Educational Gender Inequality in Sub-Saharan Africa: a Long-term Perspective

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Abstract:

To what extent did sub-Saharan Africa's 20th century schooling revolution benefit boys and girls equally? Using census data and a cohort approach, we examine gender gaps in years of education over the 20th century at world region, country and district levels. First, we find that compared to other developing regions, Africa had a small initial educational gender gap but subsequently made the least progress in closing the gap. Second, in most of the 21 African countries studied, gender gaps increased during most of the colonial era (ca. 1880-1960) and declined, albeit at different rates, after independence. On the world region and country level, the expansion of men's education was initially associated with a growing gender gap, and subsequently a decline, a pattern we refer to as "educational gender Kuznets curve." Third, using data from 6 decadal cohorts across 1,177 birth districts, we explore sub-national correlates of educational gender inequality. This confirms the inverse-U relationship between the gender gap and male education. We also find that districts with railroads, more urbanization and early 20th century Christian missions witnessed lower attainment gaps. We find no evidence that cash crop cultivation, agricultural division of labor or family systems were linked to gender gaps.

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Introduction

While sub-Saharan Africa (SSA) has a poor and erratic record of economic growth over the long 20th century, its sustained expansion of education is beyond dispute. Primary school enrollment rose from 6 percent of school-aged children in 1910 to 78 percent in 2018 (Barro and Lee 2015; UNESCO 2020). Average educational attainment increased from 0.2 years of schooling in 1900 to 2.3 in 1970 and 5.7 in 2010 (Barro and Lee 2015). Despite this significant progress, SSA's educational expansion was highly uneven, with certain regions and particular sections of the population benefiting earlier and more than others.

Gender was a major fault line, as boys benefitted disproportionally from emerging educational opportunities. In many developing countries women have caught up and sometimes even today outperform men in terms of school attainment (Grant and Behrman 2010; Psaki et al. 2018; Bossavie and Kanninen 2018). SSA, however, not only exhibits the lowest level of education worldwide[2] but also the highest degree of schooling inequality in favor of boys (Psaki et al. 2018; UNICEF 2020). Twelve (15) out of the 17 (20) countries in the world where girls have not yet caught up with boys in primary (lower secondary) school enrolment are located in SSA (UNESCO 2019).

Gender equality in education has been linked to a great variety of favorable outcomes for women, their households, and for society as a whole. Such positive outcomes include women's economic and political participation later in life (World Bank 2017), lower fertility and reduced incidence of early marriage (Lloyd et al. 2000; Duflo et. al. 2015; Boahen and Yamauchi 2018; Kebede et al. 2019), reduced child mortality (Makate and Makate 2016; Keats 2018; Andriano and Monden 2019), improved family well-being (Abuya et al. 2012; Pratley 2016), and economic growth (Klasen 2002; Baliamoune-Lutz and McGillivray 2009; Klasen and Lamanna 2009). It is thus crucial to understand the origins and drivers of African women's educational attainment relative to men's.

In this article, we trace and take a first step towards exploring and explaining gender inequality in education across SSA over most of the 20th century – thus covering the rise of African mass-education. To trace educational gender inequality over time, we rely on census data and apply a cohort approach, selecting individuals aged 25-80 years. We assign men's and women's acquired years of education to their region, country or district of birth. We reconstruct the absolute *gender gap in years of education* covering approximately 15.8 million individuals across 21 countries and 1,177 districts.

Gender gaps are obviously shaped by policy decisions on the national level. However, since they are also highly heterogeneous within individual countries, it is important to explore sub-national variation. While existing datasets (e.g., Barro and Lee 2013; Lee and Lee 2016) provide time series of educational attainment of men and women at the *country-level*, the use of individual-level data enables us to also investigate historical educational gender gaps in Africa at the *sub-national level*. Our regression analysis does not identify causal relationships, but rather explores relevant initial and dynamic local conditions that plausibly contributed to educational gender inequality in the long-run, including religion, agriculture, family systems, urbanization and educational expansion. Unlike earlier "persistence" studies that have linked historical determinants, such as Christian missionary presence (Nunn 2014; Montgomery 2017) or colonial cash crop agriculture (Miotto 2019), to present-day gender-biased education outcomes in SSA, our paper offers a *dynamic* perspective, showing that gender gaps shifted significantly over the 20th century. In our regional analysis, we control for spatial autocorrelation (Kelly 2019).

We analyze gender gaps at three levels of aggregation. First, we place Africa's trajectory into perspective by comparing SSA to South Asia, Southeast Asia and the Middle East and North Africa (MENA). In each region, we find that the educational gender gap first rose and subsequently declined over time and as male education expanded, a relationship that we refer

to as the "educational gender Kuznets curve." While SSA's progression to gender equality was the slowest over time, SSA also had the lowest level of educational gender inequality at each level of male educational expansion. This leads us to conclude that Africa's comparatively gender unequal outcomes today are linked to its lower levels of overall educational expansion, rather than region-specific gender biases. Second, we compare long-term trajectories of the educational gender gap across African countries. We document significant cross-country heterogeneity. Most former French colonies progressed slowly in closing the gender gap in educational attainment, which we link to their slower overall educational expansion. Southern Africa's gender gaps were remarkably small. Third, we analyze gender gaps at the district level for three periods (1920-39, 1940-59, 1960-1979), using decadal birth cohorts. We explore various initial and dynamic factors associated with gender gaps. We find that districts with large cities, coastal location and railroad connection had significantly lower educational gender inequality. We also find that districts treated by intensive and early Christian missionary activity witnessed lower educational gender inequality. We do not find evidence that agricultural practices, such as cash crop cultivation, were significantly associated with gender gaps.

Our study makes a contribution at the intersection of two empirical literatures on schooling outcomes. First, we relate to a thriving empirical scholarship on long-term patterns and determinants of gender differences in educational attainment in Europe and the US (Goldin et al. 2006; Becker and Woessmann 2008; Bertocchi and Bozzano 2016; Baten et al. 2017), Latin America (Duryea et al. 2007; Baten and Manzel 2009), and Asia (Friesen et al. 2012).[3] Second, we contribute to an expanding literature that traces colonial Africa's expansion of formal education, human capital formation and educational mobility, which has so far focused primarily on boys and men (Frankema 2012; Cogneau and Moradi 2014; Dupraz 2019; Juif 2019; Alesina et al. 2021; Cappelli and Baten 2021).

There are some studies at the intersection of these two literatures, looking at trends in African gender gaps. Alesina et al. (2021, Figure 3) examine intergenerational mobility in education for 26 African countries, 1960s-1990s, reporting lower mobility for girls in the Sahel region. Barro and Lee (2015, Table 2.10) present decadal female-male ratios of years of schooling (1870-2010) for SSA as a whole. Cogneau and Moradi (2014) measure boys-girls enrollment ratios for colonial Ghana and Togo for several reference years. Evans et al. (2021) as well as Psaki et al. (2018) trace gender attainment and enrollment gaps across middle- and low-income countries, from 1960-2010 and 1997-2014 respectively. Meier zu Selhausen (2014), Meier zu Selhausen and Weisdorf (2016) and De Haas and Frankema (2018) trace gender gaps in colonial and post-colonial Uganda. Our study further advances this literature by tracing and interpreting gender gaps over the 20th century continent-wide, and in a large number of countries and sub-national regions across SSA.

We also contribute to a diverse body of studies that explore correlates and drivers of educational gender gaps across countries and regions. Some studies have linked educational gender inequality to structural differences between spatial units. For example, Norton and Tomal (2009), Platas Izama (2014) as well as Alesina et al. (2021) compare gender gaps between Muslims and Christians. Nunn (2014) and Montgomery (2017) show positive effects of historical Protestant and Catholic missionary presence on educational gender equality today. Miotto (2019) finds that colonial legacies of cash crop farming are linked to better female educational outcomes today, while Ashraf et al. (2020) have linked the cultural practice of bride price to lower educational gender inequality. Others, in contrast, have emphasized that gender gaps are dynamic within spatial units over time, and endogenously linked to processes of economic change and educational expansion itself. Both Psaki et al. (2018) and Evans et al. (2021) stress that a country's stage of educational development provides critical context for evaluating progress in achieving gender parity in years of education. Studies on contemporary gender gaps similarly observe rapid narrowing or even reversal of gender gaps in developing

countries, which attests to their dynamic nature (Grant and Behrman 2010; Jones and Ramchand 2016).

"Local-structural" and "temporal-dynamic" explanations of gender gaps are not inconsistent with each other, but place different emphasis and have divergent policy implications. If gender gaps are primarily dynamic, the implication is that they can be best resolved through investment in overall educational expansion. If they are structural, region-specific biases toward female education should be identified and tackled. Our multi-level and long-run study design allows us to analyze these different types of explanations jointly. On the one hand, we find that gender gaps are highly dynamic, following an inversely U-shaped trajectory as educational attainment expands. On the other hand, we unpack the structural forces that are associated with the magnitude of gender gaps along such trajectories in some countries and districts compared to others, such as missionary exposure and urbanization. The next section justifies the inclusion of various correlates and states our expected findings, based on theory and earlier empirical studies.

The paper proceeds as follows. We first expand on the theory and previous empirical literature that shaped the scope of our investigation. Second, we present the data and method. Third, we (i) compare long-term patterns of educational gender inequality in SSA with other colonized world regions where mass education expanded over the twentieth century, (ii) analyze country trajectories in SSA (iii) explore various initial and dynamic factors on Africa's sub-national level that are associated with educational gender inequality 1920-1979 in a multivariate regression framework. Finally, we discuss those findings.

Educational gender inequality in Africa: theory and literature

Educational expansion

Based on educational attainment from the 1960s onwards, Evans et al. (2021, 7) find that absolute gender gaps in education "often got worse before they got better," as overall education attainment increased from very low levels. However, evidence on such inverse U-shaped trajectories of gender gaps in Africa before 1960 is limited, despite the fact that many African countries had witnessed substantial educational expansion by this time. Based on data on male and female literacy and numeracy as well as occupational status and marriage ages of Christians in and close to Kampala (Uganda), Meier zu Selhausen and Weisdorf (2016) observe a "gender Kuznets curve" between ca. 1900 and 1960, peaking in the 1920s. Based on more representative census data on numeracy, literacy and years of education, De Haas and Frankema (2018) confirm this inverse U-curve over time, but date its peak much later, during the 1950s, just before independence.

In this paper, we further investigate this "educational gender Kuznets curve." Most importantly, we hypothesize that regularities in the trend of attainment gender gaps are not primarily linked to time, but to the expansion of (male) education. As has been shown across various societies, including in Asia (Friesen et al. 2012) and Latin America (Manzel and Baten 2009), boys tend to accumulate substantially more years of education than girls in the early stages of educational expansion. Consequently, they develop an increasing educational lead over girls. At some point, as most boys have attained a certain amount of schooling, demand for further male education begins to diminish. The level at which this occurs depends on labor market dynamics and skills demand, which differed across time and space in SSA (Frankema and van Waijenburg 2019). All the while, schooling opportunities for girls continue to expand, resulting in a reduction of the gender gap. Rising attainment inequality between men and women may also be slowed down and eventually reversed when too much gender inequality is considered undesirable from a labor market and marriage market perspective (Meier zu Selhausen and Weisdorf 2020). The flattening off and subsequent reversal of the attainment gender gap is at least partially driven by educational expansion itself, as educated fathers tend to see value in girls' education and are

therefore more likely to send their daughters to school (Coquery-Vidrovitch 1997:151; De Haas and Frankema 2018; Meier zu Selhausen and Weisdorf 2016, 2020).

Our key interest is to compare African educational gender Kuznets curves with other world regions, across African countries and across sub-national regions. We not only expect to find such curves, but also seek to exploit variations in the timing of their peaks, both in time and along educational expansion trajectories, to obtain a better understanding of the extent to which local and structural factors, such as cultural attitudes and colonial legacies, are associated with educational gender inequality. We expect that the gender Kuznets curve itself accounts for a substantial share of the variation in gender gaps observed over time and at our three different levels of observation.

Openness

During the 20th century, SSA experienced a dramatic increase of outward orientation, both in terms of trade integration with world markets and exposure to new cultural, religious and social influences (Cooper 1981, 2014; Bayart and Ellis 2000). This process, which we refer to as "openness," was spatially uneven.[4] Coastal, urban and railroad-connected areas were exposed sooner and more intensely. We expect that more open regions are associated with lower gender inequality in education. Trade and urbanization generated new income opportunities and resulted in greater demand for labor in urban areas, quelling anxiety among men about female competition for jobs and creating incentives to extend education to women (Elkan 1957; Boserup 1970; de Haas and Frankema 2018). Moreover, new occupational strata, family arrangements and "modern" identities emerged in urban areas over the colonial era (Elkan 1960; Meier zu Selhausen et al. 2018). Cities were often hubs of early educational expansion for men and also attracted educated labor migrants, who were subsequently more likely to send their urban-born daughters to school. Such demand for female education was met by supply, as urban areas were typically the first to cater for female secondary education and increasingly

provided administrative, teaching and nursing jobs from the late colonial era onward (Obbo 1980; Leach 2008; Meier zu Selhausen and Weisdorf 2021). Railroads, built to connect mines and cash crop regions to ports, played a crucial role in connecting remote rural areas in the interior to coastal urban areas. Moreover, urban agglomerations themselves tended to emerge along railroads, an effect that persisted even as, after independence, railroads lost their colonial function (Jedwab and Moradi 2016; Jedwab et al. 2017).

Colonizer identity

Several historical studies have found uneven educational expansion across colonizers; in particular, lower enrollment in French than British colonies (Frankema 2012; Cogneau and Moradi 2014; Dupraz 2019; Guarnieri and Rainer 2021). As overall educational expansion progressed more slowly in French colonies, we should expect (former) French colonies to occupy earlier stages of the educational gender Kuznets curve than their (former) British counterparts. If we follow the inverse U-shaped logic of the curve, this implies that French colonies initially should have had smaller gender gaps than British colonies, but also experienced a widening of their gender gaps as education expanded in the post-colonial period from very low levels while (former) British colonies had already reached their attainment gap peak and were on a trajectory towards lower educational gender inequality. At the same time, we have no reason to expect different degrees of structural gender bias among colonizers. Thus, we should expect gender gaps to be similar at each level of male educational expansion (i.e. along the gender Kuznets curve). Potentially, mandated territories (former German colonies) had smaller gaps than colonies proper, since they had to report educational statistics to the League of Nations, a modicum of accountability towards the international community that may have been associated with better educational outcomes for girls (Pedersen 2015, 134). We are agnostic about the trend of the gender gap in countries that were not or only briefly colonized (Ethiopia and Liberia, in the case of SSA).

Religion

Christian missions provided the bulk of formal education in colonial Africa, particularly in British colonies and especially before the 1930s (Frankema 2012; Meier zu Selhausen 2019). Various studies have observed substantial positive effects on local contemporary educational outcomes of missionary activities during early colonial times (Gallego and Woodberry 2010; Wantchekon et al. 2015; Jedwab et al. 2019; Alesina et al. 2021; Cappelli and Baten 2021). Historians have suggested, though, that missionaries promoted patriarchal social order, and disproportionally allocated educational resources to boys (Egbo 2000; Bantebya Kyomuhendo and McIntosh 2006; Hanson 2010). As a result, girls received not only fewer years of education, but also lower quality, which further disincentivized parents to educate their daughters, although female missionaries may have more actively promoted girls' education.

Nevertheless, there is a substantial literature that argues for a positive association between missionary schooling, especially by Protestants, and female educational advancement and gender equality in education. Nunn (2014) finds that Protestant missionary exposure in early colonial Africa is associated with more female years of education today, while Catholic missionary exposure is associated with greater male educational attainment. Montgomery (2017) establishes a positive effect of both Protestant and Catholic missions on male and female years of education in Tanzania, but like Nunn (2014) observes that Protestant missionary legacies are linked to smaller present-day gender gaps, while Catholic missions are linked to larger gaps.[5] At the same time, it has been argued that the Catholic tradition of gender-segregated schooling made girls' attendance more palatable to conservative parents, and increased their educational attainment, at least quantitatively (the curriculum would still be focused on religious devotion and domesticity) (Coquery-Vidrovitch 1997: 155). Based on these previous findings and considerations, we expect consolidated missionary presence to be

associated with smaller educational gender gaps. We also expect Protestant missions to be more strongly associated with gender equality.

Large regions of Africa, especially the West African interior and East African coast, have deep Islamic roots which predated European presence. In many Islamic areas, colonial governments and Christian missionaries played only a marginal role in the provision of education. As a result, Muslims tended to have lower educational attainment than their Christian counterparts, both within and across countries (Platas Izama 2014). Based on the analysis of global data, Norton and Tomal (2009) conclude that Islam on average exerts a negative influence on female schooling. However, detailed case studies on pre-colonial Sokoto Caliphate Nigeria (Boyd and Last 1985) and colonial Zanzibar (Decker 2006) have shown that Islam cannot be considered uniformly incompatible with female education. Moreover, Coquery-Vidrovitch (1997, 151) points out that African Muslims sent their children to public rather than missionary schools, which may have affected girls' opportunities more than religion per se. Globally, cross-country regressions including countries with large Muslim populations fail to find a statistically significant effect of Islam on the educational gender gap for birth cohorts aged 25–34 in 2010 (McClendon et al. 2018). While Islam is a relevant variable to explore, we acknowledge its heterogeneous nature across Africa, pointed out in previous literature, and do not expect it to be associated with the size of gender gaps as long as we control for male education (the Kuznets curve effect).

Agriculture

We consider three dimensions of agriculture. First, we examine cash crops and gender gaps. Cash crops were central to African colonial economies, and are associated with sharp spatial inequalities, past and present (Roessler et al. 2020). Even if cash crops expanded economic opportunities, it has been argued that their introduction also undermined the status of women, as men tended to control most cash crop income, while women were pressured to provide

increased non-remunerated agricultural labor inputs. Such dynamics were reinforced by colonial authorities who focused their efforts to promote cash crops on men and treated women and children as "family labor" (Boserup 1970; Whitehead 1990; Byfield 2018). Rising opportunity costs of going to school in a context of increased demand for agricultural labor may have reduced girls' access to school and widened educational gender gaps. More indirectly, women's loss of status, power and economic autonomy associated with cash cropping under colonial rule may have reduced the perceived value of girls' skills accumulation and thus demand for education, further compounding educational gender gaps. Nevertheless, Miotto (2019) reports a positive long-run effect of colonial-era cash crop agriculture on women's status today, measured as household bargaining power, less willingness to justify husbands' violence, and higher levels of education. She argues that this effect is driven by increased female labor force participation in the cash crop economy, which benefited girls' education. However, Miotto does not address attainment gender gaps per se. In sum, we expect cash crop regions to exhibit larger education gender gaps.

Second, we explore spatial variation in pre-colonial gender division of labor in agriculture. In her landmark study, Ester Boserup (1970, 16) posited that "Africa is the region of female farming par excellence." However, she also noted that there was considerable variation in terms of male and female roles in agriculture across African societies, a point that has been emphasized by other scholars as well (Alesina et al. 2013; Baumann 1928; Whitehead 1990). The agricultural division of labor may have affected educational gender inequality. Boserup herself argued that traditional agricultural practices play a crucial role in shaping societies' variation in gender roles more broadly, reasoning that women's lack of participation in agriculture resulted in the development of unequal gender norms, relegating women into domestic duties and seclusion. The clearest example of such a practice is plough-based agriculture, which historically relied on upper body strength (male task) and required less weeding (female task). Studying the long-run effects of traditional plough use on gender norms

and female labor force participation in a global context, Alesina et al. (2013) find evidence for this theory.

Following Boserup (1970), we may expect that the more involved women were, the more equal gender norms emerged and the smaller educational gender inequality was. Conversely, one might argue that the opportunity cost of girls' education was higher in female farming systems, which would reduce their participation in education. Based on these considerations, we expect lower gender inequality in female farming systems, but also that this effect is negated in regions that were deeply involved in cash crop production, which increased the opportunity cost of girls' education.

Livestock-oriented societies in eastern and southern Africa tended to be deeply patriarchal, valuing male hunting and herding activities over female domestic ones (Coquery-Vidrovitch 1997). However, the effect of pastoralism on the educational gender gap is not obvious. On the one hand, we may expect more female seclusion in pastoral societies, as men were primarily responsible for herding and hunting and women tended to stay behind in the compounds. Following Boserup (1970) and Alesina et al. (2013), we would expect this to result in more gender inequality, which may in turn translate into a larger educational gender gap. For education, however, a specific opposite mechanism may counteract this: boys' absence from home and a culture that glorified livestock and discounted the value of modern education for the most valued members of society may have produced opportunities for stay-at-home girls to receive (missionary) education. Several scholars have observed that women's relative immobility has resulted in low gender gaps in Southern Africa, Botswana and Lesotho in particular, where boys were absent herding cattle, as well as engaging in labor migration, leaving girls behind to populate schools (Coquery-Vidrovitch 1997: 148, 154; Stromquist 2007: 157; Mafela 2008: 338). Due to these heterogeneous mechanisms, we do not expect to find a strong correlation between pastoralism and educational gender gaps.

Family systems

Finally, family systems that regulate degrees of female autonomy can also be expected to affect educational gender inequality. Van der Vleuten (2016), for example finds a strong correlation between the value assigned to women in the family and the educational gender ratio in developing regions during 1950-2005. Bride price, which is a payment at marriage by the groom or his family to the bride's family, gives the latter an incentive to invest in their girls' education (Lowes and Nunn 2018; Ashraf et al. 2020); as opposed to dowry, which is paid by the bride's family. On the other hand, it has been shown that adverse shocks to family income can increase girls' chances of early marriage at the expense of their education (Archibong and Annan 2020; Corno and Voena 2016; Björkman-Nyqvist 2013). Patrilineal systems, where property is passed on through the male line, are likely to see gender discrimination in favor of boys, while matrilineal systems have better outcomes for girls (Holden and Mace 2003; Henderson and Whatley 2014). Polygamy, a long-established practice in most SSA countries (Fenske 2012), is associated with lower female status, in the case of additional wives (United Nations General Assembly 1979). Thus, we expect that family systems that suppress female autonomy, involving dowry, patrilineal inheritance and polygamy, are associated with larger gender gaps.

Data and methods

We analyze attainment gender gaps in SSA over the twentieth century (i) in a *world-region* comparative perspective, (ii) at the *country level*, and (iii) at the *sub-national (district) level*. Since we are interested in historical changes in gender differences in educational attainment, rather than accumulated human capital of men and women, we do not consider the stock of education in the entire population at a certain moment in time, but instead use a *flow* approach,

tracing the average years of education completed[6] for birth cohorts of men and women per world region, country and district. We then calculate the gender gap in educational attainment by subtracting the average level of educational attainment among women from the average level of educational attainment among men, assuming constant returns to education regardless of the absolute level.[7] Hence, a positive value indicates that men are more educated than women and vice versa. Table 1 summarizes the geographical scope, data sources, sample sizes and cohorts as well as units of observation.

Measuring sub-Saharan African gender gaps in a global historical perspective

We compare gender inequality in SSA to other developing regions with similar levels of educational expansion in the 20th century using the dataset by Barro and Lee (2013) that provides world-wide data on male and female years of education completed for 5-year age cohorts (15-74) for 5-year intervals in the 1950-2010 period, based on census data.[8] Their estimates for each interval are corrected for selective mortality (i.e., educated people may live longer). We use their dataset to trace country-level male and female education back to the early 20th century. To identify the birth year, we consider the year of census enumeration minus the age at enumeration. We transformed the repeated 5-year cohorts in Barro and Lee (2013) into a single 10-year (e.g., 1920-1929) gender gap (i.e., male minus female years of education completed) trend for each country by taking arithmetic averages of the two relevant 5-year cohorts.[9] We then compute regional arithmetic averages on the basis of countries' average educational gender gap, as weighted averages would let South Asia be dominated by India and Southeast Asia by Indonesia. Pre-1890 birth decades were dropped due to potential survivorship bias (as discussed below).

Measuring gender gaps over time in sub-Saharan African countries

Our *cross-country* analysis of educational gender gaps is based upon aggregated individual-level data, retrieved from *IPUMS International* (Minnesota Population Center 2019). IPUMS provides 63 harmonized, representative census samples, covering ~10% of country's population on 24 SSA countries between 1960 and 2013. We restrict our sample to the earliest and latest census years for each country recording both *age* and *years of education completed*. This leaves us with data from 36 national censuses for 21 countries on about 43 million individuals from Benin, Botswana, Burkina Faso, Cameroon, Ethiopia, Ghana, Guinea, Kenya, Lesotho, Liberia, Malawi, Mali, Nigeria,[10] Rwanda, Senegal, Sierra Leone, South Africa, Tanzania, Uganda, Zambia, and Zimbabwe. As of 2020, those sampled countries were home to about 650 million people, representing approximately 60 percent of SSA's population. We construct the absolute gap between male and female years of education completed, analogous to the world region analysis above, except that we use 5-year birth cohorts here.

To obtain coverage of all cohorts for the 1900-1984 period, and to avoid double counting of individuals observed in consecutive censuses, we only keep the birth decades of the 1900s to 1950s from one early census year and the 1960s and 1970s birth decades from one late census year of each country. For Burkina Faso, Ethiopia, Rwanda and Sierra Leone we derive all observed birth decades from the only available census year that records individuals' years of education and age at enumeration. Next, we restrict our sample to individuals aged 25-80 years. At age 25, schooling can reasonably be expected to have been completed (Charles and Luoh 2003). We drop individuals older than 80 years due to small cohort sample sizes and likelihood of the very elderly to have overstated both age and educational attainment (Guntupalli and Baten 2006; Crayen and Baten 2010; Barro and Lee 2013). Table A1 in the online Appendix provides further details on sample construction.

Investigating correlates of educational gender gaps in sub-national regions across SSA

For our *sub-national* analysis, we further refine our sample to countries for which IPUMS also records individuals' birth location. For Nigeria and Zimbabwe, included in the country analysis, no district of birth is reported. Table 2 provides details on sample construction: census years, birth decades covered and number of regions included. Our final data set is based on 15.4 million individuals, born across 1,177 districts in 19 SSA countries, retrieved from 32 national censuses.[11] We aggregate individuals' mean years of schooling by decadal birth cohort and sex at the administrative sub-national level, our unit of observation. Because sample sizes shrink considerably when we disaggregate from country to district, we start in 1920, and drop observations in case they are based on less than 30 individuals. The aggregated sample with 5,226 districts allows us then to calculate our dependent variable: *the absolute attainment gap* (in average years of schooling completed) between males and females per birth region and birth decade.[12]

Our spatial units of observation correspond to either first- or second-level geographic units,[13] depending on their availability in IPUMS-I, and vary across countries (e.g., districts, regions or circles). For brevity and clarity, we consistently refer to them as "districts." To account for the different sizes of these administrative subdivisions, we use weights for birth regions' population size per birth decade. IPUMS offers an integrated, year-specific geography variable providing information at the administrative unit level and the corresponding GIS boundary files, which allows us to account for the fact that many territorial divisions change their geographic borders between the two census years that we use for most countries.

To investigate long-run correlates of educational gender gaps, we construct a geospatial data set of relevant independent variables at the sub-national level relying on multiple data sources. Table 3 reports the summary statistics.[14]

Male educational expansion. We use male years of schooling completed from IPUMS censuses.

Openness. We calculate the share of the urban population (i.e., cities >10,000 inhabitants) per district from OECD/SWAC's (2020) *Africapolis* database and Jedwab and Moradi (2016). A dummy for the presence of colonial railroads was derived from Jedwab and Moradi (2016). We also compute a dummy if the district contains an ocean coastline.

Colonizer. We create a dummy for colonizer's identity for territories being ruled by the British, the French (reference category), League of Nations mandate, or being independent during the period of observation.

Religion. We construct a dummy for the presence of major Christian missions (Protestant and Catholic) in a district in 1924, based on Roome (1925) and digitized by Nunn (2010). Although widely used to investigate persistent effects of missionary activity,[15] this source has been demonstrated to be incomplete, reporting mostly European missions and thus missing out on large numbers of smaller out-stations, mostly run by African missionaries (Jedwab et al. 2019, 2021). We argue that sub-national regions with a missionary post in 1924 can be considered the early "heartlands" of Christianization in Africa, with the strongest degrees of institutionalization of missionary educational practices, and potentially the largest number of converts in the colonial era, relative to areas without main stations. We also create a dummy for whether Muslims constituted more than 50 percent of each district's population based on individuals' religion (IPUMS censuses).[16]

Agriculture. We obtain locations of colonial export crop output from Hance, Kotschar, and Peterec (1961). The source also reports mining output, which we include as a separate variable. We obtain country-level export commodity output from 1920 to 1979 from a range of sources. We express cash crop and mineral output per capita. Details and sources are outlined in the online Appendix. Following German ethnographer Hermann Baumann (1928) and Boserup 1970, 18), we distinguish three gender-divided tasks in agriculture: entirely female (*farm female),* mostly female but with substantial male involvement *(farm shared)* and mostly male

(farm male), including pastoralism (mapped in online Appendix Figure A5). We calculate the log of the relative share of pastureland to cropland in squared kilometers based on Goldewijk et al. (2017).

Family systems. We create an index of three variables that proxy cultural practices regarding low female autonomy, consisting of ethnic groups' (i) absence of brideprice, practice of (ii) polygamy and (iii) patrilineality based on Murdock (1967). Country-level fertility rates 1960-1979 are taken from World Bank (2021).

Regression analysis

To examine key factors related to the regional differences of gender gaps in educational attainment we use a LSDV (least-squares dummy variables) estimator and estimate the following regression model:

$$y_{it} = \beta_0 + \beta_1 X1_{it} + \beta_2 X2_i + \beta_3 X3_{it} + \mu_c + \upsilon_{t_t} + \varepsilon_{it}$$

where $\boldsymbol{y_{it}}$ represents our dependent variable that measures the gender gap in average years of schooling between males and females per district *i* during birth decades *t* ={1920-39, 1940-59, 1960-79}, $X1_{i,t}$ is our vector of time-variant variables (e.g., male years of education, railway presence, urbanization, cash crop and mining output), and $X2_{i,}$ stands for time-invariant locational factors (e.g., coastal location, missions, agricultural systems, family systems). $X3_{i,t}$ captures the effect of our interaction variables. The term μ_c takes into account country fixed effects, $\boldsymbol{\upsilon_t}$ captures time fixed effects, while $\boldsymbol{\varepsilon_{it}}$ represents the idiosyncratic error term. Kelly (2019) recently cautioned that many findings using spatial regressions could have arisen from random spatial patterns. We therefore control for spatial autocorrelation.[17] Our model does

not strictly identify causal effects. Our goal is to uncover a set of factors that based on theory and previous research plausibly correlate with gender inequality, and assess their association with education gender inequality outcomes over time.

Data limitations

Our approach has three limitations that should be kept in mind when interpreting the results. First, our main variable, years of education, indicates educational attainment as measured by years in school completed but does not inform about the quality of education, which may vary across space, time and gender (Psaki et al. 2018). It is also the most generic indicator of educational attainment, not distinguishing between different levels of schooling, and not reporting on grade repetition. Nevertheless, we consider years of education to be the most suitable variable for the purpose of tracing and comparing gender gaps over a long time-period and large geographical coverage, because of its uniquely wide availability and uniformity across countries and sub-national regions.

Second, our approach of back-casting census data may introduce some measurement error. The possibility exists that the more educated may have a better chance of making it into the older cohorts. Such survivorship bias in cohort analysis has been studied in earlier literature, but its magnitude proved to be modest (Guntupalli and Baten 2006; Crayen and Baten 2010; Barro and Lee 2013).[18] As shown in online Appendix Figure A1 survivor bias in our sample is minimal. Moreover, we include only individuals aged 25-80. A related concern is that the earliest cohorts in our analysis are smaller so that confidence intervals widen considerably as we go back in time, especially in our analysis on the sub-national level. Consequently, we drop district-level birth decades pre-1920, due to the small number of observation. From the 1920s onwards, we drop 10-year district-averages in case they are based on fewer than 30 individuals.

Third, we analyze years of schooling by districts of *birth* rather than *residence*. The reason for this choice is that an unknown share of residents enumerated in districts at the time of the census will have migrated there at an earlier (unknown) point in their life. Since migration is strongly age-, skill- and sex-selective, the average years of education in districts of residence reflects this compositional effect. Averages in districts of residence would thus tell us little about spatially uneven educational opportunities for boys and girls, but rather about (gender differences in) district-sorting by level of education (Alesina et al. 2021), which is an altogether different topic of study. For our purposes, we consider district of birth to be a much more appropriate unit of analysis. Linking individuals to their districts of birth allows us to explore how the local conditions of openness, religion, agriculture or family systems in which people were born (and raised, in most cases) affected their subsequent educational attainment. Moreover, we may reasonably expect that most people accumulated (most of) their education in their district of birth, even if they ended up migrating at some point in their life. Still, it should be borne in mind that some individuals will have migrated before or during their schooling, (i) moving with parents, or (ii) explicitly seeking educational opportunity (especially at the tertiary level).[19] Strictly speaking our analysis therefore captures gender gaps between boys and girls born in the same district, but not necessarily having completed their full education there.

Results

This section presents the results of our comparison of educational gender gaps (i) between SSA and other developing regions, (ii) among SSA countries, and (iii) at the sub-national region level, where we use multivariate regression analysis to explore some variables that are plausibly associated with educational gender gaps over time.

Educational gender gaps in comparable world regions

SSA, MENA, South Asia, and Southeast Asia, all experienced a rise in mass-education over the long 20th century from a similarly low initial level, and achieved independence from European colonizers during the mid-20th century. While South and Southeast Asia as well as MENA experienced decolonization soon after World War II, most African countries gained their independence almost two decades later, which may have delayed their expansion of education, and therefore also progression through the educational gender Kuznets curve. Otherwise, we do not have reasons to expect gender bias in education to be different in Africa compared to the other three regions. In fact, following Boserup, we might expect smaller gender gaps in Africa (and Southeast Asia) compared to MENA and South Asia, due to the predominance of female farming systems. Missionaries' Christianization efforts were also particularly successful in Africa, compared to the other regions, which may have reduced gender gaps by furthering educational expansion. Islam was widespread in all three regions, and, as noted before, likely had heterogeneous impact.

Gender Gap. Figure 1 presents the unweighted country average of the gender gap for each of the four world regions. It shows that SSA transitioned from being the least gender unequal region during the early 20th century to the most gender unequal by the 1980s, a situation that persists to the present-day (Barro and Lee 2015). Overall, we can see a pattern of rising absolute inequality in each of the four world regions before mid-century, and declining inequality thereafter. Educational attainment in the MENA region started out as relatively gender-equal, but saw a rapidly widening gap of more than two years by the 1940s birth cohort, after which equally strong convergence took place. South Asia presents a picture of relatively high gender inequality in education throughout the entire period, with its gap peaking, jointly with MENA, for the 1940s birth cohort. Southeast Asia peaked two decades earlier and exhibits decreasing absolute gender inequality already for those born after the 1930s. SSA has the latest inequality peak, for the 1950s birth cohort, and has achieved the least progress in closing the gap since.[20]

Kuznets Curve. Figure 2 relates the gender gap to the expansion of male education. In all regions gender inequality over male educational expansion followed the hypothesized inverted U-shape, as the absolute gender gap initially rose and then fell with sustained educational expansion of men. Throughout, SSA's curve was the *least* gender unequal, starting out, peaking and ending up at lower levels than the other world regions. When African boys received about one year of education on average, the gap was just under half a year of education (meaning that girls received just over half a year of education on average), compared to just over half a year in the MENA region, and close to a year in South Asia and South East Asia. At about 6 years of education, the gender gap was again smallest in SSA, this time trailed by South East Asia and, at a larger distance, South Asia and the MENA region. This brings us to an important observation, namely that SSA's comparatively poor progress towards educational gender equality, shown in Figure 1, is linked to its slower expansion of male education, which has not progressed as far along the downward sloping part of the educational gender Kuznets curve as in the other world regions. All the while, because SSA performs relatively well in terms of gender equality at different stages of its male education expansion, we have no reason to infer that SSA's relatively poor performance in reducing educational gender inequality across time is linked to more severe structural attainment gender bias.

Trends in educational gender gaps in sub-Saharan African countries

How did individual countries perform relative to SSA's regional pattern presented in Figures 1 and 2? Figure 3 presents the gender gap in years of education for 5-year birth cohorts. Figure 4 presents the gender gap relative to overall male educational expansion (i.e., the educational gender Kuznets curve).[21] For purposes of analysis and presentation, we show country trajectories in four panels, sorted by (i) the height of their peak gender gap being below/at or above the median (2.5 years of education), and (ii) the timing occurring before/at or after the median date (the 1945-1949 birth cohort).

Early and high gender gap peak

Figure 3(a) shows five countries. Four are British colonies, in West Africa (Ghana), East Africa (Kenya and Uganda), and Southern Africa (Zambia). The fifth is Cameroon, which was initially colonized by Germany, and divided between Britain and France after World War I as a mandated territory (Dupraz 2019). Figure 3(a) shows that, in each of these countries, gender gaps rose steadily from the first birth cohort observed and peaked in the 1945 cohort, at levels varying between 2.5 and 3.5 years. For those born between 1945 and 1960 (independence), we see a steady decline of the gender gap. After independence, trajectories diverged, as Kenya continued to steadily close its gap, while progress in the other four countries slowed down. Figure 4(a) relates the gender gap to years of male education. It shows that the five countries moved along the same steady upward slope of the educational gender Kuznets curve until boys reached four years of education. This initial trajectory implies, approximately, that for every 4 years of education received by boys, girls received only 1. From 4 years of male education onwards, this relationship breaks down, as the curve flattens out and then tilts down. Among the five countries, Uganda started bending its curve towards lower gender inequality comparatively sooner as male education expanded, while Ghana bent its curve comparatively late along its progression of male education.

Early and low gender gap peak

This second panel comprises six countries: three Southern African countries with remarkably low or even reverse gender gaps in favor of females (Botswana, Lesotho and South Africa), two former German colonies, which post-1918 were assigned to Belgium (Rwanda) and Britain (Tanzania) under a League of Nations mandate, and Sierra Leone, formerly a British colony. Figure 3(b) illustrates that countries' performance in closing the gap was heterogeneous.

Botswana, Rwanda and Tanzania had erased a large share of their male educational advantage between 1945 and 1985, while Sierra Leone's gender gap barely closed post-1945. Figure 4(b) shows that Rwanda, Sierra Leone and Tanzania initially followed the same Kuznets curve as the countries in the first panel, until men had reached three years of education on average. At this point Rwanda started to bend its curve, much earlier than the other countries. Contrary, Sierra Leone's educational expansion stagnated at a low level of 3-4 years of male education, and the gender gap persisted at 2 years post-independence. Tanzania followed a curve quite similar to countries in the first panel, achieving comparatively fast expansion of male education, but with slightly smaller gender gaps throughout.

Botswana and South Africa both had very small gender gaps compared to other SSA countries. In both cases, women in fact outperformed men for the most recent decades observed. The case of Lesotho is even more at odds with the overall pattern, with women accumulating more years of education than men during the entire period, reaching an absolute lead of almost 2 years by the 1970 birth cohort. Lesotho is the only country which does not follow the typical educational gender Kuznets curve at all. One possible explanation for the small gender gaps in Southern Africa is that women's marginalization from cattle farming had unintendedly benefitted their educational attainment, a factor that may also have been at play in Rwanda. In the case of Lesotho, sample selection bias may also play some role, as educated men may have disproportionally migrated to South Africa seeking employment, thus not being observed in the census contrary to (presumably less mobile) educated women and less educated men.

Late and high gender gap peak

Our third panel comprises four countries. Each of them witnessed major Christian missionary expansion, providing the bulk of formal education. Figure 3(c) indicates that experiences within this group are heterogeneous. From very low levels at the start of the 20th century, Liberia saw

its gender gap widen rapidly up to the 1950 birth cohort, before narrowing fast in subsequent decades. The widening of the gender gap in Benin and Nigeria was more gradual, but also continued all the way up to the 1980s, suggesting a comparatively poor post-colonial performance in reducing gender inequality. The first cohorts observed in Malawi and Zimbabwe exhibit comparatively high levels of gender inequality, but witnessed only modest increases subsequently. Malawi performed poorly in closing the gap after its peak in 1955, while Zimbabwe had closed most of its gap by 1985.

When we relate the absolute gap to male educational expansion in Figure 4(c), we see that countries with late peaks initially followed a trajectory quite similar to countries with early and high peaks: growing gaps until approximately 4-6 years of male education. In the case of Nigeria and Zimbabwe, however, we observe that gender gaps persist at high levels as male education expanded to 9 and 10 years respectively. In other words, Nigeria and Zimbabwe failed to bend their gender Kuznets curves towards lower gender gaps despite sustained expansion of male education. Also striking is the fact that gender gaps in both Liberia and Zimbabwe had fallen substantially among cohorts in which male educational expansion had come to an abrupt halt, while female education continued to expand.

Late and low gender gap peak

This final panel contains four French colonies (Burkina Faso, Guinea, Mali, and Senegal), as well as Ethiopia, which remained independent for most of the colonial era. Figure 3(d) displays that gender gaps were particularly low in Burkina Faso, Ethiopia and Mali during the first half of the 20th century, but also did not decline much in the later decades. Gender gaps in Guinea and Senegal increased more sharply early on, but experienced at least some reduction subsequently.

Placing the gender gaps in the context of male educational expansion in Figure 4(d) reveals that low gender gaps were clearly linked to limited overall educational expansion, barely above 3 years of male education. This, in turn, is plausibly explained by the marginal role played by Christian missionaries in most of French colonial Africa, which already had different and firmly-rooted religious traditions at the start of the 20th century (Islam and, in the case of Ethiopia, Orthodox Christianity). Limited local demand for Christian conversion in those contexts thus resulted into a low supply of mission schools. In each of the countries in this cluster, we observe a similar initial expansion along the educational Kuznets curve as in the previous two country clusters. Perhaps surprisingly, Mali reduced the gap quite early on in its educational expansion trajectory. Senegal also bent its curve early (at about 3.5 years of male education), as male education barely expanded among those born in the birth cohorts 1950 to 1975.

Exploring factors related to sub-national gender gaps in sub-Saharan Africa

We now zoom in further to explore relevant regional characteristics *within* countries in a multivariate regression framework. Table 4 reports the regression results for the gender gap in three time periods (1920-39, 1940-59, 1960-1979), controlling for spatial autocorrelation.[22] Our baseline results use country fixed-effects (columns 1-3) which capture country-specific unobservables. We also show results with regional fixed-effects (columns 4-6), which enable us to examine colonizer dummies and country-level fertility data. Our main results remain similar when we take the male-female ratio as the dependent variable (online Appendix Table A8). In the following, we discuss the regression results for each of the correlates introduced in the data and method section above: dynamic expansion of male education, openness, colonizer effects, religion, agriculture and culture. Figure 5 maps the gender gap on the sub-national level, after controlling for the linear and quadratic effects of male educational expansion, which is

expected to have a strong, independent, inverse U-shaped effect on the gender gap. The online Appendix provides variable definitions, source descriptions, and further base model specifications.[23]

Male educational expansion. Previously, we have shown that on both world region and country levels the absolute gender gap tended to grow rapidly during early stages of male educational expansion, then flattened, and eventually fell, creating an inverted U-shaped relationship. By entering the linear and quadratic impact of male education in the gap regression in Table 4, we capture this curvilinear relationship, which explains a large share of the variation we observe, and also allows for a cleaner interpretation of our other variables. We find that both linear and quadratic expansion in male education have a strong and statistically significant correlation with educational gender gaps throughout all periods (columns 1-3, 4-6), consistent with an inversely U-shaped curve.[24]

Openness. We find some evidence that coastal regions had lower gender inequality over the colonial period (columns 1, 4 and 5). Our measure of urbanization, log city population (>10,000 inhabitants) per region, was consistently associated with less inequality (columns 1-3, 4-6) but is only significant in the early colonial period (column 1, 4). Also, we find that the regional presence of colonial railroads was significantly and consistently associated with lower gender inequality across time (columns 1-3, 4-6). Overall, we find that better connected and urban locations tended to be linked to more gender equality, supporting the idea that increased openness benefited African girls' education during most of the 20th century.

Religion. Columns 1-6 show that regions in the initial European Christian missionary "heartlands" of the early 20th century had lower gender gaps even for cohorts born post-independence. Mission schools lost their monopoly in British Africa after the end of the colonial era (Frankema 2012), but these locational effects appear to have persisted and even grown in importance over time. When separating mission denominations, both the presence of Protestant

and Catholic main stations is associated with lower educational gender inequality across time (see online Appendix Table A4).[25] Thus, contrary to earlier studies (Nunn 2014; Montgomery 2017), we do not find evidence for a differential effect of mission denominations on educational gender outcomes. Contrary, four out of the six columns indicate some evidence that Muslim majority regions had larger gender gaps over both early colonial and post-independence periods.

Agriculture. Contrary to Boserup's (1970) hypothesis, we do not find evidence that cash crop cultivation (or mining activities) affected gender gaps. We also do not find evidence that districts where women traditionally participated actively in agriculture had different educational gender gaps compared to districts where tasks in agriculture were mainly carried out by men (reference category). We interact the cash crop variable with the gender division of labor variables, to explore if cash crop adoption affected gender gaps differently depending on women's role in agriculture, yet this interaction does not yield significant results either. The variable expressing pasture relative to cropland indicates that greater suitability for pastoralism is positively correlated with gender gaps (but) only for the latest cohort (1960-79).

Family systems. We do not find evidence that low female autonomy aggravated educational gender inequality. Instead, we find some evidence for the post-colonial era (column 3) that low female autonomy is linked to lower gender gaps. Age at onset of fertility is an obvious mechanism linking family systems to gender gaps in educational outcomes. We did not obtain historical district-level fertility data but included a country-level average fertility variable for the latest time period. We find that fertility increased gender gaps but did not change the signs or significance levels of the other variables.

Colonizer effects. To test for colonizer effects on the sub-national regional level, we introduce dummies for British colonies, mandated territories and independent countries (columns 4-6), taking French colonies as reference category and using African region (rather than country)

fixed effects. We confirm our tentative findings from SSA cross-country analysis that the regions' mandated and independent territories had significantly smaller gender gaps during colonial era cohorts than French dependencies (columns 4-5). We also find that regions in British colonies had smaller gaps for the 1940-59 cohorts (column 5). Colonizer effects on gender gaps disappear after independence (column 6).

Discussion

We have conducted an exploration of gender inequality in education across developing regions, African countries, and country districts since the early colonial era. First, compared to other developing world regions, SSA started out the 20th century with small gender gaps but had the largest gaps by the 1980s. In all developing regions, we observe an inverse U-shaped relationship between the gender gap and male educational expansion, which we have termed educational gender Kuznets curve. Interestingly, along each stage of its curve, SSA had smaller gender gaps than other world regions. This finding should caution policy makers to attribute SSA's comparatively modest progress in closing the gender gap over the 20th century to male preference, and instead to acknowledge how SSA's gender inequality today is linked to its comparatively slow expansion of education. Potentially, then, one of the most effective policy interventions would be to stimulate overall educational expansion, especially in disadvantaged regions, which we should, based on the historical experience, expect to have strong benefits for girls in the medium- to long runs.

Second, our country comparison confirms this pattern of inverse U-shaped gender attainment gap trajectories. All 21 observed SSA countries, with the exception of Lesotho, saw an initial increase of their gender gaps until the mid-20th century. In most countries, gaps levelled off or declined subsequently. When we relate gender gaps to the trajectory of male educational expansion, we observe that most countries started out on very similar paths, with girls

accumulating about 1 year of education for every 4 years accumulated by boys. Some countries did not yet progress beyond 4 years of male education for the latest observed birth cohort. Others had progressed much further. In some cases, such progress of male education was accompanied by a decisive bending of the gender Kuznets curve towards less inequality (Tanzania, Kenya); while in others, large gaps persisted (Malawi, Nigeria). The only major exceptions to this broader pattern are Botswana, Lesotho, South Africa and Zimbabwe, all located in Southern Africa. While educational progress in South Africa and Zimbabwe had already advanced quite far at the start of the 20th century, this was much less the case for Lesotho and especially Botswana. Nevertheless, the latter two countries exhibit the smallest gender gaps. Potentially, male absence due to pastoralism and male labor migration have played a role in lowering their gender gaps, although our sub-national findings do not confirm an association between gender gaps and pastoralism (or any other of our agricultural variables).

As hypothesized on the basis of earlier literature on colonizer effects and religion, British colonies and countries with major Christian missionary presence during the colonial era experienced faster (male) educational expansion. They are also overrepresented among those countries with large gender gap peaks, suggesting that the supply and demand of mission schooling can be linked to rapidly rising gender differences in years of education. However, colonizer effects and religion are not clearly associated with gender gaps along the gender Kuznets curve on the country level. In most countries, whether Christian or Muslim, or French or British colonies, gender gaps approximated 2 years at 3 years of male education. Cameroon, Rwanda and Tanzania reduced their gender gaps comparatively early along the gender Kuznets curve, which suggests that League of Nations/United Nations mandated status may have played a role in achieving more gender-balanced education in a colonial context. However, many of the regularities observed during the colonial era break down in the post-colonial era, where we observe much heterogeneity, as some countries bent their Kuznets curve earlier (Rwanda, Senegal) or more decisively (Tanzania, Kenya, Zimbabwe) than others. This suggests that,

despite clearly visible colonial legacies on education, gender gaps were strongly influenced by idiosyncratic policies and events in the post-colonial era, an issue that future studies can explore in more detail.

Third, we examined how various local factors were associated with sub-national inequality over time, keeping country- or region effects constant. Although our analysis does not establish causality, documenting relevant conditional correlations for such a large body of evidence on African gender equality of schooling brings us closer to identifying local factors that compound gender inequality on the continent. We observe that regional economies that benefited from urbanization, coastal access or railway proximity also achieved more gender equality, compared to more remote places and regions characterized by agricultural labor markets and family economies. Globalization, long before the term had been invented, promoted gender equality in African education. Closer integration of marginalized regions in national, regional and global economies may, therefore, plausibly contribute to reducing gender-unequal educational attainment. We do not find that cash crop agriculture was linked to gender gaps. Moreover, , we do not find substantial evidence that the historical division of labor in agriculture and family systems were associated with gender gaps in education. This is reassuring, as it suggests that educational outcomes are not primarily driven by deeply rooted systems of gender inequality but rather by more dynamic and mutable forces, such as educational investment and economic change. Indeed, we find that districts with consolidated missionary presence in the early colonial era had lower gender inequality in years of schooling throughout the entire period studied. This illustrates how strong and lasting specific local investments in education can be, but also suggests that such investments had limited diffusive effects beyond specific locations.

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TABLES

TABLE 1 Data sources, periods/units of observation and sample sizes

	Geographical scope	Sources	Cohorts	Unit of obs.	Method	Obs.
1.	Developing regions	Barro and Lee (2013)	1890-1979	Region	Time trend	4
2.	Sub-Saharan Africa	36 Censuses (IPUMSI)	1885-1984	Country	Time trend	21
3.	Sub-Saharan Africa	32 Censuses (IPUMSI)	1920-1979	District	Repeated cross section (regression)	1,177

TABLE 2 Number of birth regions and observations per country and census year

Country	Census Year	Birth decades used	N Regions	Obs.
Benin	1979	1920-1950	76	304
Benin	2013	1960-1970	77	154
Botswana	2001	1920-1950	19	74
Botswana	2011	1960-1970	19	38
Burkina Faso	1985	1920-1960	30	150
Cameroon	1976	1920-1950	112	447
Cameroon	2005	1960-1970	306	612
Ethiopia	1984	1920-1950	85	340
Ghana	1984	1920-1950	10	40
Ghana	2010	1960-1970	10	20
Guinea	1983	1920-1950	33	132
Guinea	1996	1960-1970	34	68
Kenya	1969	1920-1940	41	123
Kenya	2009	1960-1970	156	312
Lesotho	1996	1920-1950	1	4
Lesotho	2006	1960-1970	1	2
Liberia	1974	1920-1940	11	33
Liberia	2008	1960-1970	15	30
Malawi	1987	1920-1950	26	104
Malawi	2008	1960-1970	31	62
Mali	1998	1920-1950	45	180
Mali	2009	1960-1970	46	92
Rwanda	2002	1920-1970	101	606
Senegal	1988	1920-1950	30	120
Senegal	2002	1960-1970	34	68
Sierra Leone	2004	1920-1970	66	396
South Africa	2001	1920-1950	9	36
South Africa	2011	1960-1970	9	18
Tanzania	1988	1920-1950	25	100
Tanzania	2012	1960-1970	30	60
Uganda	1991	1920-1950	34	136
Uganda	2002	1960-1970	56	112
Zambia	1990	1920-1950	52	207
Zambia	2010	1960-1970	71	142
Total			**1,701**	**5,322**

TABLE 3 Descriptive statistics, educational gender gap for all time periods

	1920 - 1939					1940 - 1959					1960 - 1979				
Variable	Obs.	Mean	SD	Min	Max	Obs.	Mean	SD	Min	Max	Obs.	Mean	SD	Min	Max
Gender educational gap	1,569	1.141	1.063	-3.600	6.500	1,529	1.833	1.164	-3.000	6.107	2,126	1.489	1.006	-2.100	5.394
Male years of educ.	1,569	1.598	1.560	0.000	11.000	1,529	3.352	2.243	0.051	10.000	2,126	5.592	2.753	0.1005	11.828
Male years of educ. sq.	1,569	4.987	10.204	0.000	121.000	1,529	16.261	18.705	0.003	100.000	2,126	38.850	30.485	0.010	139.892
Urban share (log)	1,569	0.125	0.646	0.000	5.252	1,529	0.231	0. 852	0.000	6.513	2,126	0.351	0.938	0.000	5.656
Dummy if railroad	1,569	0.253	0.435	0.000	1.000	1,529	0.250	0.433	0.000	1.000	2,126	0.239	0.427	0.000	1.000
Dummy if coast	1,569	0.099	0.299	0.000	1.000	1,529	0.095	0.293	0.000	1.000	2,126	0.086	0.280	0.000	1.000
Dummy if main mission 1924	1,569	0.251	0.434	0.000	1.000	1,529	0.241	0.428	0.000	1.000	2,126	0.227	0.419	0.000	1.000
Dummy if Protestant mission	1,569	0. 198	0.398	0.000	1.000	1,529	0.186	0.390	0.000	1.000	2,126	0.178	0 .382	0.000	1.000
Dummy if Catholic mission	1,569	0.117	0.322	0.000	1.000	1,529	0.116	0.321	0.000	1.000	2,126	0.096	0.295	0.000	1.000
Dummy if Muslim majority	1,569	0.296	0.46	0.000	1.000	1,529	0.302	0.459	0.000	1.000	2,126	0.244	0.429	0.000	1.000
Dummy if farm female	1,194	0.347	0.476	0.000	1.000	1,149	0.336	0.473	0.000	1.000	1,752	0.403	0.491	0.000	1.000
Dummy if farm shared	1,194	0.570	0.495	0.000	1.000	1,149	0.566	0.496	0.000	1.000	1,752	0.549	0.498	0.000	1.000
Cash crop p.c. (log)	1,529	0.563	1.158	0.000	5.945	1,500	0.664	1.231	0.000	6.594	2,106	1.310	2.183	0.000	9.295
Cash crop p.c. (log) * Dummy if farm female	1,154	0.276	0.825	0.000	4.977	1,120	0.336	1.034	0.000	6.594	1,732	0.665	1.799	0.000	9.295
Cash crop p.c. (log) * Dummy if farm shared	1,154	0.271	0.806	0.000	5.945	1,120	0.330	0.796	0.000	4.742	1,732	0.726	1.559	0.000	7.422
Minerals p.c. (log)	1,569	0.042	0.468	0.000	7.877	1,529	0.0311	0.401	0.000	7.299	2,126	0.003	0.039	0.000	0.995
Pasture / Cropland (log)	1,569	0.694	0.538	0.000	2.890	1,527	0.761	0.582	0.000	3.726	2,106	0.641	0.601	0.000	4.396
Low female autonomy index	1,335	0.037	1.653	-2.195	2.534	1,300	0.072	1.662	-2.195	2.534	1,666	0.204	1.584	-2.196	2.534
Fertility (log)	-	-	-	-	-	-	-	-	-	-	2,126	1.932	0.110	1.672	2.123
French colony	1,569	0.259	0.438	0.000	1.000	1,529	0.268	0.443	0.000	1.000	2,126	0.187	0.390	0.000	1.000

British colony	1,569	0.312	0.463	0.000	1.000	1,529	0.296	0.457	0.000	1.000	2,126	0.384	0.486	0.000	1.000
Mandated colony	1,569	0.297	0.457	0.000	1.000	1,529	0.307	0.461	0.000	1.000	2,126	0.406	0.491	0.000	1.000
Independent country	1,569	0.133	0.339	0.000	1.000	1,529	0.129	0.335	0.000	1.000	2,126	0.023	0.149	0.000	1.000

TABLE 4 Correlates of sub-national educational gender gaps, panel regression

Dependent Variable:	Educational Gender Gap			Educational Gender Gap		
	1920-39	1940-59	1960-79	1920-39	1940-59	1960-79
	(1)	(2)	(3)	(4)	(5)	(6)
Male years of educ.	1.053***	1.031***	0.565***	1.076***	0.948***	0.508***
	(0.0540)	(0.0332)	(0.0363)	(0.0603)	(0.0320)	(0.0327)
Male years of educ. sq.	-0.0571***	-0.0783***	-0.0407***	-0.0632***	-0.0685***	-0.0353***
	(0.0134)	(0.00374)	(0.00336)	(0.0144)	(0.00372)	(0.00289)
Urban share (log)	-0.0769**	-0.00862	-0.0202	-0.139***	-0.0119	-0.0289
	(0.0304)	(0.0212)	(0.0186)	(0.0478)	(0.0228)	(0.0198)
Dummy if railroad	-0.0688**	-0.191***	-0.168***	-0.0670*	-0.229***	-0.205***
	(0.0296)	(0.0446)	(0.0423)	(0.0364)	(0.0473)	(0.0474)
Dummy if coast	-0.139**	-0.153	0.128	-0.134*	-0.167*	0.0592
	(0.0635)	(0.100)	(0.0874)	(0.0760)	(0.101)	(0.0827)
Dummy if main mission 1924	-0.115***	-0.157***	-0.201***	-0.129***	-0.106*	-0.180***
	(0.0385)	(0.0539)	(0.0486)	(0.0467)	(0.0601)	(0.0522)
Dummy if Muslim majority	0.0555**	-0.00886	0.142**	0.0509*	-0.0282	0.185***
	(0.0230)	(0.0473)	(0.0559)	(0.0298)	(0.0461)	(0.0551)
Dummy if farm female	0.0349	-0.0847	-0.0471	-0.0595	-0.172***	0.0228
	(0.0413)	(0.0577)	(0.0508)	(0.0486)	(0.0618)	(0.0550)
Dummy if farm shared	0.0520	0.0637	0.0872*	0.0249	0.0183	0.0945*
	(0.0378)	(0.0529)	(0.0459)	(0.0483)	(0.0586)	(0.0496)
Cash crop p.c. (log)	-0.00645	-0.0167	-0.00417	0.0619***	0.0235	0.00260
	(0.0198)	(0.0243)	(0.0178)	(0.0227)	(0.0278)	(0.0172)
Cash crop p.c. (log) * Farm female	-0.0223	-0.0234	-0.0104	-0.00623	-0.0208	0.00141
	(0.0226)	(0.0300)	(0.0207)	(0.0253)	(0.0340)	(0.0194)
Cash crop p.c. (log) * Farm shared	0.0123	0.0150	0.00470	-0.0439	0.0387	0.0190
	(0.0238)	(0.0275)	(0.0208)	(0.0269)	(0.0327)	(0.0197)
Minerals p.c. (log)	-0.0834**	0.0719	-0.366	-0.0462	0.0941	-0.101
	(0.0392)	(0.0773)	(0.251)	(0.0469)	(0.0790)	(0.246)
Pasture / Cropland (log)	0.0401	-0.0201	0.103***	0.0282	0.0164	0.121***
	(0.0255)	(0.0281)	(0.0343)	(0.0307)	(0.0346)	(0.0357)
Low female autonomy index	-0.00162	-0.00290	-0.0225	-0.0163	-0.0277*	-0.0266*
	(0.00965)	(0.0172)	(0.0150)	(0.0106)	(0.0165)	(0.0140)
British Colony				-0.0708	-0.327***	-0.107
				(0.0604)	(0.0713)	(0.0750)
Mandated territory				-0.155**	-0.621***	0.0476
				(0.0787)	(0.143)	(0.111)
Independent country				-0.293***	-0.655***	0.276*
				(0.103)	(0.163)	(0.158)
Fertility rate						0.213***
						(0.0583)
Constant	-0.0286	-1.081***	-2.075***	0.228*	-2.099***	-5.750***
	(0.0637)	(0.0854)	(0.102)	(0.129)	(0.193)	(0.395)
Rho	-0.1000	0.850***	1.432***			
	(0.0893)	(0.0492)	(0.00186)			
Observations	1,554	1,462	2,082	1,554	1,462	2,082
No. admin. clusters	777	731	1,041	777	731	1,041
Country FE	Yes	Yes	Yes	No	No	No

Region FE	No	No	No	Yes	Yes	Yes
Decade FE	Yes	Yes	Yes	Yes	Yes	Yes

Notes: Panel regressions for 3 periods with two decades respectively and a large number of regions in each panel. Models (1-3) include country fixed effects. Models (4-6) include African region fixed effects (Central Africa, East Africa, South Africa, West Africa) Regression models are corrected for spatial autocorrelation. Rho is the spatial autocorrelation coefficient. We include a control for population density (log). The reference category to the two farm variables is Male Dominated Farming. Variables are temporally dynamic except those capturing initial and invariant condition: Dummy if Main Mission in year 1924; farming practices that were measured from Baumann (1928); Low Female Autonomy Index constructed based on Murdock (1967); and Coastal Dummy. Robust standard errors (in parentheses) are clustered at the sub-national administrative level. Significance codes: *** p<0.01, ** p<0.05, * p<0.1. See online Appendix for data construction and sources.

FIGURES

FIGURE 1 Educational gender gaps in developing world regions, 1890-1980 birth decades

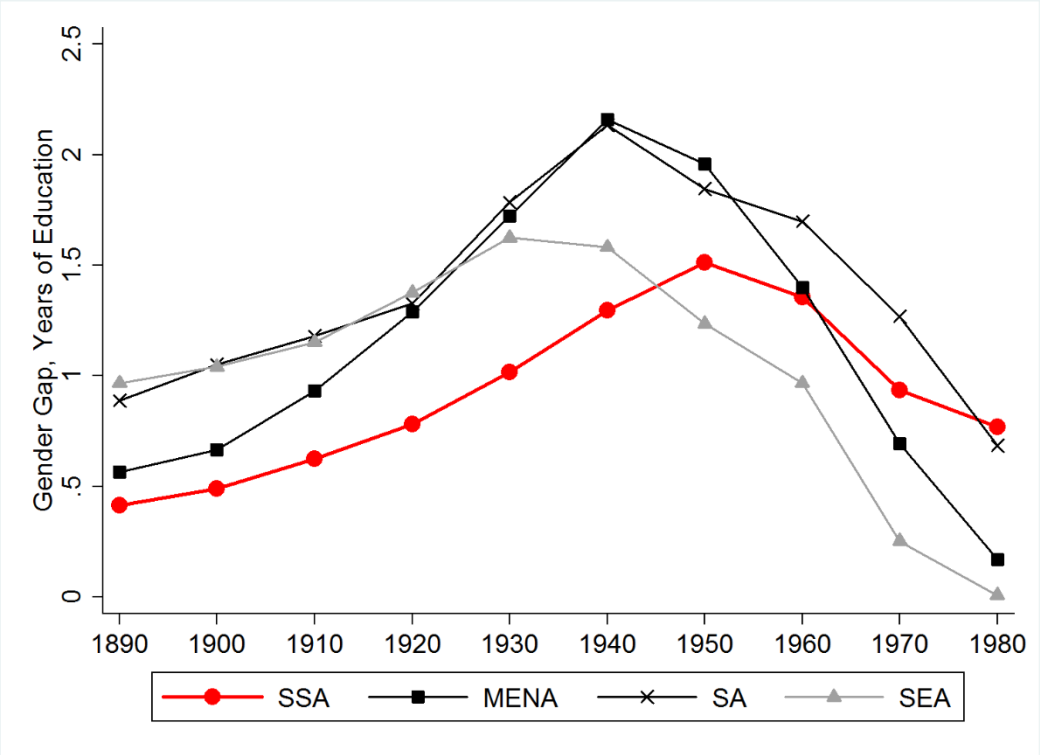
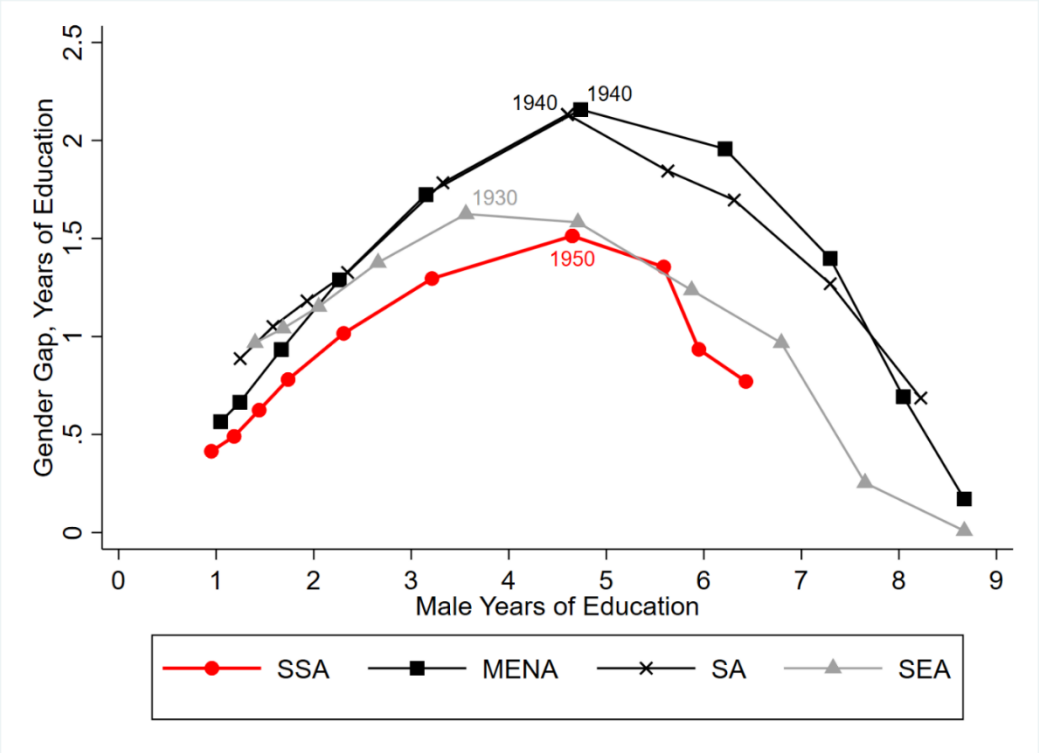


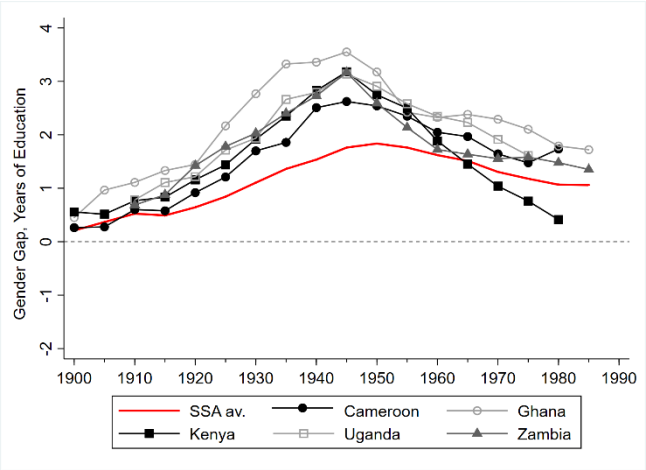
FIGURE 2 Educational gender gaps and male years of education in developing world regions, 1890-1980



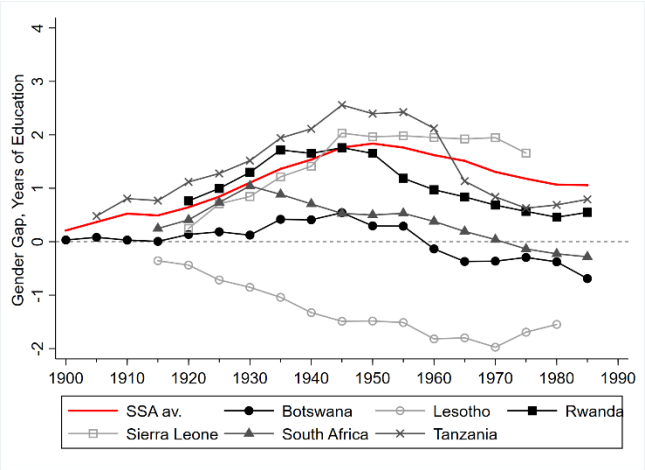
Note: Year figures in graph indicate the peak birth decade of the educational gender gap.

FIGURE 3 Educational gender gaps in African countries, 1900-1985

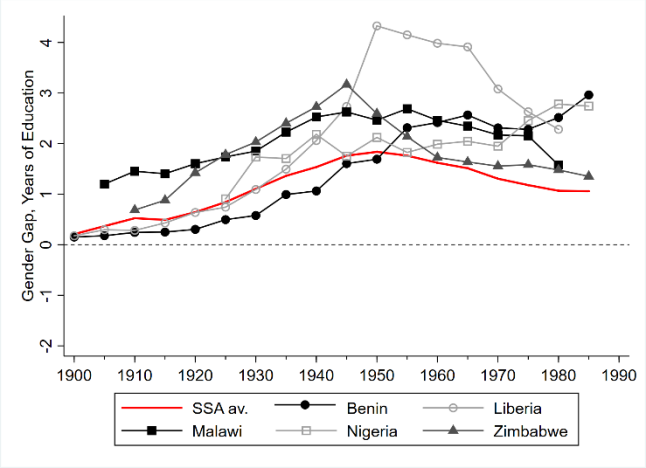
(a) Early high peak



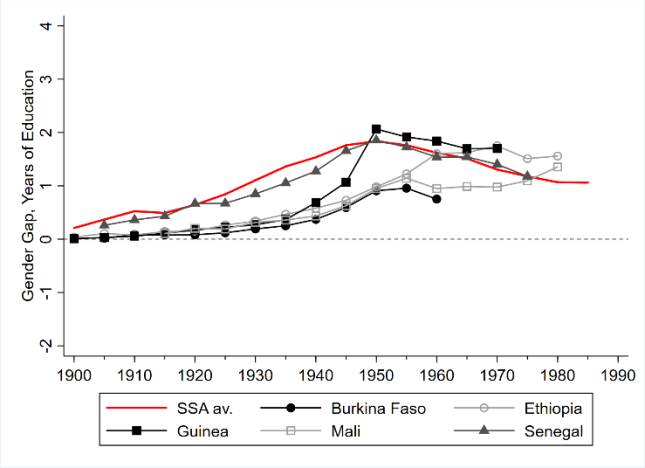
(b) Early low peak



(c) Late high peak



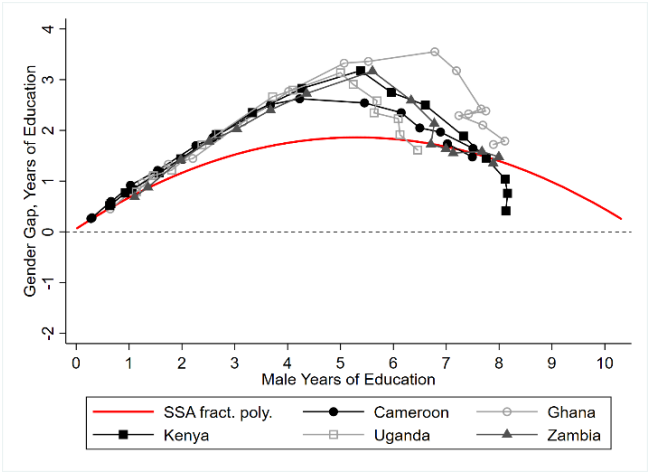
(d) Late low peak



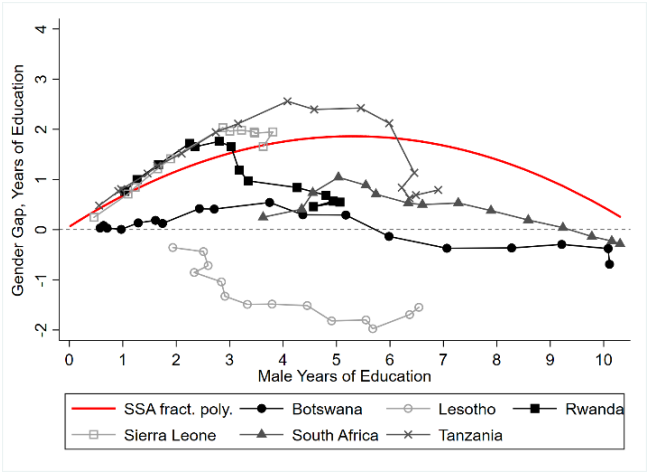
Notes: Graphs show 5-year birth cohort averages. Gender gap of 0 indicates gender equality. Red line represents the average for our sub-Saharan African sample.

FIGURE 4 Educational gender gaps and male years of education in African countries, 1900-1985

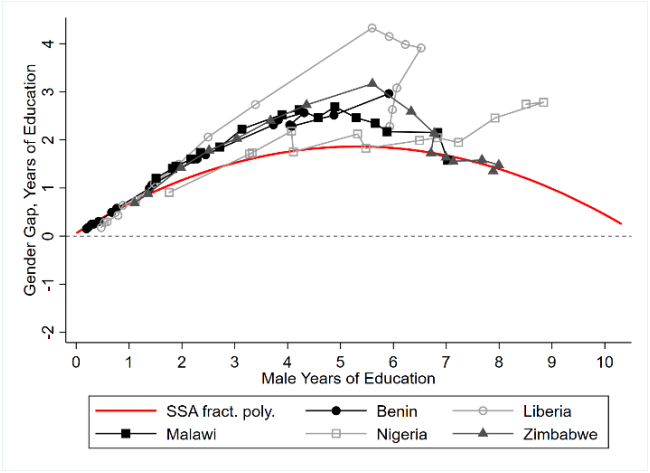
(a) Early high peak



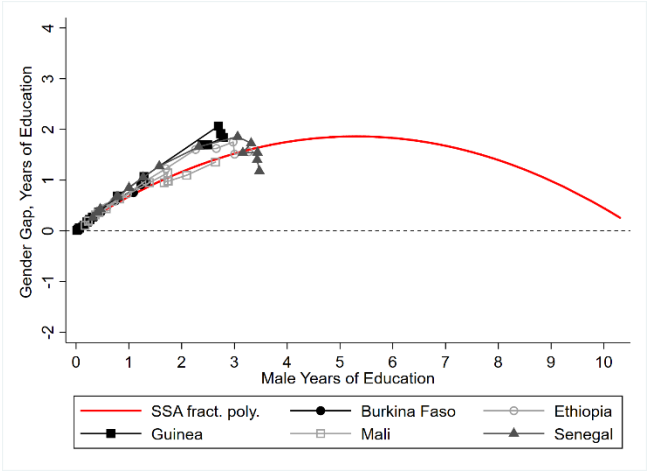
(b) Early low peak



(c) Late high peak

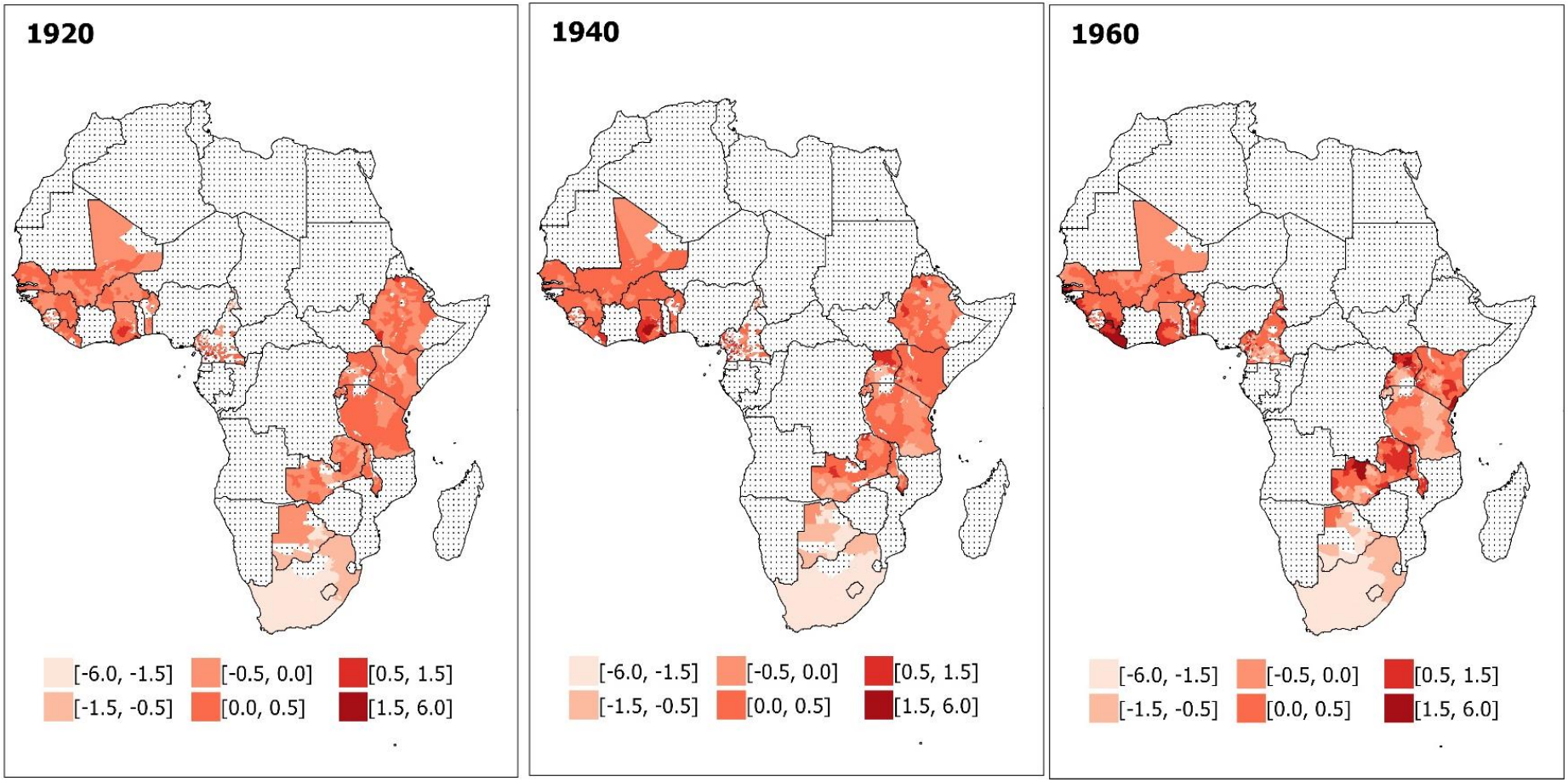


(d) Late low peak



Notes: Graphs show 5-year birth cohort averages. Gender gap of 0 indicates gender equality. Red line represents the fractional polynomial fit for our sub-Saharan African sample.

FIGURE 5 Educational gender gaps per decade across sub-national sub-Saharan Africa



Notes: Brighter colour = smaller gender gaps. Educational gender gaps controlling for linear and quadratic effects of male years of schooling (educational gender Kuzents curve) for 1920s, 1940s and 1960s. No data available for 1960s Ethiopia.

Notes

[1] Acknowledgements: We thank Belinda Archibong, Gabriele Cappelli, Sarah Carmichael, Alice Evans, Johan Fourie, Ewout Frankema, Daniel Gallardo Albarrán, Laura Maravall, Alexander Moradi, Elias Papaioannou, Leandro Prados de la Escosura, Eric Schneider, and seminar audiences at AEHN 2019 (University of Barcelona), "Measuring Wellbeing in the Past" Workshop (Utrecht University), LEAP Webinar (Stellenbosch University), and the "The Rise of Education across European Regions in the last two Centuries" online seminar (University of Sienna) for helpful comments. We thank Pim Arendsen, Jasper Snijders and Stefan de Jong for valuable research assistance. Meier zu Selhausen gratefully acknowledges financial support of the British Academy (Postdoctoral Fellowship pf160051 – Conversion out of Poverty? Exploring the Origins and Long-Term Consequences of Christian Missionary Activities in Africa). Baten thanks DFG for the grant BA-1503/18-1.

[2] SSA has the highest rate of exclusion, with 19 percent (37 percent) of primary (lower secondary) school-age children being denied the right to education (UNESCO 2020).

[3] See Bertocci and Bozzano (2020) for a survey of this literature.

[4] We derive the use of the term "openness" from economics, where it is typically associated with trade. See for example Edwards (1998) and Stulz and Williamson (2003).

[5] For India, Lankina and Getachew (2012) associate Christian missionary activity with higher female literacy during colonial and post-colonial eras. Calvi et al. (2021) shows that this relationship is particularly strong for missions with greater female missionary staff presence.

[6] Individuals who never enrolled in school are included in our sample and coded as having zero years of education.

[7] The absolute gap is the same if women have 1 year of education and men 2, relative to women 9 and men 10. In the online Appendix, we replicate our results using a gender ratio (i.e. ratio of male to female educational attainment), which assumes declining returns to education as the absolute level increases. The ratio is the same if women have 1 year of education and men 2, relative to women 5 and men 10.

[8] Barro and Lee (2013) provide educational attainment data on: SSA (33 countries), South Asia (6 countries), Southeast Asia (10 countries), and MENA (17 countries).

[9] Appendix Figure A2 reports results using the gender ratio.

[10] Nigeria is an exception, where data comes from household surveys 2006-2010.

[11] Appendix Table A1 presents details on sample construction: countries included, census years, number of birth regions, total observations, observations aged 25-80 and the share of men and women in the sample. Appendix Table A2 reports the number of observed districts per country for each time period.

[12] When calculating the ratio in average years of education between men and women, our dataset reduces to 4,924 observations since females did not receive any education in some regions. Therefore, the level of schooling for women is zero within these regions and therefore these observations are not taken into account in the denominator.

[13] Most countries are divided into administrative divisions which have different levels. First level geography corresponds to the largest administrative subdivisions of a country (i.e. region) whereas second level geography corresponds to administrative boundaries that are inferior to the first level administrative divisions and hence constitute a smaller unit (e.g. districts).

[14] Appendix Table A3 reports descriptive statistics for variables included in educational male-female ratio regressions.

[15] Including the effects of missions on present-day women's education (Nunn 2014; Montgomery 2017).

[16] This late 20th century benchmark is likely to represent the situation throughout the entire 20th century, as the arrival of Islam dates back much further than Christianity in most parts of Africa and its diffusion took place long before our first cohort, the 1920s, was educated.

[17] Appendix 1.4 explains in detail the spatial autoregressive (SAR) model.

[18] The graphs respectively present sampled countries of (a) East, (b) West, (c) Central and (d) Southern Africa.

[19] The magnitude of both types of migration were modest. Especially during the colonial era, young adult men seeking work predominated long-distance migration, while young children and wives typically did not. Moreover, tertiary educational shares (>14 years of schooling) are negligible during all time periods, except for those born in 1960-79 (5.3 for men and 2.6 for women). Even if we were to assume that during the colonial era to attend secondary schools rural children had to migrate outside their birth district, the share of boys and girls having attained more than 7 years of education only came to 6.6 and 1.2 percent in 1920-39 and 16.8 and 6.2 percent in 1940-59 cohorts respectively (calculations based on IPUMS). Post-independence, secondary schools became more available in rural areas too, making migration less necessary.

[20] SSA's relative position, moving from least to most gender unequal, is also visible when we take the ratio (M/F) rather than the absolute gap in Appendix Figure A2.

[21] Appendix Figures A3 and A4 show those trends in educational male-female ratios.

[22] Gender gap and ratio results without spatial autocorrelation controls are shown in Appendix Tables A5, A7 and A9 respectively. We have to drop 91 birth districts when controlling for spatial autocorrelation in the regression in order to establish repeated panels that are balanced and consistent.

[23] We specify our base model without controlling for spatial correlation (Appendix Tables A5, A7 and A9).

[24] Beta coefficients for all variables are reported in Appendix Table A6. The Beta coefficients of the male educational expansion variables are substantially larger than for the other variables.
[25] We thus do not find that Protestant missions had a larger (negative) effect on educational gender gaps than Catholics (Nunn 2014).