda-Ribeiro 2018). Links between socioeconomic inequality and divergent patterns in the transition to the first birth have also been reported in studies conducted in the Southern Cone region (Nathan 2015; Sacco and Borges 2018) and in the Andean region (Batyra 2020) of South America. Given the high levels of socioeconomic inequality in these countries, divergence in the timing of the first birth by socioeconomic status is a very commonly observed phenomenon. A study of the fertility transition in Bolivia, Brazil, Chile, Colombia, Paraguay, and Mexico (Castro Torres 2020) found that there were class differences in the age at first birth among women who were born as early as in the 1920s, and that these differences increased across cohorts throughout the second half of the 20th century.

There is little research on this topic for other areas of the world, perhaps because in most other countries, socioeconomic inequality is not as high (e.g., in the former Soviet republics), or fertility has yet not declined to levels at which first births could drive variability in the overall fertility patterns (e.g., Sub-Saharan Africa).

Although some researchers have hypothesized that socioeconomic inequality could be responsible for the increasing heterogeneity in the timing of motherhood, none of the existing studies on this topic attempted to empirically examine the link between these two processes. Moreover, in these studies, bifurcation (or increasing heterogeneity) in the timing of childbearing was often conceptualized as a one-dimensional phenomenon, and sometimes as a binary outcome: i.e., as bimodal vs. non-bimodal shapes. This approach did not consider that the rising heterogeneity depended on several parameters (e.g., the size of the groups and the heterogeneity in the timing of fertility within groups) that could have been affected differently by inequality.

In light of these background, we have chosen to study the heterogeneity in the timing of the first birth using a two-population mixture model that assumes the existence of two subgroups with potentially divergent fertility schedules. The following sections describe the details of our data and methodology.

Data, methods, and hypothesis

Demographic and Health Surveys and supplementary data

We use data from the Demographic and Health Surveys (DHS). The DHS are cross-sectional, nationally representative surveys of women of reproductive ages (15 to 49) that include retrospective information about each respondent's age at first birth (ICF 2018). We supplement these data with nationally representative surveys for countries not covered by the DHS, or with only one DHS wave. These countries are Argentina, Brazil, Chile, Ecuador, Mexico, and Uruguay.[1] Together, these data cover 288 survey-waves (country-year combinations) from 87 countries.

Panel A in Figure 1 displays the geographical coverage of these data, and the regional grouping of countries. Panel B provides information on the temporal coverage of our sample, and the representation of the world regions over time. We cover a period of more than three decades, with a relatively balanced representation of regions over time.

Measurement of the variability in the timing of first births

Our measurement strategy includes three steps, all of which rely on the survey data described above as well as standard demographic and statistical techniques: (i) estimating conditional age-specific first birth rates (hereafter, age-specific first birth rates, or ASFBR), (ii) smoothing of these conditional rates, and (iii) fitting mixture models to the empirical density of the age at first birth implied by these smoothed ASFBR (s-ASFBR). In addition to these three steps, we also use simulated data to examine the properties of mixture models for exploring the variability of the timing of motherhood.

First, we compute conditional age-specific first birth rates by dividing the number of first births occurring during the 10 years preceding the survey by the person-years of exposure (life-years of nulliparous women). A 10-year reference period ensures sufficiently large samples for all of the surveys, which vary in size (Schoumaker 2013).[2] *Second,* because ASFBR are erratic in the early and late ages, especially for small samples (n<1,000), we smooth them using third-order P-splines (Camarda 2012). Smoothed ASFBRs give us a more robust representation of the first birth patterns. *Third,* we fit a two-population normal-mixture model to the empirical density of the age at first birth implied by the s-ASFBR. This procedure yields estimates of the means (μ1, μ2) and standard deviations (σ1, σ2) of the age at first birth for the two populations, and the mixture proportion that describes the relative sizes of these populations (ρ1, ρ2 = 1 - ρ1). We obtain an additional (sixth) indicator of first birth dispersion by taking the difference between the two means (δ = μ2 - μ1). We subsequently correlate these six indicators with measures of inequality, as described in the next sections.

Before describing our further analysis, in Figure 2 we show simulations that help us understand some of the properties of mixture models. This figure shows four scenarios of simulated ASFBR based on the combination of two populations with diverging mean ages at first birth. These scenarios do not represent real populations and simulated ASFBR are not used in further analysis. We use them only as a way to show how ASFBR could look under varying conditions, which illustrates the usefulness of mixture models for capturing several aspects of first birth dispersion.

Although in all of the scenarios the two populations that produce the ASFBR have a fairly distinct mean age at first birth (μ1 = 18, and μ2 = 30 years), not all of the panels display a two-hump shape, which is typically taken as an indicator of bimodality (e.g., Burkimsher 2017; Lima et al. 2018; Sullivan 2005). The standard deviations and the relative size of the sub-populations play a key role in generating curves with two humps (scenarios 2 and 4). This means that indicators and visual assessments based on the humps and valleys of the ASFBR curves do not always capture diverging patterns in the age at first birth, particularly when the variance of the age at first birth is large.

Inequality measures and other country-level predictors

To measure country-level inequality, we use the World Bank estimates of the Gini index (World Bank Group 2020a). The Gini index measures the extent to which the distribution of income among individuals or households within an economy deviates from a perfectly equal distribution. The main advantage of this indicator is its availability. There is no other country-level indicator that has more comprehensively captured the relative distribution of income for countries of the Global South over the period of our analysis. However, this indicator has some limitations. The Gini index does not capture all important aspects of inequality, such as extreme concentration; or other pervasive forms of inequality, such as educational inequality, inequality in access to land, or gender inequality.

We partially compensate for these limitations by including in our analysis additional information on income distribution from other sources. We use data from the World Inequality Database (WID) (The World Inequality Lab 2020), which provides rich information about income distribution for some of the countries in our sample. The main strength of the WID is that it includes information about the full distribution of both net and fiscal income. The main drawback of the WID is that the database's coverage is limited.

Multivariate linear regression models

We use linear regression models to correlate measures of first birth dispersion to our main predictor (the Gini index) and one benchmark predictor: the average years of schooling for women (United Nations 2020). To make these measures consistent with the period for which we are calculating the first birth schedules, we compute the average of each indicator over the 10 years preceding each survey, while omitting the years for which no information is available. This approach also helps us to increase the number of periods for which we can match information from DHS to data in the World Bank and United Nations Development Program databases, especially for the Gini index.[3]

The mean years of schooling for women is a useful benchmark for assessing the strength of the association between measures of income inequality and dispersion of first births because there is extensive research on the relationship between educational attainment and the tempo of fertility (National Research Council 1999). There is a robust negative relationship between educational attainment and fertility and educational attainment has a positive impact on the postponement of the first birth at the country level. These associations vary according to each country's level of development and fertility transition stage, and the coverage and the quality of its educational system. This latter finding underscores the importance of considering contextual factors when studying determinants of the timing of the transition to motherhood. We account for these developmental stage differences using multivariate regression models. These models allow us to incorporate dummy variables for the geographical region (as in Figure 1) and the total fertility rate groups when estimating the correlation between measures of first birth dispersion and income inequality.

Our baseline specification is a bivariate model that provides a comparative reference for the multivariate models. The goodness of fit of this specification, measured by the Akaike Information Criterion (AIC), enables us to assess the relative improvement in the goodness of fit in the multivariate specifications. These specifications include controls and interaction terms to test the robustness of the bivariate correlations, and to highlight the contextual aspects that affect the relationship between first birth schedules on the one hand, and income inequality and educational attainment on the other.

The first multivariate specification includes dummy variables for survey years (grouped by five years). The second specification adds a categorical variable that groups countries into four categories according to their TFR. This grouping reflects the countries' stages in the fertility transition: i.e., countries with the lowest fertility levels (TFR<=2.5), countries in the intermediate stages (2.5<TFR<=3.5 and 3.5< TFR<=4.5), and countries where fertility is still high (TFR>4.5). A third specification includes an interaction term between the TFR group and the Gini index. This specification examines the interplay between levels of income inequality and the countries' stages in the fertility transition. A fourth multivariate specification evaluates the robustness of the interaction term by adding dummy variables for geographical regions. This is our preferred specification. Finally, to test the robustness of our results, we include the gross national income (GNI) per capita based on purchasing power parity (PPP) in 2011 dollars (World Bank Group 2020b). Results for this latter specification are included in the appendix.[4]

Our overarching hypothesis is that economic inequality is positively associated with the difference between the means ($\delta = \mu2 - \mu1$). We hypothesize that the sign of the association between inequality and each of the two means is distinct: i.e., is positive at $\mu2$, and is negative at $\mu1$. Due to the strong connection between fertility decline and fertility inequality, we expect to find that these relationships are strong and robust only in low-fertility contexts. Among countries with fertility far above the replacement level (>4 children per woman), we expect to observe that the relationship between inequality and first birth dispersion is weak to nonexistent. As for the other parameters, we do not hypothesize about how they are related to socioeconomic inequality. Instead, we use their empirical values to better understand the drivers and the consequences of the relationship between inequality and reproductive polarization.

Results

Descriptive statistics for the dependent variables

Figure 3 displays all the 288 s-ASFBR curves by region, highlighting with solid lines the surveys conducted after 2013. These patterns are consistent with the time trends in fertility and fertility timing, as well as with the regional differences in the age at first birth documented elsewhere, which suggest that most of our estimates of ASFBR are plausible despite sample size constraints (Bongaarts, Mensch, and Blanc 2017; Hertrich 2017). The only exceptions are Sao Tome & Principe (2008) and El Salvador (1985). Based on this visual analysis, we decided to exclude these two samples from further analysis.

Several indicators are needed to characterize the heterogeneity of these s-ASFBR. Limiting our examination to the presence or lack thereof of two humps will be insufficient, not only because two humps are only distinguishable in 56 out of the 288 samples,[5] but also because there is an appreciable degree of diversity in the first birth schedules beyond the two-hump pattern. For example, the s-ASFBR curves for surveys conducted after 2013 display a variety of shapes, from strongly right-skewed curves (e.g., among former Soviet republics and Sub-Saharan Africa countries) to almost bell-shaped curves (e.g., among Middle Eastern and North African, and Asian countries), and curves for which the second hump is higher than the first (e.g., among Latin American and Caribbean countries).

This diversity is better captured by the set of indicators yielded by two-population normal mixture models. Table 1 presents descriptive measures for our five dependent and three independent country-level variables. Panel A includes all of the 288 waves, and Panel B includes only those waves with information on the Gini index (227 waves). The descriptive statistics do not differ much between these panels, which gives us confidence that our conclusions are not driven by data availability.

The mixture-model parameters capture divergent first birth schedules between the two populations in terms of both mean levels and variability. According to Table 1, μ1 and μ2 are, on average, separated by 6.5 years, with a country-level standard deviation of 0.9 years. The minimum and maximum values of δ (4.6 and 10.0 years) suggest that there is substantial variability in this measure. In addition, the median of δ is 6.5 years, which is more than the time that it takes to finish college education in all of these countries. These findings further underline the significance of the differences in the timing of the first birth between subpopulations in these countries.

These ranges of μ1 (6.4 years) and μ2 (8.3 years) indicate that the country-level variation in the timing of the first birth among women who postpone childbearing is larger than that among women who start childbearing earlier. The country-level means of σ1 and σ2 confirm this result. In both samples, the country-level average of σ2 is twice as large as the country-level average of σ1 (2.6 vs. 5.3 years in Panel A). This result implies that there is more heterogeneity in the timing of the first birth among women who delay family formation than there is among women who start having children at an early age.

The relative size of the second population also varies considerably, from being a minority group (min = 10%), to being the majority group (max = 68%). The second population is the majority only in eight out of 87 countries: namely, Argentina (2011), Brazil (2007), Chile (2011, 2015), Comoros (2012), Dominican Republic (2013), Ghana (2014), Haiti (2016), Morocco (2003), and Uruguay (2015). All of these cases were reported in surveys conducted after 2000, which points to the relative novelty of this phenomenon.

Descriptive statistics for the independent variables

Figure 4 displays the time trends of the 10-year lagged Gini index (left panel) and mean years of schooling for women (right panel) from 1980 to 2018. The light gray lines represent all countries in the two databases; data points and regional trends are added for the countries included in our analysis. We also plot data for the United States for comparative purposes.

The findings indicate that inequality is the highest in the LACar countries, followed by in the Sub-Saharan and West African nations. While the Gini index values have declined in these regions, their inequality levels are either higher or comparable to those of the United States, a country that is known for large discrepancies in individuals' socioeconomic conditions. The regional differences are substantial in what seems to be a divide between western (i.e., LACar, and Africa) and eastern countries (i.e., Middle East, North Africa, former Soviet republics, and Asian countries).

The right panel in Figure 5 shows that substantial gains have been made in the mean years of schooling for women in the former Soviet republics, the LACar countries, and the MENA countries.[6] The other three regions all have meager positive trends. Despite these positive trends, the educational gaps with respect to the United States are dramatic, especially for countries with virtually flat trends. Except for the ex-Soviet states, the gap in the mean years of schooling with respect to the United States is at least 50% for all regions (e.g., four years for the LACar countries in 2018). Moreover, these trends should be interpreted while taking into account the substantial differences in educational quality, labor market opportunities, and structural poverty conditions that are pervasive among the countries in our analysis.

Income inequality and divergence of first birth schedules

Table 2 presents standardized OLS estimates for the relationship between the Gini index and the differences in the mean ages at first birth between the two populations (δ). A positive coefficient for the Gini index indicates that higher inequality is associated with larger difference between the means. Five model specifications are organized by columns (M1 to M5). The last two specifications (M4 and M5) include an interaction term between the Gini index and the TFR groups. These coefficients display the association between income inequality and the difference between the means for each of the TFR groups. M5 is our preferred specification, as it accounts for time trends, TFR differences, and differences across world regions. Moreover, this specification yields the lowest AIC (579; i.e., 9% lower than the AIC of M1), which further supports the adequacy of this specification to describe the data.

According to the first specification (M1), income inequality and the difference in the two means are positively correlated. A one-standard-deviation increase in the Gini index is associated with a 0.33-standard-deviation increase in the difference between the two means. In other words, as income inequality increases, the mean ages at first birth of the two populations diverge. The second and the third specifications (M2 and M3) add dummy variables for the period of the survey and the TFR group, respectively. In these two specifications, the association between the Gini index and the outcome variable is stable in terms of direction (+), magnitude (0.38, 0.34), and significance (p-value < 0.001), which reinforces the findings of M1. In addition, the coefficients for the dummy variables display directions and magnitudes that are consistent with the literature on changes in the fertility schedules of women in low- and middle-income countries. Over time, the difference in the means increases, especially after 2010, and higher fertility is associated with a smaller difference between the two mean ages at first birth. The AIC of these two specifications is lower than that of M1; meaning that adding these dummy variables improves the goodness of fit of the model.

The fourth specification (M4) includes an interaction term between the TFR groups and the Gini index. This interaction term allows us to test the hypothesis that income inequality may have a stronger influence on the difference between the means for countries that are more advanced in the fertility transition than for countries where fertility is high. According to this specification, the association between income inequality and the difference in the mean ages at first birth of the two populations is positive and significant for the first three TFR groups: namely, among the countries with a TFR below 4.5 (β=0.52, 0.53, and 0.42).

Finally, the last specification tests the robustness of the previously described relationships by adding dummy variables for world regions as proxies of cultural practices affecting the timing of family formation (Therborn 2004). Since there are significant differences in levels of inequality and in fertility schedules across these world regions, we deem this specification to be more adequate. The estimated coefficients for regions other than Asia (reference category) are consistently large and significant, except among the MENA countries: the former Soviet republics and the LACar countries stand out as having very high coefficients (1.40 and 1.23, respectively), while the two subregions within Africa display lower and similar coefficients (0.74 for SSA and 1.10 for West Africa).

According to M5, the estimated associations in M4 are robust to the regional fixed effects for the first TFR group only. This means that, net of regional differences, income inequality is associated with larger within-country discrepancies in the timing of the first birth in low-fertility contexts only. A one-standard-deviation change in the Gini index (i.e., approximately nine index points) is associated with a 0.5-standard-deviation increase in the difference between the two mean ages at first birth (0.5 years according to Table 1) among countries where fertility is below 2.5 children per woman. This relationship is, at most, very weak and non-significant in all other TFR groups.

We proceed in a similar way for the other indicators of the two-population mixture models. We fit specifications M1 to M5, and focus on the standardized association between each indicator and the Gini index. For all indicators, M5 displays the lowest AIC, and is, therefore, our preferred specification. We include descriptive scatter plots for all indicators and the Gini index in Figure A1, and all results from multivariate linear models in Appendix Tables T1 to T5.

Figure 5 summarizes the main findings for all of the indicators of the two-population mixture models, and compares them with the results for the mean years of schooling for women. The left panel in Figure 5 displays the standardized associations between all of the indicators of the two-population mixture models and the Gini index for each of the four TFR groups (different colors and markers). The right panel displays analogous results using the mean years of schooling for women as a predictor variable, instead of the Gini index.

Both predictors display associations of comparable magnitudes for the highest TFR group: i.e., for countries with TFR above 4.5. These associations range between -0.2 and 0.2, and none of them is statistically significant; meaning that income inequality and the mean years of schooling are not associated with the distributional characteristics of the age at first birth in high-fertility contexts. These results make sense if we consider the biological and social processes that underlie the strong and negative correlation between high fertility and the age at first birth. For a country to have a high average number of children born per women, reproduction would have to start early, which would, in turn, reduce the heterogeneity of the timing of the initiation of childbearing.

The reverse is true for the lowest TFR group (1.0, 2.5], and particularly for δ, $\sigma1$, and $\sigma2$; i.e., for outcomes that directly measure the distributional aspects of first birth schedules. According to these results, income inequality is positively associated with the difference between $\mu1$ and $\mu2$ (δ) among countries with TFRs below 2.5 (std. assoc. = 0.51, as reported in Table 2). This association is consistent with the negative and positive associations between the Gini index and $\mu1$ and $\mu2$, respectively; although these two associations are not statistically significant (p-values: 0.197 and 0.566, respectively). Moreover, the associations between the Gini index and $\sigma1$ and $\sigma2$ are also opposed in sign, are relatively strong (especially that of $\sigma1$), and are statistically significant. Higher income inequality is associated with lower heterogeneity in the age at first birth for the women who transition to motherhood early, and with higher heterogeneity in the timing of the first birth for the women who transition to motherhood later. These results make sense from a demographic standpoint, because lower fertility allows for higher heterogeneity in the timing of the first birth. But they also make sense from a sociological standpoint, given that distributional indicators, such as the Gini index, should be good predictors of distributional outcomes (differences in means and standard deviations). Therefore, the unequal distribution of income – and the consequences it has for fostering unequal life course opportunities – is associated with three processes: (i) larger differences in the age at first birth between women depending on whether they transition to motherhood early or later; (ii) lower heterogeneity in the timing of the first birth among the former group; and (iii) higher heterogeneity in the age at motherhood among women in the latter group (women who postpone motherhood). Although the association between the Gini index and $\rho 2$ is not statistically significant for countries with TFRs below 2.5 and above 4.5, it is important to note that this association is positive for the two other TFR groups (std. associations between 0.26 and 0.27). These results mean that in settings with intermediate fertility levels, the relative size of the population who delay the transition to the first birth tends to increase as inequality increases.

Conversely, the mean years of schooling indicator displays mostly positive, weak, or non-statistically significant associations with indicators of the two-population mixture models. The associations are particularly weak for $\sigma 1$ and $\sigma 2$. In line with our expectations, we find that a non-distributional variable (mean years of schooling) is not a good predictor of distributional outcomes. The only exception is the association between the average years of schooling and ρ for countries with TFRs below 2.5. This result means that as the average years of schooling for women increase, the proportion of women who delay the transition to motherhood also increases. This observation is not new, as this association has been extensively documented (National Research Council 1999). However, this result does add to our understanding of how – and, potentially, why – the timing of the first birth has changed in recent decades among countries of the Global South. Notably, the strength of this association (std. assoc. = 0.48) is comparable in magnitude to that of the Gini index and δ (std. assoc. = 0.51, as reported in Table

2), which underlines the significance of the relationship between inequality and first birth dispersion.

Robustness checks

We have conducted three ancillary analyses that support our results, and increase our confidence in our conclusions. First, we include an additional control variable in the M5 specification: namely, the GNI per capita based on purchasing power parity (Figure A2). Second, we estimate the relationship between the Gini index and the mean years of schooling, and the three non-parametric indicators of first birth schedules: a1 and a2 (the two closest ages that comprise 50% of the total area under the s-ASFBR curves), and the difference between these ages, denoted by d[7] (Figure A3). Third, we examine whether these results extend beyond the Gini index to other measures of income concentration (Figure A4). These robustness checks confirm results of our main analyses in showing that income inequality is associated with growing heterogeneity in the age at first birth.

Conclusions and discussions

Discussions about the implications of rising income inequality across the globe feature prominently in both the academic and political arenas (Pikkety 2019). These debates are very pertinent for countries of the Global South, where levels of socioeconomic inequality are especially high. The historical origins of these inequalities make it hard to envision fundamental changes to these patterns in the near future, unless drastic economic and political reforms are enacted. Moreover, poverty, pervasive informality in labor markets, weak welfare states, and – in some cases – violence worsen the implications of inequality for the overall societal well-being of countries of the Global South.

In this paper, we examined the implications of income inequality for the timing of motherhood among women in 86 countries for the period of 1986 to 2018. The first birth is a fundamental marker of the transition to adulthood. The changes in the societal roles of individuals that accompany this transition make it a milestone event in each person's life. The arrival of the first child influences an individual's subsequent opportunities for accessing education, participating in the labor market, or migrating (to mention a few potential life paths of young adults). In the context of the Global South, where welfare states are poorly developed, family formation profoundly shapes individuals' opportunities. Thus, understanding how the timing of the transition to motherhood relates to inequality is very pertinent when studying these populations.

We found that income inequality – and, potentially, income concentration – is positively associated with increasing disparities in the age at first birth. The strength of this association is comparable in magnitude to the strength of the association between the number of years of schooling and the overall delay in the age at first birth. Overall, income inequality is as important for reproductive polarization as educational attainment is for fertility postponement. The association between inequality and the age at first birth at the country level can be understood as reflecting the interplay of two populations with divergent trends in the timing of motherhood. We found that in settings characterized by high levels of income inequality, a portion of the population of women continue to transition to motherhood early. The size of this population becomes smaller and the ages at first birth of women in this group more homogenous as inequality increases, potentially due to negative selection in terms of socioeconomic status. Small/minoritarian populations are not necessarily more homogenous than large/majoritarian groups (e.g., immigrant women display more heterogeneous fertility schedules than native-born (Adserà and Ferrer 2015; Parrado 2015)). A shared set of disadvantages could be the common denominator that factors into the early transition to motherhood among this shrinking group of women. At the same time, a growing (occasionally a majority) and increasingly heterogeneous group of women delay the start of reproduction.

This larger heterogeneity may be related to the diversity of life-path alternatives faced by young middle- and upper-class women in high inequality contexts. If resources and opportunities are concentrated at the top-end of the class structure, more heterogeneity in the age at first birth is expected among this group than among disadvantaged women, regardless of their relative size. We identified these patterns in countries with low fertility; i.e., in countries where the fertility transition is advanced, and is potentially even more pronounced in urban areas and large cities where fertility has historically been lower than in rural areas, and socioeconomic inequalities more acute (Montgomery et al. 2003). This result sheds light on an important interaction of demographic change and inequality that has been previously described in theoretical terms, and was tested in this paper using a large and diverse sample of countries.

Our results indicate that only in contexts where the TFR is below 2.5 is the positive correlation between inequality and the increasing spread of the first birth schedules significant, both statistically and substantially. The importance of this result is twofold. First, it is predictive of the future of all of these societies, as fertility continues to decline in these countries, despite regional differences in the pace of this trend (Dorius 2008; Esteve and Liu 2017; Pesando and GFC-team 2019). Second, it is indicative of the current socioeconomic well-being of populations in large cities and urban areas where fertility is either low or declining at a faster pace than at the national level (Montgomery et al. 2003, chap. 6). These results represent a response to several pleas to examine demographic and socioeconomic dynamics as interrelated phenomena, and not as exogenous to one another (Johnson-Hanks et al. 2011, chap. Introduction).

Greater heterogeneity in the fertility schedules of women who delayed motherhood implies that this group may have very different life course trajectories, not only compared to women who transition to childbearing early, but also among themselves. Challenges such as school interruptions, emigration and return migration, participation in informal labor markets, and financial instability are likely to factor into how women in this group make their decisions about when to start childbearing. This observation is consistent with the lack of a strong middle class in low-income countries. Van de Kaa (1996) has argued that given this particular feature of class structures, what he calls *anchored narratives* about how and why demographic change occurs in less-developed countries require a thoughtful revision.

The main lessons from these revisions is that when studying demographic change in these countries, more attention should be paid to structural factors (poverty, lack of opportunities, extreme inequalities), and to how these factors may restrict the range of possibilities for demographic transitions. Some scholars have pointed out that this structural approach may be useful beyond Global South settings. According to Schulze and Tyrell (2002), structural interpretations of reproductive polarization may also apply to the divergence of fertility schedules in European countries during the 1980s. However, these interpretations remain far less common than the more individualistic understanding of demographic change (Esping-Andersen and Billari 2015).

In addition to documenting the associations between the timing of fertility and inequality, our study shows that more and better-quality data on these issues are needed. Likewise, we are fully aware that income inequality is only one form of resource concentration. We did not consider other forms of inequality, such as educational inequality (quality and access), gender inequality, racial/ethnic inequalities, or rising disparities in terms of citizenship and migration status. We thus call upon authors to pursue research that examines how these other forms of inequality may affect first birth schedules; for which we make our data available upon request. Finally, it is important to highlight that two-population mixture models do not exhaustively summarize the myriad of fertility schedules across countries and over time. The positive association between inequality and the variance of the age at first birth among women who delay motherhood needs further examination, as there may substantially different fertility schedules that are being neglected by the assumption of two populations.

Data Availability

The survey data used in this paper are available upon registration through the Demographic and Health Survey program (https://dhsprogram.com/), the Generation and Gender (https://www.ggp-i.org/) program, and the World Bank data catalog (https://www.worldbank.org/en/home). The country-level data is available upon request from the corresponding author.

References

Adserà, Alícia, and Ana Ferrer. 2015. "Immigrants and Demography." In *Handbook of the Economics of International Migration*, edited by Barry Chiswick and Paul Miller, 1st ed., 1A:315–374. North-Holland: Elsevier. https://doi.org/10.1016/B978-0-444-53764-5.00007-4.

Adserà, Alícia, and Alicia Menendez. 2011. "Fertility Changes in Latin America in Periods of Economic Uncertainty." *Population Studies* 65 (1): 37–56. https://doi.org/10.1080/00324728.2010.530291.

Amato, Paul, Alan Booth, Susan McHale, and Jennifer Van hook. 2015. *Families in an Era of Increasing Inequality*. Edited by Paul R. Amato, Alan Booth, Susan M. McHale, and Jennifer Van Hook. First. Vol. 5. National Symposium on Family Issues. Cham: Springer International Publishing. https://doi.org/10.1007/978-3-319-08308-7.

Batyra, Ewa. 2020. "Increasing Educational Disparities in the Timing of Motherhood in the Andean Region: A Cohort Perspective." *Population Research and Policy Review*, no. 0123456789. https://doi.org/10.1007/s11113-019-09535-0.

Bloom, David E, and James Trussell. 1984. "What Are the Determinants of Delayed Childbearing and Permanent Childlessness in the United States?" *Demography* 21 (4): 4.

Bongaarts, John, Barbara S. Mensch, and Ann K. Blanc. 2017. "Trends in the Age at Reproductive Transitions in the Developing World: The Role of Education." *Population Studies* 71 (2): 139–154. https://doi.org/10.1080/00324728.2017.1291986.

Burkimsher, Marion. 2017. "Evolution of the Shape of the Fertility Curve: Why Might Some Countries Develop a Bimodal Curve?" *Demographic Research* 37 (1): 295–324. https://doi.org/10.4054/DemRes.2017.37.11.

Camarda, Carlo G. 2012. "MortalitySmooth : An R Package for Smoothing." *Journal of Statistical Software July* 50 (1): 24.

Castro Martín, Teresa. 1992. "Delayed Childbearing in Contemporary Spain: Trends and Differentials." *European Journal of Population* 8 (3): 217–46. https://doi.org/10.1007/BF01797211.

Castro Torres, Andrés Felipe. 2020. "Analysis of Latin American Fertility in Terms of Probable Social Classes." *European Journal of Population*, November. https://doi.org/10.1007/s10680-020-09569-7.

Chandola, T., D. A. Coleman, and R. W. Hiorns. 2002. "Distinctive Features of Age-Specific Fertility Profiles in the English-Speaking World: Common Patterns in Australia, Canada, New Zealand and the United States, 1970-98." *Population Studies* 56 (2): 181–200. https://doi.org/10.1080/00324720215929.

Chandola, T., D.A. Coleman, and W. Hiorns. 1999. "Recent European Fertility Patterns: Fitting Curves to 'Distorted' Distributions." *Population Studies* 53 (3): 317–29.

Chant, Sylvia, and Cathy McIlwaine. 2009. *Geographies of Development in the 21st Century. An Introduction to the Global South*. Fist. Cheltenham: Edward Elgar Publishing Limited.

Coontz, Stephanie. 2014. *Marriage, a History : How Love Conquered Marriage*. 1st ed. New York: Penguin Books.

Dorius, Shawn F. 2008. "Global Demographic Convergence? A Reconsideration of Changing Intercountry Inequality in Fertility." *Population and Development Review* 34 (3): 519–537. https://doi.org/10.1111/j.1728-4457.2008.00235.x.

Dunbar, R. I. M., ed. 1995. *Human Reproductive Decisions*. London: Macmillan Education UK. https://doi.org/10.1007/978-1-349-23947-4.

Eloundou-Enyegue, Parfait, Sarah Giroux, and Michel Tenikue. 2017. "African Transitions and Fertility Inequality: A Demographic Kuznets Hypothesis: African Transitions and Fertility Inequality." *Population and Development Review* 43 (May): 59–83. https://doi.org/10.1111/padr.12034.

Esping-Andersen, Gosta, and Francesco C. Billari. 2015. "Re-Theorizing Family Demographics." *Population and Development Review* 41 (1): 1–31. https://doi.org/10.1111/j.1728-4457.2015.00024.x.

Esteve, Albert, and Chia Liu. 2017. "Family and Household Composition in Asia." In *Routledge Handbook of Asian Demography*, 370–393. New York : Routledge, 2018.: Routledge. https://doi.org/10.4324/9781315148458-20.

Fox, Jonathan, Sebastian Klüsener, and Mikko Myrskylä. 2019. "Is a Positive Relationship Between Fertility and Economic Development Emerging at the Sub-National Regional Level? Theoretical Considerations and Evidence from Europe." *European Journal of Population* 35 (3): 487–518. https://doi.org/10.1007/s10680-018-9485-1.

Furstenberg, Frank. 2010. "Diverging Development: The Not-so-Invisible Hand of Social Class in the United States." In *Families as They Really Are*, edited by B.J. Risma, 276–94. New York: W.W. Norton & Company.

Grant, Monica J., and Frank F. Furstenberg. 2007. "Changes in the Transition to Adulthood in Less Developed Countries." *European Journal of Population* 23 (3–4): 415–28. https://doi.org/10.1007/s10680-007-9131-9.

Hertrich, Véronique. 2017. "Trends in Age at Marriage and the Onset of Fertility Transition in Sub-Saharan Africa." *Population and Development Review*. https://doi.org/10.1111/padr.12043.

ICF. 2018. "Demographic and Health Surveys (Various) [Datasets]." Funded by USAID.

Johnson-Hanks, Jennifer, Christine A. Bachrach, Philip Morgan, and Hans-Peter Kohler. 2011. *Understanding Family Change and Variation: Toward a Theory of Conjunctural Action*. 1st ed. New York: Springer.

Juarez, Fatima, and Cecilia Gayet. 2014. "Transitions to Adulthood in Developing Countries." *Annual Review of Sociology* 40: 521–38. https://doi.org/10.1146/annurev-soc-052914-085540.

Kaa, D.J. van de. 1996. "Anchored Narratives : The Story and Findings of Half a Century of Research into the Determinants of Fertility." *Population Studies* 50 (3): 389–432.

Lerch, Mathias. 2019. "Regional Variations in the Rural-Urban Fertility Gradient in the Global South." Edited by Bernardo Lanza Queiroz. *PLOS ONE* 14 (7): e0219624. https://doi.org/10.1371/journal.pone.0219624.

Lima, Everton E.C., Krystof Zeman, Tomas Sobotka, Mathias Nathan, and Ruben Castro. 2018. "The Emergence of Bimodal Fertility Profiles in Latin America." *Population and Development Review* 0 (0): 1–21. https://doi.org/10.1111/padr.12157.

Luci-Greulich, Angela, and Olivier Thévenon. 2014. "Does Economic Advancement 'Cause' a Re-Increase in Fertility? An Empirical Analysis for OECD Countries (1960-2007)." *European Journal of Population* 30 (2): 187–221. https://doi.org/10.1007/s10680-013-9309-2.

Lutz, Wolfgang. 1989. *Distributional Aspects of Human Fertility*. 1st ed. London: Academic Press.

McLanahan, Sara, and Christine Percheski. 2008. "Family Structure and the Reproduction of Inequalities." *Annual Review of Sociology* 34 (1): 257–276.

Montgomery, Mark, Richard Stren, Barney Cohen, and Holly Reed. 2003. *Cities Transformed*. Washington, D.C.: National Academies Press. https://doi.org/10.17226/10693.

Myrskylä, Mikko, Hans-Peter Kohler, and Francesco C Billari. 2009. "Advances in Development Reverse Fertility Declines." *Nature* 460 (7256): 741–43. https://doi.org/10.1038/nature08230.

Nathan, Mathias. 2015. "La Creciente Heterogeneidad En La Edad al Primer Hijo En El Uruguay: Un Análisis de Las Cohortes de 1951 a 1990." *Not*, no. 100: 35–60.

National Research Council. 1999. *Critical Perspectives on Schooling and Fertility in the Developing World*. Washington, D.C.: National Academies Press. https://doi.org/10.17226/6272.

Pantazis, Athena, and Samuel J. Clark. 2018. "A Parsimonious Characterization of Change in Global Age-Specific and Total Fertility Rates." *PLoS ONE* 13 (1): 1–19. https://doi.org/10.1371/journal.pone.0190574.

Parrado, Emilio A. 2015. "Migration and Fertility." In *International Encyclopedia of the Social and Behavioral Sciences*, 397–406. Elsevier. https://doi.org/10.1016/B978-0-08-097086-8.31128-X.

Pesando, Luca Maria, and GFC-team. 2019. "Global Family Change: Persistent Diversity with Development." *Population and Development Review* 45 (1): 133–68. https://doi.org/10.1111/padr.12209.

Pikkety, Thomas. 2019. *Capital et Idéologie*. 1st ed. Paris: Seuil.

Rendall, M, O Ekert-Jaffe, H Joshi, K Lynch, and R Mougin. 2009. "Universal versus Economically Polarized Change in Age at First Birth: A French-British Comparison." *Population and Development Review* 35 (1): 89–115.

Rendall, Michael, Encarnacion Aracil, Christos Bagavos, Christine Couet, Alessandra Derose, Paola Digiulio, Trude Lappegard, et al. 2010. "Increasingly Heterogeneous Ages at First Birth by Education in Southern European and Anglo-American Family-Policy Regimes : A Seven-Country Comparison by Birth Cohort" 64 (3). https://doi.org/10.1080/00324728.2010.512392.

Rios-Neto, Eduardo L. G., Adriana Miranda-Ribeiro, and Paula Miranda-Ribeiro. 2018. "Fertility Differentials by Education in Brazil: From the Conclusion of Fertility to the Onset of Postponement Transition." *Population and Development Review* 44 (3): 489–517.

Sacco, Nicolás, and Gabriel Borges. 2018. "¿Converge La Fecundidad En Brasil y Argentina? Un Enfoque Desde Las Desigualdades." *Revista Brasileira de Estudos de População* 35 (1): 1–29. https://doi.org/10.20947/S0102-3098a0039.

Schoumaker, Bruno. 2013. “A Stata Module for Computing Fertility Rates and TFRs from Birth Histories: Tfr2.” *Demographic Research* 28 (May): 1093–1144. https://doi.org/10.4054/DemRes.2013.28.38.

Schulze, H.J, and H. Tyrell. 2002. “What Happen to the European Family in the 1980s? The Polarization between the Family and Other Forms of Private Life.” In *Family Life and Family Policies in Europe: Volume 2: Problems and Issues in Comparative Perspective*, edited by X. Kaufman, A. Kuijsten, H.J. Schulze, and K.P. Stromeiher, 69–119. Oxford: Oxford University Press.

Sullivan, Rachel. 2005. “The Age Pattern of First-Birth Rates among U.S. Women: The Bimodal 1990s.” *Demography* 42 (2): 259–73. https://doi.org/10.2307/4147346.

The World Inequality Lab. 2020. *World Inequality Database*. https://wid.world/data/.

Therborn, G. 2004. *Between Sex and Power: Family in the World 1900–2000*. Routledge.

United Nations. 2020. *United Nations Development Indicators*.

World Bank Group. 2020a. *GINI Index (World Bank Estimate)*. Washington.

———. 2020b. *World Bank Indicators*. https://data.worldbank.org/indicator.

TABLE 1 Descriptive statistics for five outcomes related to the first birth schedules (results of the two-population mixture models) and for three explanatory variables.

a

Full sample (288 waves)	Mean	Standard deviation	Median	Min.	Max.
$\delta = \mu 2 - \mu 1$	6.5	0.9	6.5	4.6	10.0
$\mu 1$	19.3	1.1	19.3	16.1	22.5
$\mu 2$	25.8	1.5	25.8	21.4	29.7
$\sigma 1$	2.6	0.3	2.6	1.7	3.9
$\sigma 2$	5.3	0.4	5.3	4.2	6.6
$\rho 2$	29.0	11.0	27.0	10.0	68.0

b

Waves with information on Gini (227 waves)	Mean	Standard deviation	Median	Min.	Max.
$\delta = \mu 2 - \mu 1$	6.5	0.9	6.5	4.6	10.0
$\mu 1$	19.2	1.1	19.2	16.1	22.5
$\mu 2$	25.7	1.6	25.7	21.4	29.7
$\sigma 1$	2.6	0.3	2.6	1.7	3.9
$\sigma 2$	5.2	0.4	5.3	4.2	6.4
$\rho 2$	29.0	11.0	27.0	10.0	68.0
GINI Index	43.0	9.0	42.2	27.3	65.8
Mean years of schooling-women	4.3	2.7	3.7	0.4	11.1
Total Fertility Rate	4.4	1.5	4.6	1.2	7.8

Note: The Gini index and the mean years of schooling for women are the 10-year averages. The total fertility rate refers to the three years (DHS) or five years (World Bank Development Indicators) that preceded the survey depending on the source. μ1, μ2 – mean ages at first birth in the first and the second population, respectively. σ1, σ2 – standard deviations of the age at first birth in the first and the second population, respectively. δ – difference in the mean age at first birth between the second and the first population. ρ2 – relative size of the second population (%).

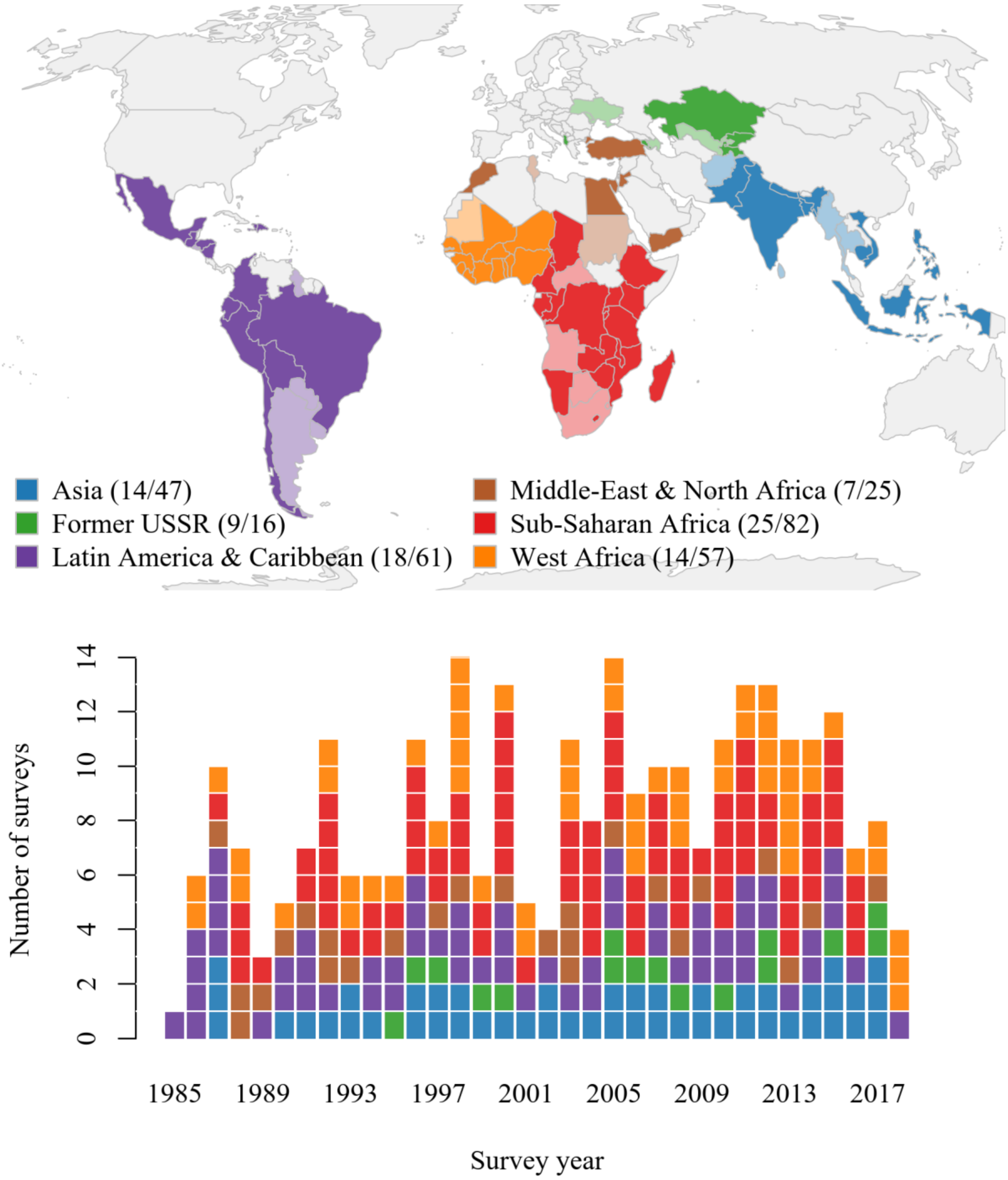
TABLE 2 Standardized associations between income inequality and the difference in the mean ages at first birth in two-population mixture models ($\delta = \mu 2 - \mu 1$).

	M1		M2		M3		M4		M5	
	β	Sig.	β	Sig.	β	Sig.	β	Sig.	β	Sig.
Constant	-0.04 (0.1)		-0.63 (0.17)	***	0.35 (0.27)		0.39 (0.27)		-0.50 (0.28)	†
GINI Index	0.33 (0.09)	***	0.38 (0.09)	***	0.34 (0.08)	***				
TFR group (ref: <2.5)										
(2.5-3.5)					-0.65 (0.26)	*	-0.79 (0.27)	**	-0.13 (0.27)	
(3.5-4.5)					-1.06 (0.24)	***	-1.09 (0.25)	***	-0.53 (0.22)	*
(> 4.5)					-0.98 (0.26)	***	-1.04 (0.26)	***	-0.72 (0.28)	*
Dummies TFR * GINI Index										
(< 2.5) * Gini index							0.52 (0.14)	***	0.51 (0.23)	*
(2.5-3.5) * Gini index							0.53 (0.17)	**	0.00 (0.22)	
(3.5-4.5) * Gini index							0.42 (0.1)	***	0.20 (0.15)	
(> 4.5) * Gini index							0.16 (0.13)		0.00 (0.1)	
Survey year (ref: 1986-1989)										
1990-1994			0.47 (0.22)	*	0.46 (0.22)	*	0.48 (0.23)	*	0.32 (0.2)	
1995-1999			0.32 (0.22)		0.26 (0.2)		0.28 (0.19)		0.05 (0.2)	
2000-2004			0.35 (0.23)		0.28 (0.21)		0.30 (0.2)		0.13 (0.19)	
2005-2009			0.57 (0.21)	**	0.32 (0.2)		0.31 (0.2)		0.07 (0.22)	
2010-2014			0.85 (0.22)	***	0.70 (0.2)	**	0.68 (0.21)	**	0.33 (0.22)	
2015-2018			0.96 (0.29)	**	0.64 (0.28)	*	0.62 (0.28)	*	0.36 (0.27)	
Region (ref: Asia)										
Former USSR									1.40 (0.29)	***
Latin America & the Caribbean									1.23 (0.39)	**
Middle-east & North Africa									0.28 (0.39)	
Sub-Saharan Africa									0.74	*

					(0.34)	
West Africa					1.10	**
					(0.32)	
AIC	634	629	609	608	579	
Obsv.	227	227	227	227	227	

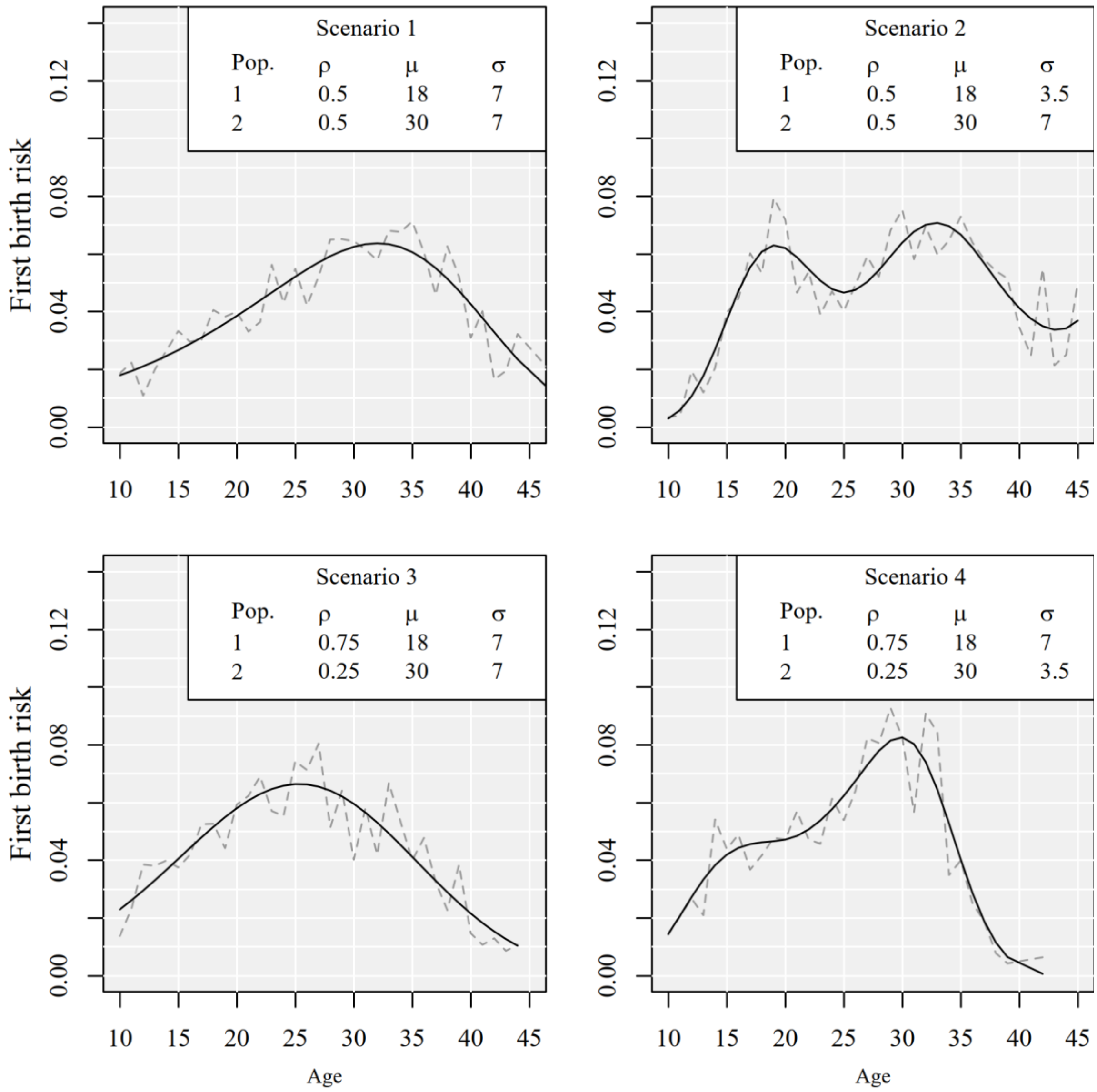
Note: Significance levels are presented as '***' 0.001, '**' 0.01, '*' 0.05, and '†' 0.1. Standard errors in parentheses are clustered at the country level.

FIGURE 1 Geographical and temporal coverage of the data.



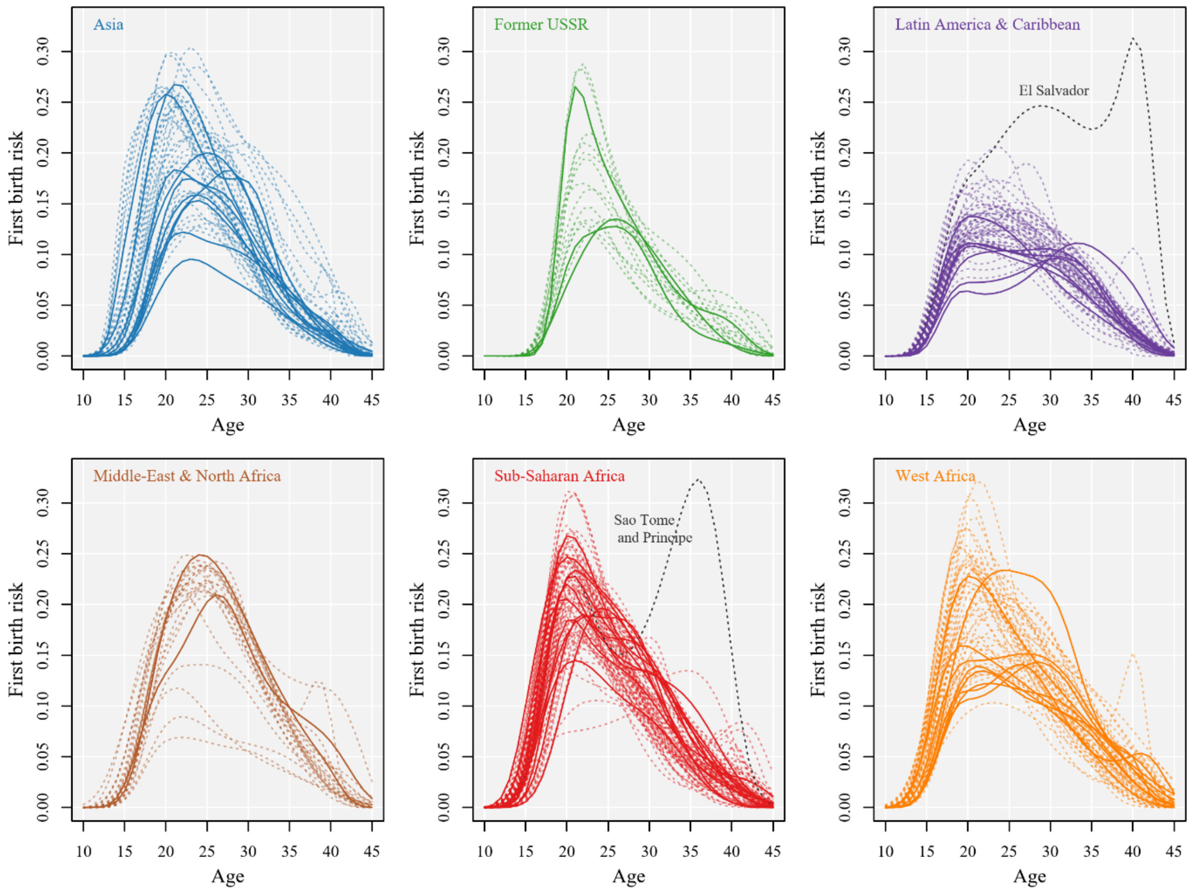
Note: The numbers in parentheses indicate the number of countries / and the number of survey waves. Total: 86 countries / and 288 survey waves. Light-colored countries only have one survey.

FIGURE 2 Raw and smoothed age-specific first birth risks (ASFBR) for a mixture of two populations – simulated data.



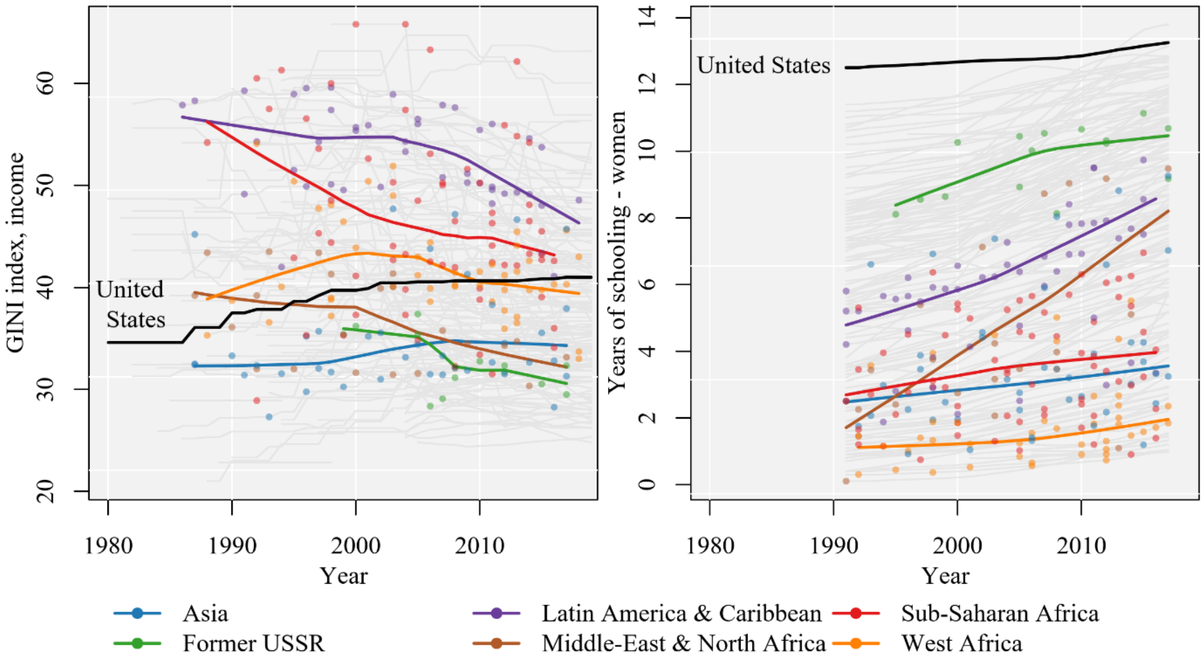
Note: These patterns do not represent real data. Data are simulated under realistic conditions, and the parameters are chosen to produce divergent shapes across smoothed-ASFBR. μ – mean ages at first birth in a given population. σ – standard deviations of the age at first birth in a given population. ρ – relative size of the populations.

FIGURE 3 Smoothed age-specific first birth (s-ASFBR) curves by region.



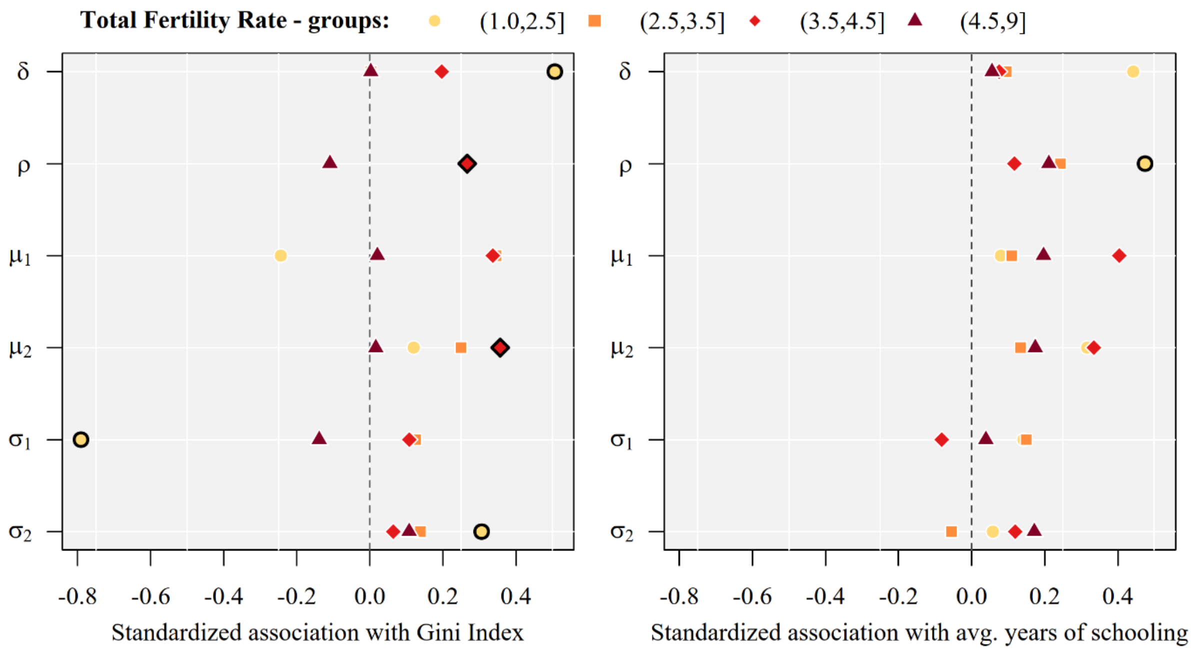
Note: Dotted and continuous lines correspond to the Demographic and Health Surveys conducted before and after 2013, respectively. The high risk after age 35 may be driven by the relatively small size of the population at risk. We ran robustness check analysis, including rates until age 34. The results were consistent with those presented below.

FIGURE 4 Regional trends of inequality and mean years of schooling for countries included in the analysis.



Note: Colored lines represent regional trends using data points for countries included in this analysis; i.e., those with information on the age at first birth. Indicators are averaged over the 10 years prior to each estimate.

FIGURE 5 Standardized associations between two-population mixture models' indicators, and the Gini index (left panel) and mean years of schooling for women (right panel), for different TFR levels. Black borders indicate statistically significant associations, (p-value < 0.1).



Note: These associations are estimated using an interaction term between the four TFR groups and the Gini index in a multivariate model that includes dummy variables for the survey year and world regions (as in Table 2). Standard errors are clustered at the country level. $\mu 1$, $\mu 2$ – mean ages at first birth in the first and the second population, respectively. $\sigma 1$, $\sigma 2$ – standard deviations of the age at first birth in the first and the second population, respectively. δ – difference in the mean age at first birth between the second and the first population. $\rho 2$ – relative size of the second population.

Appendix: Supplemental Materials

FIGURE A1 Associations between income inequality and first birth schedules' parameters. Regression lines are obtained via stratified Ordinary Least Squares for each of the TFR groups and the pooled sample.

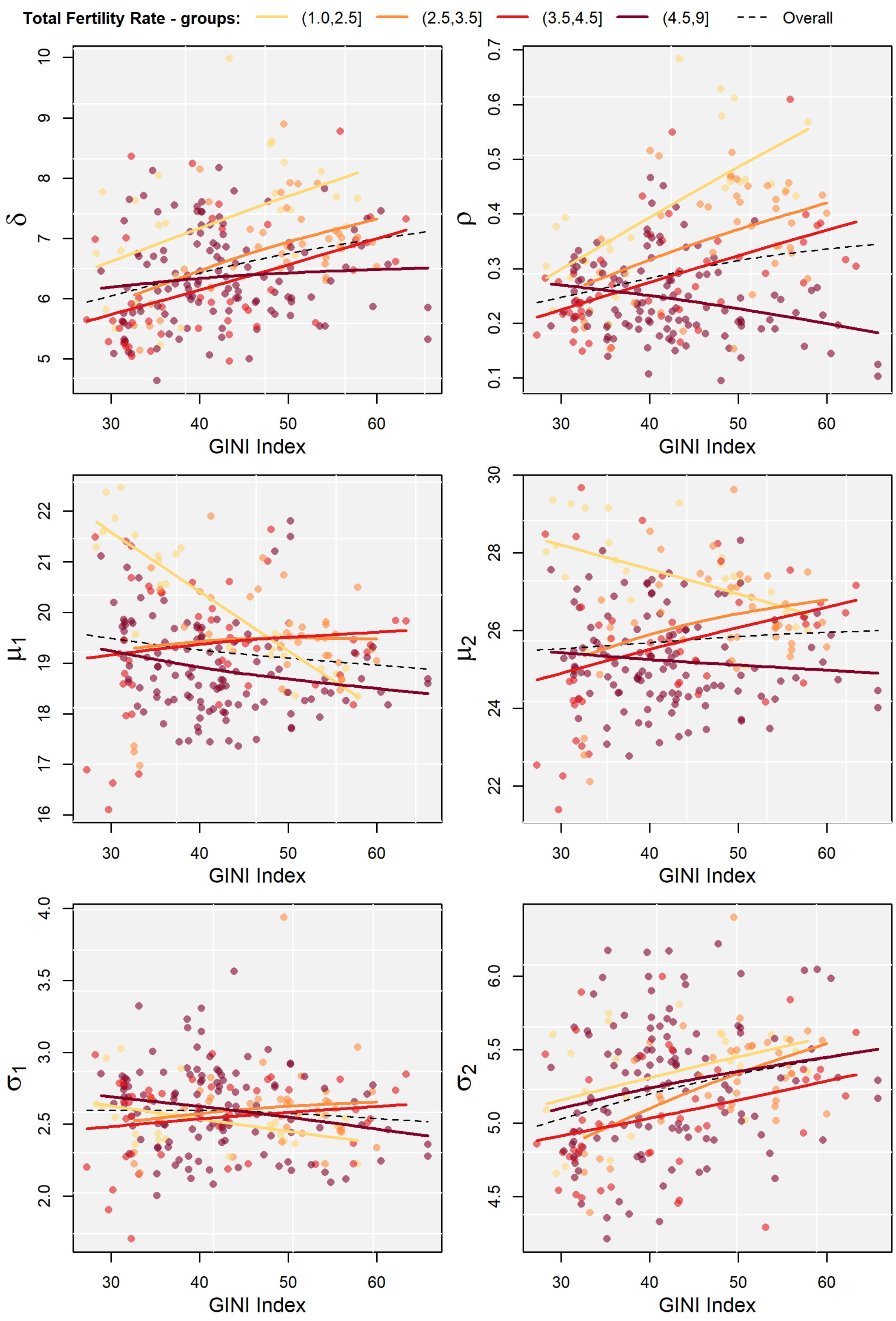


TABLE T1 Standardized associations between income inequality and the relative size of the subpopulation with the higher mean age at first birth (ρ2).

	M1		M2		M3		M4		M5	
	β	**Sig.**	**β**	**Sig.**	**β**	**Sig.**	**β**	**Sig.**	**β**	**Sig.**
Constant	0.03		-0.53	**	0.58	†	0.69	*	0.30	
	(0.11)		(0.17)		(0.31)		(0.3)		(0.32)	
GINI Index	0.26	*	0.33	**	0.25	**				
	(0.1)		(0.1)		(0.09)					
TFR group (ref: <=2.5)										
(2.5, 3.5]					-0.41		-0.68	*	-0.69	**
					(0.29)		(0.28)		(0.26)	
(3.5, 4.5]					-0.92	***	-1.00	***	-0.85	***
					(0.26)		(0.25)		(0.22)	
> 4.5					-1.34	***	-1.47	***	-1.41	***
					(0.27)		(0.24)		(0.26)	
Dummies TFR * GINI Index										
(<= 2.5) * Gini index							0.78	***	0.27	
							(0.17)		(0.21)	
(2.5, 3.5] * Gini index							0.55	**	0.26	
							(0.18)		(0.2)	
(3.5, 4.5] * Gini index							0.41	***	0.27	*
							(0.1)		(0.12)	
(> 4.5) * Gini index							-0.12	†	-0.11	
							(0.07)		(0.07)	
Survey year (ref: 1986-1989)										
1990-1994			0.23		0.23		0.26		0.21	
			(0.25)		(0.24)		(0.21)		(0.22)	
1995-1999			0.14		0.07		0.11		0.10	
			(0.21)		(0.23)		(0.21)		(0.23)	
2000-2004			0.24		0.15		0.19		0.26	
			(0.25)		(0.24)		(0.22)		(0.23)	
2005-2009			0.63	**	0.33		0.29		0.39	
			(0.22)		(0.25)		(0.23)		(0.24)	
2010-2014			0.83	***	0.66	**	0.59	*	0.65	*
			(0.23)		(0.24)		(0.24)		(0.24)	
2015-2018			1.26	***	0.92	**	0.87	**	0.88	***
			(0.27)		(0.27)		(0.26)		(0.25)	
Region (ref: Asia)										
Former USSR									-0.36	†
									(0.22)	
Latin America & the Caribbean									0.86	**
									(0.3)	
Middle-east & North Africa									0.38	
									(0.28)	
Sub-Saharan Africa									0.00	
									(0.27)	
West Africa									0.59	†
									(0.3)	
AIC	641		617		554		516		484	
Obsv.	227		227		227		227		227	

Note: Significance levels are presented as '***' 0.001, '**' 0.01, '*' 0.05, and '†' 0.1. Standard errors in parentheses are clustered at the country level.

TABLE T2 Standardized associations between income inequality and the mean age at first birth of the first subpopulation (μ1).

	M1		M2		M3		M4		M5	
	β	**Sig.**	**β**	**Sig.**	**β**	**Sig.**	**β**	**Sig.**	**β**	**Sig.**
Constant	-0.02		0.12		0.97	**	0.84	***	0.29	
	(0.13)		(0.23)		(0.34)		(0.24)		(0.28)	
GINI Index	-0.15		-0.11		-0.15					
	(0.12)		(0.12)		(0.15)					
TFR group (ref: <=2.5)										
(2.5, 3.5]					-0.44		-0.48		0.00	
					(0.38)		(0.36)		(0.26)	
(3.5, 4.5]					-0.63		-0.48	†	-0.12	
					(0.38)		(0.25)		(0.2)	
> 4.5					-1.07	**	-0.96	***	-0.27	
					(0.32)		(0.2)		(0.23)	
Dummies TFR * GINI Index										
(<= 2.5) * Gini index							-0.97	***	-0.24	
							(0.11)		(0.19)	
(2.5, 3.5] * Gini index							0.12		0.35	
							(0.37)		(0.36)	
(3.5, 4.5] * Gini index							0.11		0.34	
							(0.22)		(0.2)	
(> 4.5) * Gini index							-0.15	†	0.02	
							(0.09)		(0.09)	
Survey year (ref: 1986-1989)										
1990-1994			-0.41		-0.41		-0.36		-0.24	
			(0.28)		(0.25)		(0.22)		(0.24)	
1995-1999			-0.50		-0.53	†	-0.54	*	-0.37	
			(0.31)		(0.28)		(0.24)		(0.24)	
2000-2004			-0.28		-0.33		-0.35	†	-0.26	
			(0.28)		(0.24)		(0.21)		(0.23)	
2005-2009			0.12		-0.08		-0.06		0.07	
			(0.3)		(0.28)		(0.25)		(0.25)	
2010-2014			-0.14		-0.24		-0.17		0.04	
			(0.28)		(0.27)		(0.24)		(0.25)	
2015-2018			0.21		-0.03		-0.03		0.34	
			(0.31)		(0.26)		(0.24)		(0.28)	
Region (ref: Asia)										
Former USSR									1.51	***
									(0.37)	
Latin America & the Caribbean									-0.39	
									(0.34)	
Middle-east & North Africa									0.67	*
									(0.3)	
Sub-Saharan Africa									-0.34	
									(0.37)	
West Africa									-0.53	
									(0.37)	
AIC	654		652		627		601		569	
Obsv.	227		227		227		227		227	

Note: Significance levels are presented as '***' 0.001, '**' 0.01, '*' 0.05, and '†' 0.1. Standard errors in parentheses are clustered at the country level.

TABLE T3 Standardized associations between income inequality and the mean age at first birth of the second subpopulation (μ2).

	M1		M2		M3		M4		M5	
	β	**Sig.**	**β**	**Sig.**	**β**	**Sig.**	**β**	**Sig.**	**β**	**Sig.**
Constant	-0.04		-0.28		0.90	**	0.83	***	-0.08	
	(0.12)		(0.19)		(0.29)		(0.22)		(0.26)	
GINI Index	0.09		0.14		0.09					
	(0.12)		(0.11)		(0.13)					
TFR group (ref: <=2.5)										
(2.5, 3.5]					-0.69	*	-0.81	*	-0.08	
					(0.34)		(0.35)		(0.29)	
(3.5, 4.5]					-1.07	***	-0.98	***	-0.39	*
					(0.3)		(0.23)		(0.19)	
> 4.5					-1.34	***	-1.29	***	-0.61	*
					(0.27)		(0.2)		(0.24)	
Dummies TFR * GINI Index										
(<= 2.5) * Gini index							-0.39	***	0.12	
							(0.1)		(0.21)	
(2.5, 3.5] * Gini index							0.39		0.25	
							(0.34)		(0.36)	
(3.5, 4.5] * Gini index							0.32	†	0.36	†
							(0.18)		(0.19)	
(> 4.5) * Gini index							-0.02		0.02	
							(0.07)		(0.09)	
Survey year (ref: 1986-1989)										
1990-1994			-0.02		-0.02		0.02		0.01	
			(0.25)		(0.23)		(0.21)		(0.23)	
1995-1999			-0.17		-0.23		-0.22		-0.24	
			(0.27)		(0.23)		(0.19)		(0.2)	
2000-2004			0.00		-0.07		-0.08		-0.11	
			(0.26)		(0.2)		(0.17)		(0.2)	
2005-2009			0.42	†	0.13		0.14		0.09	
			(0.25)		(0.22)		(0.19)		(0.21)	
2010-2014			0.39		0.24		0.28		0.22	
			(0.25)		(0.22)		(0.2)		(0.2)	
2015-2018			0.71	**	0.35		0.33		0.45	†
			(0.26)		(0.24)		(0.23)		(0.27)	
Region (ref: Asia)										
Former USSR									1.91	***
									(0.29)	
Latin America & the Caribbean									0.43	
									(0.41)	
Middle-east & North Africa									0.65	†
									(0.36)	
Sub-Saharan Africa									0.19	
									(0.39)	
West Africa									0.26	
									(0.39)	
AIC	657		650		611		599		577	
Obsv.	227		227		227		227		227	

Note: Significance levels are presented as '***' 0.001, '**' 0.01, '*' 0.05, and '†' 0.1. Standard errors in parentheses are clustered at the country level.

TABLE T4 Standardized associations between income inequality and the standard deviation of the mean age at first birth of the first subpopulation (σ1).

	M1		M2		M3		M4		M5	
	β	**Sig.**	**β**	**Sig.**	**β**	**Sig.**	**β**	**Sig.**	**β**	**Sig.**
Constant	-0.02		-0.15		-0.42		-0.44		-0.45	
	(0.11)		(0.26)		(0.33)		(0.32)		(0.46)	
GINI Index	-0.07		-0.06		-0.07					
	(0.11)		(0.11)		(0.12)					
TFR group (ref: <=2.5)										
(2.5, 3.5]					0.41		0.28		-0.02	
					(0.27)		(0.26)		(0.3)	
(3.5, 4.5]					0.09		0.14		-0.02	
					(0.28)		(0.26)		(0.27)	
> 4.5					0.35		0.35		0.14	
					(0.24)		(0.24)		(0.29)	
Dummies TFR * GINI Index										
(<= 2.5) * Gini index							-0.29	†	-0.79	**
							(0.16)		(0.28)	
(2.5, 3.5] * Gini index							0.18		0.12	
							(0.23)		(0.27)	
(3.5, 4.5] * Gini index							0.16		0.11	
							(0.19)		(0.22)	
(> 4.5) * Gini index							-0.24	†	-0.14	
							(0.14)		(0.13)	
Survey year (ref: 1986-1989)										
1990-1994			0.39		0.39		0.42		0.43	
			(0.32)		(0.31)		(0.28)		(0.29)	
1995-1999			0.01		-0.01		0.01		0.09	
			(0.35)		(0.35)		(0.33)		(0.33)	
2000-2004			0.02		-0.01		0.00		0.12	
			(0.32)		(0.33)		(0.3)		(0.31)	
2005-2009			0.26		0.28		0.27		0.45	
			(0.32)		(0.33)		(0.3)		(0.32)	
2010-2014			0.13		0.11		0.11		0.29	
			(0.3)		(0.32)		(0.29)		(0.31)	
2015-2018			0.06		0.12		0.09		0.20	
			(0.33)		(0.34)		(0.33)		(0.34)	
Region (ref: Asia)										
Former USSR									-0.94	†
									(0.55)	
Latin America & the Caribbean									0.35	
									(0.42)	
Middle-east & North Africa									0.52	
									(0.34)	
Sub-Saharan Africa									-0.24	
									(0.43)	
West Africa									0.38	
									(0.43)	
AIC	653		662		664		660		647	
Obsv.	227		227		227		227		227	

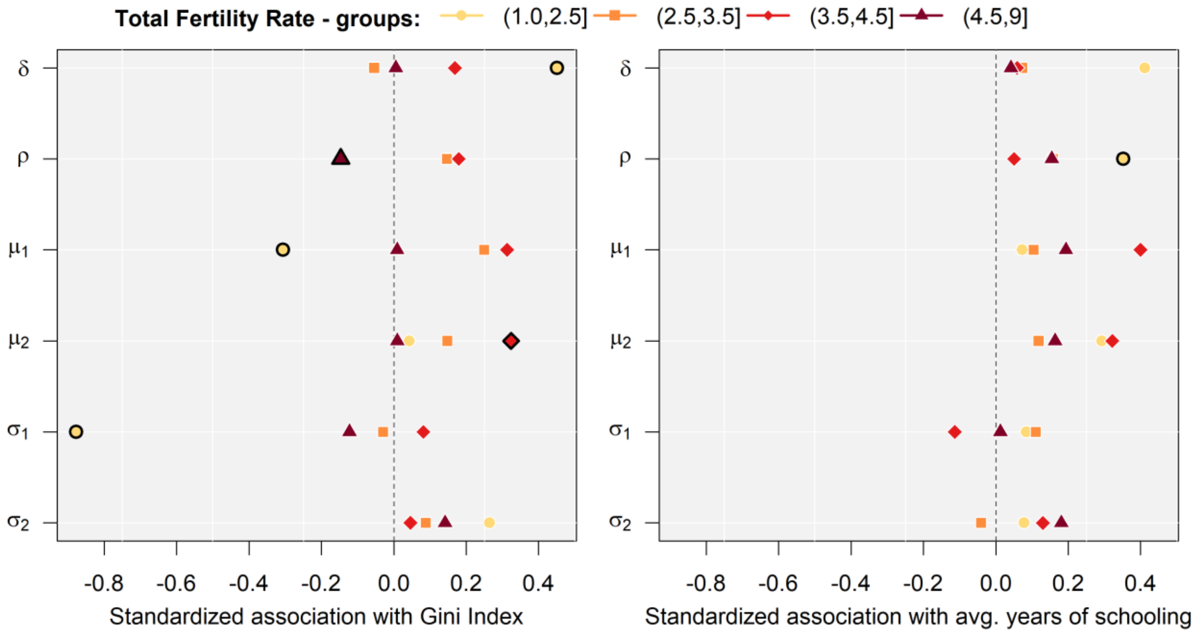
Note: Significance levels are presented as '***' 0.001, '**' 0.01, '*' 0.05, and '†' 0.1. Standard errors in parentheses are clustered at the country level.

TABLE T5 Standardized associations between income inequality and the standard deviation of the mean age at first birth of the second subpopulation (σ2).

	M1		M2		M3		M4		M5	
	β	**Sig.**	**β**	**Sig.**	**β**	**Sig.**	**β**	**Sig.**	**β**	**Sig.**
Constant	-0.05		-0.54	*	-0.21		-0.25		-0.88	**
	(0.08)		(0.22)		(0.27)		(0.26)		(0.29)	
GINI Index	0.29	***	0.30	***	0.30	***				
	(0.07)		(0.07)		(0.07)					
TFR group (ref: <=2.5)										
(2.5, 3.5]					-0.32		-0.45	*	0.07	
					(0.21)		(0.22)		(0.22)	
(3.5, 4.5]					-0.60	**	-0.59	**	-0.17	
					(0.2)		(0.2)		(0.17)	
> 4.5					-0.17		-0.16		0.06	
					(0.18)		(0.17)		(0.23)	
Dummies TFR * GINI Index										
(<= 2.5) * Gini index							0.27	**	0.31	†
							(0.09)		(0.16)	
(2.5, 3.5] * Gini index							0.54	**	0.14	
							(0.16)		(0.22)	
(3.5, 4.5] * Gini index							0.25	**	0.06	
							(0.09)		(0.12)	
(> 4.5) * Gini index							0.26	*	0.11	
							(0.13)		(0.1)	
Survey year (ref: 1986-1989)										
1990-1994			0.44		0.43		0.45		0.31	
			(0.3)		(0.3)		(0.3)		(0.28)	
1995-1999			0.42		0.39		0.40		0.19	
			(0.29)		(0.3)		(0.29)		(0.28)	
2000-2004			0.30		0.27		0.30		0.13	
			(0.28)		(0.3)		(0.29)		(0.28)	
2005-2009			0.48	†	0.38		0.43		0.20	
			(0.26)		(0.29)		(0.27)		(0.29)	
2010-2014			0.73	**	0.65	*	0.70	**	0.37	
			(0.25)		(0.27)		(0.26)		(0.28)	
2015-2018			0.54	†	0.39		0.42		0.17	
			(0.28)		(0.3)		(0.29)		(0.31)	
Region (ref: Asia)										
Former USSR									1.14	***
									(0.19)	
Latin America & the Caribbean									0.89	**
									(0.28)	
Middle-east & North Africa									0.07	
									(0.27)	
Sub-Saharan Africa									0.66	*
									(0.29)	
West Africa									0.80	**
									(0.29)	
AIC	622		626		623		627		616	
Obsv.	227		227		227		227		227	

Note: Significance levels are presented as '***' 0.001, '**' 0.01, '*' 0.05, and '†' 0.1. Standard errors in parentheses are clustered at the country level.

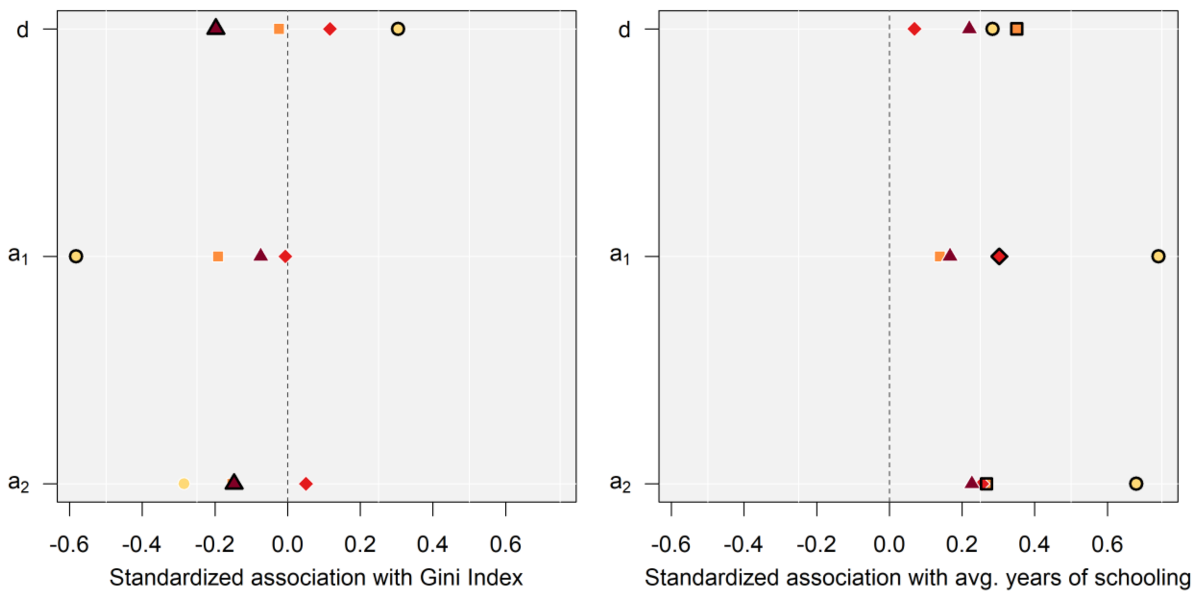
FIGURE A2 Standardized associations between two-population mixture models' indicators, and the Gini index (left panel) and mean years of schooling for women (right panel). Black borders indicate statistically significant associations, (p-value < 0.1).



Note: These associations are estimated using an interaction term between the four TFR groups and the Gini index in a multivariate model that includes dummy variables for the survey year, world regions (as in Table 2), and the gross national income per capita based on purchasing power parity. Standard errors are clustered at the country level.

Interpretation: These results resemble those presented in Figure 6. There are, however, two main differences for the Gini index: (i) the negative association between income inequality and μ1 is slightly stronger and statistically significant for countries with TFRs below 2.5; and (ii) the positive association between income inequality and σ2, although similar in magnitude to the association presented in Figure 6, is not statistically significant. For the mean years of schooling, we find that while some associations are slightly stronger, the direction and the statistical significance of the association do not change compared to those reported in Figure 6.

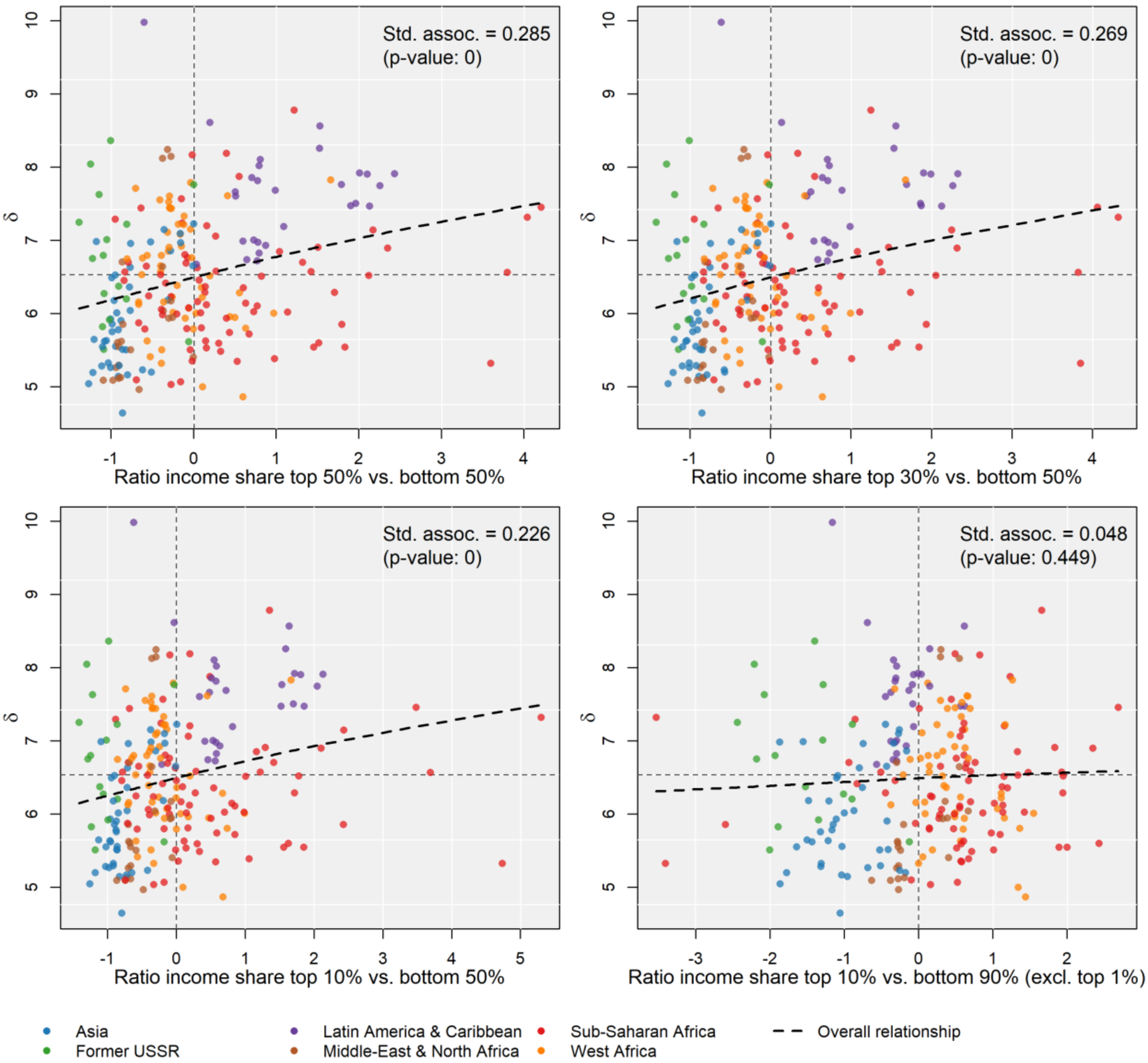
FIGURE A3 Standardized associations between non-parametric indicators of first birth schedules, and the Gini index (left panel) and mean years of schooling for women (right panel). Black borders indicate statistically significant associations, (p-value < 0.1).



Note: These associations are estimated using an interaction term between the four TFR groups and the Gini index in a multivariate model that includes dummy variables for the survey year, world regions (as in Table 2), and the gross national income per capita based on purchasing power parity. Standard errors are clustered at the country level.

Interpretation: These results demonstrate that our conclusions are not driven by the choice of the parametric approach. To make these results comparable, we use the model specification that includes all of the control variables and the interaction term with the TFR group dummies (equivalent to M5 in the Table 2). Figure A3 in the appendix presents the associations for each of the TFR groups, along with their statistical significance. Income inequality is shown to be positively associated with the spread of s-ASFBR among countries with TFRs below 2.5 (positive and statistically significant coefficient for the d indicator, std. assoc. = 0.31). This positive association is driven by a negative association between the Gini index and the a1 indicator (std. assoc. = -0.58). The reverse is found to be the case for countries with TFRs above 4.5; i.e., there is a negative association between income inequality and the d indicator (std. assoc. = -0.19), driven by a negative association between inequality and the a2 indicator (std. assoc. = -0.15). All of the other associations are relatively small in magnitude, and are non-statistically significant.

FIGURE A4 Bivariate association between the divergence of fertility schedules (δ) and income-concentration measures from the World Inequality Database.



Note: Authors' calculation based on data from the World Inequality Database. The ratios of income share are averaged over the 10 years prior to each survey. The axes are drawn at the average of each variable, and the background lines are separated by one standard deviation from each other.

Interpretation: These associations are in line with our main results. A higher concentration of economic resources is associated with the divergence of first birth schedules (std. assoc. between 0.23 and 0.29, p-values < 0.001). These associations are comparable in size to the bivariate correlations between the Gini index and first birth dispersion (0.33, as reported in Table 2). The only exception is the association between δ and the last income-share ratio; which means that extreme concentration is not associated with first birth dispersion (std. association = 0.048, p-value = 0.449).

Notes

Acknowledgments: We gratefully acknowledge the support of the University of Pennsylvania that hosted Dr. Batyra as a postdoctoral fellow while this research was conducted. Dr. Batyra's postdoctoral fellowship was funded through the Global Family Change Project that received funding from the National Science Foundation (Grant no. 1729185, PIs: Kohler & Furstenberg). We are thankful to the Population Association of America for allowing us to present a previous version of this work during the 2020 annual meeting.

[1] Argentina – 2011-12 Multiple Indicator Cluster Survey; Brazil - 2006 Pesquisa Nacional de Demografia e Saúde da Criança e da Mulher; Chile – 2011 and 2015 Encuesta de Caracterización Socioeconómica Nacional; Ecuador – 2004 Encuesta Demográfica y de Salud Materna e Infantil, Mexico – Encuesta Nacional de Dinámica Demográfica: 1992, 1997, 2006, 2009, 2014, and 2018, Uruguay- Harmonized Histories of the Generations and Gender Program Data Archive from the 2015 Encuesta de Comportamientos Reproductivo. We thank the Generations and Gender Programme for giving us access to the harmonized life histories for Uruguay; in particular to the seven researchers from the Universidad de la República (Uruguay) and the Max Planck Institute for Demographic Research (Germany) who produced these data. See the full list of researchers here: https://www.ggp-i.org/data/harmonized-histories/.

[2] The median country-level sample size in our analysis is 5,706 women. A five-year reference period, although conventionally used when estimating fertility indicators from DHS, yields unreliable sample sizes for several countries (median sample size of 4,277 women). To ensure that our results are not sensitive to the choice of the reference period, we replicated our analysis using a five-year period. Results are consistent between the two specifications, but we chose the 10-year reference period because the age-specific first birth rates are less erratic.

[3] Alternative time lags yielded consistent results. More backwards time lags yield similar results, while future time lags produce non-significant patterns.

[4] The sample size prevents us from testing interaction terms with regional dummies. To ensure comparability across outcome variables, we report standardized relationships; i.e., the change in standard deviations in the dependent variable associated with a one-standard-deviation change in the predictor. Standard errors are clustered at the country level to account for the nested structure of our data.

[5] We conducted this assessment by examining the number of times the derivative of the smoothed-ASFBR changed sign over age. A change from a positive to a negative sign indicates a concave hump, and a change from a negative to a positive sign indicates a convex hump. Three changes in the sign of the derivative over age indicate a two-hump-and-one-valley curve.

[6] Note that increases in the mean years of schooling should be higher when measured in single years instead of 10-year averages.

[7] Note that if the risk of first birth is strongly concentrated at early ages, d would be small because a large portion of the total area under the age-specific first birth risk curve would be concentrated within early ages. Conversely, if the risk of first birth is more spread out due to the postponement of the first birth (potentially by a subgroup of the population), then d should be larger.