Educated Girls, a Force for Development?

Gender Inequality in Education and Economic Performance in Sub-Saharan Africa: A Path-Dependency Analysis

Elisabeth KEMPTER[a,b] *

[a] University of Tuebingen, Germany
[b] University of Luxembourg, Luxembourg

Abstract

The importance of human capital for economic growth has been widely discussed. However, little attention has been paid to the relationship between gender disparities in education and economic performance. This persistence study focuses on the long-term effects of prevailing gender gaps in education during the 20th century on current per capita output in sub-Saharan Africa. Results of the repeated cross-sectional analyses at the regional level show a strong negative association between the existence of educational gender gaps during the past century and current economic development, measured by nighttime light intensity per capita. Investments into female education are positively correlated with economic output. These findings hold when using actual GDP per capita data at a higher aggregated level. Going beyond the analysis of direct effects, we carry out a mediation analysis and find that part of the negative influence of educational gender inequality on economic output is mediated through fertility.

Keywords- Education, Gender Inequality, Economic Development, sub-Saharan Africa
JEL Classification- I24, I25, N37, O15

* Corresponding author, University of Tuebingen, Faculty of Economics and Social Sciences, Tuebingen, Germany
present address: University of Luxembourg, Faculty of Law, Economics and Finance (FDEF), Luxembourg
E-mail address: elisabeth.kempter@uni.lu
Tel. n.a.

1. Introduction

Human capital is widely considered one of the fundamental factors promoting economic welfare since it is the groundwork on which sustainable economic development and social wellbeing are built. It is generally acknowledged that education contributes to poverty reduction (e.g., Cremin and Nakabugo 2012; Tilak 2007) and fosters technical progress and development (e.g., Riddell and Song 2017) . Therefore, human capital plays a key role when analyzing economic growth across different parts of the world. Although there is a vast literature available that investigates the relationship between human capital and economic performance, only a small number of studies have explicitly focused on the correlation between the gender gap in education and economic growth (e.g., Barro and Lee 1994; Klasen 2002; Klasen and Lamanna 2009). Gender-based disparities exist in all aspects of society and have become a central characteristic of development, not only on intrinsic grounds but also because of societal and economic benefits. Working towards achieving gender equity is crucial, especially in human capital, since gender gaps in education may have a negative influence on gender imbalances in a wide range of socio-economic realms, starting with domestic inequity but also affecting the employment sector and public life in general.

While existing studies have explored more recent trends in educational gender disparities and their impacts on economic performance, our study applies a path dependence approach aiming to analyze the link between historical gender gaps in schooling and today's economic outcomes in sub-Saharan Africa. More precisely, we contribute to the literature by examining the following questions: First, in what way do long-standing educational gender gaps during the 20th century play a role in today's economic performance of sub-Saharan African regions? Second, do African regions draw economic benefits from having kept girls' schooling at relatively low levels or would an increased investment in female education have been a more efficient economic choice?

Since the mid-20th century, countries in most parts of the world have made significant progress towards closing the gender gap in education, yet no country in sub-Saharan Africa has achieved gender parity in both, primary and secondary education (UNESCO 2015). Baten et al. (2021) find evidence for the existence of an educational gender Kuznets curve i.e., an increase in absolute gender inequality during the early stages of educational expansion in sub-Saharan Africa followed by a consequent decline. However, despite sub-Saharan African countries experiencing a shift towards more educational gender equity in the second half of the 20th century, in comparison with other world regions including the Middle East and North Africa, South Asia, and Southeast Asia, sub-Saharan Africa depicted the highest levels of educational gender inequality by the 1980s, persisting until today (Barro and Lee 2015).

There is no clear consensus to what extent gender inequality in education hampers economic performance or to what extent promoting women's education contributes to sustainable economic benefits. Some older empirical contributions report a puzzling result, indicating that male education has positive externalities on economic growth whereas female schooling negatively affects economic output (Barro and Lee 1994; Barro and Sala-i-Martin 1995). The authors justify their findings by stating that a large gap between female and male educational attainment may be a good measure of "backwardness". Therefore, a low level of female educational attainment indicates lack of progress, providing room for potential growth through the convergence mechanism. These findings have attracted much discussion. Stokey (1994) replicates the study of Barro and Lee (1994) and concludes that female education turns out to be insignificant when controlling for regional fixed effects. Besides she draws attention to the existing multicollinearity problem between the separately included male and female education factors. Lorgelly and Owen (1999) also replicate Barro and Lee's estimates and detect influential observations on four East Asian countries (Hong Kong, Korea, Singapore, and Taiwan) with high levels of growth but low levels of female schooling. They argue that the puzzling finding of female education inversely affecting economic growth is driven by these outliers since excluding them leads to insignificant results. Lorgelly and Owen (1999) contest Barro and Lee's argument of "backwardness" and conclude that their findings are sensitive to their sample. This is confirmed by other empirical studies whose outcomes suggest that gender inequality in educational access and attainment contributes to a decrease in economic welfare (Abu-Ghaida and Klasen 2004; Baliamoune-Lutz and McGillivray 2015; Dollar and Gatti 1999; King and Hill 1993; Klasen 2002; Klasen and Lamanna 2009; Knowles et al. 2002) and that female education fosters economic development (Duflo 2012; Esteve-Volart 2000; Hill and King 1995; King and Hill 1993; Thévenon and Del Pero 2015). Empirical evidence also shows the existence of an indirect link between gender inequality in education and economic growth. Some scholars (e.g., Blackden et al. 2007; King and Hill 1993; Lagerloef 1999) argue that low female education, as a result of educational gender inequality, leads to higher fertility rates and low investment into children's education, which in turn increases poverty and negatively affects economic development. Similarly, there is ample evidence that female education, notably in developing countries decreases fertility rates and at the same time increases the quantity and quality of children's educational outcomes (Knowles et al. 2002; Baliamoune-Lutz and McGillivray 2009).

The repeated cross-sectional design of this cohort study allows us, in contrast to previous research on this topic, to go back in time until the early 20th century and therefore to examine whether today's economic activity in sub-Saharan African regions is inter alia path-dependent on educational gender disparities, prevailing during the past century. Numerous persistence studies have shown that history matters for current economic and social outcomes such as trust in medicine (Lowes and Montero 2021; Alsan and Wanamaker 2018), state capacity and economic development (Acemoglu et al. 2002; Dell 2018; Nunn 2008).

Since path dependence should be examined at different points in time to draw generalizable conclusions, we analyze the persistence of the educational gender gap across several birth decades during the past century. To the best of our knowledge, this is the first persistence study investigating the relationship between gender inequality in education and economic development in sub-Saharan Africa at the sub-national level, using nighttime light data as a proxy for economic output. Basing our repeated cross-sectional analyses on a sample of 5,322 observations, including cohorts born between the 1920s and the 1970s, in 1,107 regions within 19 African countries, we observe that the long-term persistence of educational gender disparities over the past century is negatively associated with economic development in sub-Saharan Africa. In addition, we find evidence that an increase in girls' education is positively correlated with economic output per capita in the long run.

This study is structured as follows: Section 2 introduces satellite-recorded nighttime light intensity which we use as a proxy for regional economic output. Section 3 examines the theoretical linkages between educational gender inequality, female education, and economic performance. Section 4 describes the data and empirical methodology used. Section 5 presents the results followed by a discussion. Section 6 assesses the validity of our results. Section 7 concludes.

2. Nighttime lights as an innovative proxy for economic growth

GDP is widely recognized as one of the most important indicators of economic growth. While GDP data are available for almost all countries in the world, mostly at the national and sometimes at the state level, it fails to measure economic growth patterns of smaller areas. Due to the lack of a global indicator that allows researchers to measure economic output at the regional or local level, there is demand for an alternative statistic that enables us to assess economic development at a disaggregated level across time and space. In recent years, a growing number of scholars have been exploring alternatives to GDP and have discovered that proxies based on satellite nighttime light images inter alia are useful to measure economic activity. Two major studies (Chen and Nordhaus 2011; Henderson et al. 2011) undertook a formal analysis comparing proxies based on nighttime light data to standard economic development measures (i.e., gross domestic product). Results confirmed that nighttime lights are measured with consistent quality and can be used to proxy economic activities at sub-national levels, whereupon further economic research papers followed, using nighttime light data extensively (Henderson et al. 2012; Michalopoulos and Papaioannou 2013, 2014; Pinkovskiy and Sala-i-Martin 2016).

How can we use satellite-recorded nighttime light data as a proxy for economic activity? Nighttime lights, which are observed from space at night, result from human activity. The rationale behind this proxy variable is that higher economic performance boosts human activity, and since light is a necessity for the vast majority of goods consumed at night, the underlying assumption is that light consumption per capita increases with a rise in income. While satellite nighttime light data can be applied in multiple fields, for instance, to measure urbanization (e.g., Harari 2020; Zhang and Seto 2011), electric power consumption (e.g., Letu et al. 2010), natural and humanitarian disasters (e.g., Kohiyama et al. 2004; Li and Li 2014), human well-being and development (e.g., Elvidge et al. 2012; Ghosh et al. 2013), poverty and income inequality (e.g., Elvidge et al. 2009; Noor et al. 2008), many scholars have focused on the application of nighttime light data to study economic activity at sub-national levels including regions, districts, etc. Henderson et al. (2012), for instance, implemented a statistical model where they combined data on nighttime lights with data on income growth between 1992-1993 and 2002-2003 to develop better estimates of income growth. They base their analysis on a panel of 188 countries and find that satellite nighttime light data are suitable estimates for economic growth at disaggregated levels when income data are not available. Doll et al. (2000, 2006) provide further evidence on the suitability of nighttime light data as a proxy for GDP in European countries and the US. Bundervoet et al. (2015) as well as Michalopoulos and Papaioannou (2013, 2014) use nighttime light data to measure the regional development within sub-Saharan Africa. It should be acknowledged that some studies remain skeptical of the use of nighttime light data as a proxy for sub-national activity (Addison and Stewart 2015; Mellander et al. 2015). However, despite existing critiques, Hu et al. (2022) stress the importance of nighttime light data for improving GDP measures in a developing country context where statistical systems are often poor and GDP data prone to measurement errors.

In our study, we make use of both nighttime light data at the level of sub-Saharan African birth regions, corresponding to either first or second level geography, and actual GDP per capita data at the highest administrative level, which we derive from Gennaioli et al. (2013) to support our results. Having introduced the nighttime light indicator as a proxy for economic performance, we now turn to the discussion of the relationship between gender inequality in education and economic development.

3. The underlying theory between gender gaps in education and economic performance

Although it is widely documented that human capital positively affects economic growth, only a limited number of studies have analyzed the relationship between education-based gender differences and economic performance (e.g., Barro and Lee 1994; Klasen 2002; Klasen and Lamanna 2009). In which ways do educational gender disparities affect economic output per capita? It is natural to assume that the innate aptitudes of boys and girls are similarly distributed across both genders and that individuals with more inherent talent are more likely to be educated (Klasen 2002). The existence of gender inequality in education, therefore, means that more boys with less ability receive education compared to gifted girls, resulting in lower average innate abilities of children than if boys and girls had the same chances of acquiring education. Under the assumption that human capital does not only consist of skills acquired through education and at work but also of innate abilities, gender inequality in schooling hence first leads to a decrease in innate abilities and consequently to a decrease in the average level of a society's human capital, negatively affecting the economy's performance (Klasen 2002). Following the same logic, gender-based disparities in education would therefore also weaken the effect of male education and increase the impact of female schooling on economic performance (Dollar and Gatti 1999; Knowles et al. 2002).

Similarly, the average level of human capital declines when considering male and female human capital as imperfect substitutes. In this case, lower average human capital stems rather from higher male education, which generates decreasing marginal returns to education than from the selection of males with lower innate abilities, also hampering economic growth (Knowles et al. 2002). These theoretical claims are confirmed by empirical studies (Hill and King 1995; King and Mason 2001), whose findings show higher marginal returns to the education of girls than boys, which is likely due to this selection effect and diminishing returns to male education.

Working towards a decrease in gender-based inequality in schooling by fostering female education may exert direct and indirect effects on economic development. Evidence shows that an increase in female teachers is in line with higher enrollment rates of girls in primary schooling and an overall rise in schooling rates (Cappelli and Quiroga Valle 2021). According to King and Mason (2001), female education positively affects the quantity and the quality of education that children receive. Subsequently, a better educated next generation with higher average human capital boosts the productivity of workers, positively contributing to economic development. Additionally, it is acknowledged that similar education levels within households have positive externalities on educational quality. Klasen (2002) states that if siblings do have the same level of education, they will be able to mutually strengthen each other’s educational process and success. Hence, supporting girls’ education may positively contribute to these effects. The same is valid for partners. Being equally educated allows them to foster and encourage the gain of new knowledge throughout their lives and consolidate their acquired educational skills. The development of greater human capital through such channels can directly affect positive outcomes in economic development since it allows workers to increase their productivity. Furthermore, there is evidence that countries, which fully exploited the potential of their female population and consequently accumulated sufficient human capital became “superstars”, as Baten and de Pleijt (2018) put it, in long run development.

Some scholars (e.g., Blackden et al. 2007; King and Hill 1993) go beyond analyzing direct influences of educational gender inequality on economic growth and also emphasize indirect channels, notably, demographic effects. Evidence indeed shows that lower educational gender inequality achieved through a rise in female education leads to lower fertility rates, which in turn positively influences economic outcomes. Bloom and Williamson (1998) argue that lower fertility levels will lead to a favorable demographic constellation in the long run since a decline in fertility slows population growth, while the working-age population remains large because of previously high fertility rates. Consequently, more capital per worker will be available (capital deepening) as compared to capital widening, where additional workers are equipped with capital. It further means that the dependency burden is low, which Bloom and Williamson (1998) refer to as a “demographic gift”, allowing for increased saving rates and positively affecting per capita income. Although we will mainly focus on analyzing the direct effects of educational gender inequality on per capita output in this study, we also test for the occurrence of indirect externalities operating through fertility effects.

4. Data and methods

Our cohort study comprises a set of 19 sub-Saharan African countries (Benin, Botswana, Burkina Faso, Cameroon, Ethiopia, Ghana, Guinea, Kenya, Lesotho, Liberia, Malawi, Mali, Rwanda, Senegal, Sierra Leone, South Africa, Tanzania, Uganda, and Zambia), 1,107 administrative birth regions and is based on 5,322[1] observations.

To analyze the impact of prevailing gender inequality in education during the colonial and post-colonial periods on current per capita economic output in African regions, we extend the database used in Baten et al. (2021).[2] This database was constructed based on aggregated data of 15.8 million individuals, aged between 25 and 80 years, who were born between the decades 1920 and 1970[3]. Hence, our repeated cross-sectional analysis covers a time span of 60 years. The birth regions[4] of individuals correspond to either first- or second-level geography[5] and constitute our unit of observation, together with the time dimension of the respective birth decade. Table 1 presents the descriptive statistics of all variables used in this study.

4.1. Measuring regional economic activity with nighttime lights

To measure regional economic activity in sub-Saharan Africa, our dependent variable, we use nighttime light data provided by the National Oceanic and Atmospheric Administration (NOAA 2020). Nighttime light data are based on satellite images collected by the Defense Meteorological Satellite Program (DMSP) Operational Linescan System (OLS) sensor. Every night, between 8:30 and 10:00 pm local time, the satellites observe every part of the earth. The National Oceanic and Atmospheric Administration (NOAA) processes these satellite images and removes cloud-covered images, summer months when the sun sets late, auroral activity, and forest fires. Consequently, the yearly average value of nighttime lights observed by a

[1] Table B1 in the Appendix B gives an overview of the number of birth regions and observations per country and census year included in our sample.

[2] A detailed description of the dataset and variables included can be found in the Appendix A.

[3] Table B2 in the Appendix B provides an overview of the sample construction.

[4] In our analysis, we consider the birth region of individuals instead of their region of residence as a cross-sectional unit of observation. The reason behind this is that at the time of the census enumeration, a certain (unknown) share of residents in a district may have migrated there earlier in their life. It is generally known that migration is highly age-, skill- and sex-selective. Analyzing the level of educational attainment by districts of residence would therefore reflect this compositional effect rather than the spatially uneven educational opportunities for boys and girls, assuming that children complete most of their education in the districts where they are born.

[5] Countries are divided into administrative divisions, which have various geographic levels. In our sample, we use either first or second-level administrative divisions, whereby the first-level corresponds to the largest administrative subdivision of a country.

respective satellite is calculated across all valid observations. NOAA provides three different versions of nighttime light data, which are publicly available for research: stable lights, the average lights x pct (saturated lights that contain detections from fires and other background noise), and radiance-calibrated lights. Like most scholars (e.g., Chen and Nordhaus 2011; Michalopoulos and Papaioannou 2013, 2014), we rely on the stable lights for our analysis, which are available for a period of 22 years between 1992 and 2013. Stable lights depict the relative intensity of lit areas. Non-lit areas have been set to zero and ephemeral lightning events i.e., fires have been removed from the stable light products. Therefore, stable lights allow us to see exclusively man-made lights in the different parts of the world, excluding all sources of natural lights and lights deemed transient.

The satellite-year specific nighttime light data come in grid files with pixels 30 * 30 arc seconds whereby each pixel corresponds to a geographic location of less than one square kilometer (0.86). This allows us to map nighttime light data observed from space on small squares and aggregate them to the level of the sub-national unit we want to study, namely sub-Saharan African birth regions. Existing evidence shows that nighttime light data provided by NOAA strongly correlate with official output measures at various levels, including countries (Henderson et al. 2012), provinces (Hodler and Raschky 2014a, 2014b), and grid cells of 1° x 1° i.e., 100km x 100km near the equator (Chen and Nordhaus 2011, 2015).

Based on our data, Figure 1 shows the correlation between nighttime light intensity per capita and GDP per capita, whereas Figure 2 shows the relationship between nighttime light intensity per area (measured in km^2) and GDP per capita at the country level. For both nighttime light specifications, we find a strong positive correlation with GDP per capita data which we obtain from the World Bank (2013). Figure 3 presents the distribution of GDP data and Figure 4 the distribution of nighttime light data at the country level on the map. We observe higher nighttime light intensities for countries with a relatively higher per capita GDP (darker grey areas) including South Africa, Botswana, Zambia, and Ghana. In contrast, countries with lower GDP per capita levels, for example, Ethiopia, Malawi, Guinea, and Uganda also show lower nighttime light intensities (lighter grey areas).

The average light intensity for each nighttime light pixel is reported by a digital number (DN) ranging from 0 to 63 on a worldwide scale. While zero means no illumination, at 63 nighttime light brightness is saturated. One common caveat with the top-coded pixels is that densely populated areas, including big cities and metropoles, do not appear brighter than mid-sized towns due to sensor saturation, leading to distorted estimates of regional inequality and convergence. Indeed, since a higher light intensity than 63 DN cannot be captured, the differences between rural and urban areas are understated, which in turn leads to an understatement of inequality and overstated convergence. However, only a tiny fraction of pixels (0.1 percent), in wealthy and densely populated areas, take the value 63 (Henderson et al. 2012). Out of these 0.1 percent, less than 0.06 percent concern African countries (Bruederle and Hodler 2018). In our sample, the nighttime light intensity values (DN) range from 0 to 58. Therefore, we do not regard top coding as a major issue for our study. In fact, our concern is rather the opposite. Given the relatively high share of zero values in the stable lights data, we may actually underestimate economic performance in more rural or poorer African regions where still some economic activities take place, which we may not be able to capture with stable nighttime light data. We deal with this issue as best as possible by adding a small constant to the zero nighttime light pixels and we normalize nighttime lights by population.

Since we are interested in analyzing the long-term effects of gender gaps in education on current economic activity in sub-Saharan Africa, we use stable nighttime light data from 2013, the most recent year available. Figure 5 shows the dispersion of our nighttime light data in sub-Saharan Africa at the sub-national level of birth regions. Based on the rationale that educational gender disparity may more likely affect the level of GDP (King and Hill 1993, 1995; Knowles et al. 2002) than its growth rate and because of previous findings, which show that nighttime light data are not suitable for measuring economic growth over time (Addison and Stewart, 2015), we only take cross-sectional stable light data into account. Aggregating these data at the spatial unit of birth regions, we construct our dependent nighttime light variable following Hu and Yao (2022) and Henderson et al. (2012). We use two different specifications for our dependent variable. Since we are not only interested in measuring the overall wealth of a birth region but per capita income, we use nighttime light intensity per capita as our main specification, whereby we aggregate the sum of all DN values of nighttime lights within a birth region, normalized by population. Population data come from the LandScan population distribution database (2013). As an alternative, we construct our nighttime light per area measure for which we calculate an average DN value of all nighttime light pixels per area, measured in square kilometers.

4.2. Measuring educational gender inequality and female education

Data used to construct our main independent variable of interest come from the Integrated Public Use Microdata Series International (IPUMS-I). To measure educational gender disparity in our main analysis, we consider the absolute gender gap by calculating the difference between the average male and female years of schooling completed per birth region and birth decade. A positive number, therefore, indicates that men have acquired more years of schooling than women and a negative number the contrary. As a robustness measure, we also construct the educational gender ratio, which we obtain by dividing average male years of schooling completed by average female years of schooling completed. A ratio of 2, for instance, points out that men have acquired twice as much education as women, whereas a ratio below 1 indicates that women received more education than men. Depending on the measure used, a different perspective is provided. While the educational gender ratio (relative measure) allows us to analyze to what extent education is skewed towards men or women, providing diminishing returns to education, the educational gender gap (absolute measure) considers the difference in actual numbers of school years between men and women, implying constant returns to education.

Although sub-Saharan Africa underwent a genuine schooling revolution during the 20th century, which came along with a substantial decline in educational gender inequality, gender disparities are still considerable, leaving this world region with a poor and erratic record of economic growth. Based on all countries included in our sample, Figure 6 displays the correlation between the educational gender gap during the mid-20th century, where gender inequality was the highest, and current economic performance, proxied by nighttime light intensity per capita. Although the correlation coefficient varies in terms of magnitude, we clearly observe a negative correlation trend for all countries included in our sample, requiring further investigation into this negative association between educational gender gaps and regional per capita GDP in a regression framework.

To measure female education, our second main variable of interest, we obtain data on female years of schooling completed from IPUMS-I. First descriptive analyses displayed in Figure 7 show evidence of an overall positive correlation between the investment in girls' education and economic development at the regional level, for some countries being stronger than for others.

We account for a set of relevant factors, which play an important role in economic development including educational expansion, initial economic development, trading location, colonizer identity, cash crop and mineral production, infrastructure, Christian missions, tsetse fly, population density, labor migration, democracy, civil violence and civil war, and life expectancy. A precise description of these variables, their construction, and data sources can be found in the Appendix A.

4.3. Methodology

We apply a Repeated Cross-Sectional (RCS) Design to undertake a path dependency analysis by running our models for each birth decade separately. Firstly, we examine the association between the long-term existence of educational gender gaps during the 20th century and current economic development in sub-Saharan Africa. Secondly, we focus on female education and analyze whether sub-Saharan Africa would have drawn economic benefits from a greater investment in girls' schooling.

A persistence study usually determines the effect of an explanatory variable X at time t on an outcome variable at time $t + z$, where z represents the time difference and can range from only a few years to millennia. We run six sequent cross-sectional regressions, one per birth decade, considering the timeframe 1920-1979 for our independent variables and the year 2013 for our dependent variable, nighttime light intensity per capita. Using the Generalized Spatial Two-Stage Least Squares (GS2SLS) estimator we run two spatial autoregressive (SAR) models, one where we use the educational gender gap *(male yrsc – female yrsc)* as our main variable of interest and one where we use female education *(female yrsc)* as our main variable of interest.

Regression equation: model 1

$$log\, nighttime\ lights\ pc_i = \rho WY_i + \beta 1 gapyrsc_i^t + \beta 2 maleyrsc_i^t + X_i^t \Gamma + Z_i \gamma + \mu_{(i)r} + \varepsilon_i$$

Regression equation: model 2

$$log\, nighttime\ lights\ pc_i = \rho WY_i + \beta 1 femaleyrsc_i^t + X_i^t \Gamma + Z_i \gamma + \mu_{(i)r} + \varepsilon_i$$

Where the dependent variable *log nighttime lights pc* for the year 2013 proxies current economic per capita output, *gapyrsc* measures educational gender disparities at an absolute level, in the administrative region *i*. In our repeated cross-sectional regression framework, *t* respectively corresponds to the decades 1920, 1930, 1940, 1950, 1960, and 1970. *Maleyrsc,* measured by male years of schooling completed, accounts for educational expansion in region *i* during the birth decade t. X_i^t is a vector of factors varying for each birth decade (i.e., cash crops, endowment of minerals, access to railroads, population density, migration of workers, democracy, civil war, and life expectancy) and Z_i comprises all time-invariant controls including trading location, colonizer identity, Christian missions, tsetse fly suitability and cities 1920. In the second model specification, our main variable of interest *gapyrsc* is replaced by female years of schooling completed, *femaleyrsc,* which allows us to look at the correlation between investment in female education and economic development. To avoid multicollinearity problems, we exclude the variable *maleyrsc* from the second model since it is almost perfectly correlated with *femaleyrsc*. The term μ_r captures regional fixed effects. We account for spatial autocorrelation. Kelly (2019) emphasizes the issues of severe spatial autocorrelation in residuals leading to inflated t-statistics, especially occurring in persistence studies. Therefore, we make use of the Spatial Autoregressive (SAR) Model, controlling for the potential effects that the variation in the explained variable of neighboring birth regions may have on birth region i. ρ, therefore, measures the potential spillover effects of nighttime lights from adjacent administrative regions on birth region i. Our estimates of ρ are partially significant, indicating that our results are influenced by spatial autocorrelation.

We would like to point out that our study is correlational, and we do not claim causality in our findings. Nevertheless, we believe that they are not coincidental. While we are aware of potential endogeneity issues in our data, we are able to reduce reverse causality given the nature of a persistence study, where the outcome Y occurs at a later point in time than the potential drivers X. Indeed, analyzing potential effects of events occurring during the past century (i.e., educational gender gap, female education) on Africa's present-day economic performance allows us to argue that the occurrence of simultaneity is unlikely in our case. That being said, we now turn to the regression results of our repeated cross-sectional persistence study.

5. Results

5.1. Regression using the educational gender gap as a main explanatory variable

Direct effects

Table 2 presents the regression results looking at the link between educational gender disparities prevailing during the 20^{th} century and current regional per capita output. While we use the gap in years of schooling completed between men and women (absolute measure) to proxy educational gender inequality in our main specification, Table B3 in the Appendix B shows similar results when using the educational gender ratio (relative measure) instead[6]. We checked for potential multicollinearity amongst predictors and do not obtain values of VIF above 2.5. Our repeated cross-sectional regression model explains, depending on the birth cohort considered, between 39 and 51 percent of the variance in nighttime light intensity per capita. Coefficients for the educational gender gap variable are consistently significant across all analyzed time periods at a 1 percent significance level (5 percent significance level for the latest two birth cohorts) and are negatively associated with the dependent variable. Table 3 displays the standardized coefficients. We do observe a decline in the magnitude of the educational gender gap coefficient in the second half of the 20th century. While a one standard deviation increase in the educational gender gap is associated with an 8.4 percentage point decrease in nighttime light intensity per capita for the 1920s cohort, for the 1950s cohort, a widening in the gender gap by one standard deviation is correlated with a smaller decline of 6.5 percentage points in economic activity. For the most recent 1970s birth cohort, only a modest negative decline of 2.7 percentage points in economic output per capita can be observed. In terms of educational expansion, an increase in male education is associated with more economic activity per capita across all birth cohorts, with standardized coefficients gradually decreasing from 0.124 for the 1920s birth cohort to 0.084 for the 1970s cohort.

Indirect effects

Our findings confirm previous research (e.g., Blackden et al. 2007; King and Hill 1993), namely that negative externalities of the educational gender gap also operate through demographic effects. Increased fertility rates, potentially resulting from a neglect of female education, are negatively correlated with per capita economic output. In order to understand the extent to which the correlation effect between the educational gender gap and economic performance is mediated through fertility, we follow the approach of Hicks and Tingley (2011) and conduct a mediation analysis. We are interested in analyzing the effect of educational gender inequality on economic development operating via fertility rates. More precisely, we assess how much of the effect of the predictor on the outcome variable is indirect, in other words, transmitted by fertility rates, our mediator variable.

$$\delta_i(t) = Y_i\{t, M_i(1)\} - Y_i\{t, M_i(0)\}$$

[6] Table B4 in the Appendix B displays the results using nighttime light intensity per area (km^2) as a proxy for economic development.

Indirect effects are defined for each region *i* as for each treatment status *t*=0,1. δ_i denotes the change in Y_i, the outcome variable (i.e., economic development) corresponding to a change in M_i, the mediator variable (i.e., fertility rate). Holding the treatment status constant at *t*, we take into account the difference between the value of the mediator observed under the control condition, *Mi(0),* and the value that would be realized under the treatment condition, *Mi(1).* If *Mi(0)* = *Mi(1),* there is no effect of the treatment (i.e., educational gender gap) on the mediator (i.e., fertility rate) and hence the mediation effect would be zero. When both the mediator and outcome variable are continuous, the mediation effect can be expressed by using two linear regressions[7],

$$M_i = \alpha_1 + \beta_1 T_i + \varepsilon_1 \tag{1}$$

$$Y_i = \alpha_2 + \beta_2 T_i + \gamma M_i + \varepsilon_2 \tag{2}$$

and taking the product of treatment variable coefficient in regression *(1)* and the mediator variable coefficient in regression *(2),* i.e., $\beta_1\gamma$.

Having fertility data available for the latest birth decades (1960s and 1970s), we carry out the mediation analysis for each decade separately. Results, presented in Table 4 show that the percentage of the total effect mediated through fertility is relatively low at just under two percent for the 1960s but increases substantially to almost 19 percent for the 1970s. This can potentially be explained by emerging outside options for women. Indeed, inspired by the women's liberation movement but also due to an economic need, more and more women started entering the workforce during the 1970s. Consequently, the number of children in a household started to matter more since women had to balance their time and responsibility towards home and family on the one side and labor market opportunities on the other side.

Controlling for fertility, a widening in the educational gender gap by one year of schooling is associated respectively with a 16.5 percentage point decrease in economic output (column 1) and a 16.2 percentage point decline (column 2). These findings, however, should be interpreted with caution since we do not include further control variables in this part of the analysis.

[7] Figure C.10 represents the mediation model graphically.

5.2. Regression using female education as a main explanatory variable

Replacing our main explanatory variable, the educational gender gap with female years of education, Table 5 shows that an increase in female education is positively correlated with our dependent variable, nighttime light intensity per capita. The coefficients of female education are consistently significant at a 1 percent level across all birth cohorts. Depending on the decade considered, this repeated cross-sectional model explains between 39 and 51 percent of the variation in nighttime light intensity per capita. Table 6 displays the standardized coefficients. While a one standard deviation increase in female education is associated with an 8 percentage point rise in per capita economic output for the 1920s birth cohort, for the 1950s birth cohort, a one standard deviation change in female education results in a 7 percentage point greater level of economic activity. For the latest birth cohort, i.e., individuals born in the 1970s, a one standard deviation increase in female years of schooling completed is correlated with a 9.2 percentage point increase in per capita nighttime lights. We include the same control variables as in our main regression specification but omit male years of schooling to avoid potential multicollinearity problems since this variable is almost perfectly correlated with female years of schooling. The coefficient sizes and significance levels of our controls do not vary much compared to the results we obtain from our main regression specification, presented in Tables 2 and 3.

5.3. Discussion of results

Which mechanisms could potentially explain the correlation between the various explanatory variables used in our study and the outcome variable, nighttime light intensity per capita? In this section, we will discuss our findings in more depth, starting with the main variables of interest, namely the educational gender gap and female education, followed by the control variables.

Educational gender gap and female education

We study the long-term persistence of educational gender disparities in sub-Saharan Africa and show that educational gender gaps during the 20th century are still negatively associated with current nighttime light intensity per capita, our proxy for economic development in sub-Saharan African regions. Our findings are in line with previous studies by various scholars (e.g., Baliamoune–Lutz and McGillivray 2015; Dollar and Gatti 1999; Klasen 2000, 2002; Klasen and Lamanna 2009).

One of the main explanations for the negative correlation between educational gender inequality and economic growth provides the selection-distortion effect (Klasen 2002). Indeed, under the assumption that the distribution of innate skills for girls and boys is approximately the same, educational gender inequality implies that more boys who are less skilled than girls get the chance to receive education. This decreases the overall average innate ability, which would be higher if both girls and boys had equal educational opportunities. This misallocation of educational resources leads to lower levels of human capital, eventually resulting in lower economic output (Dollar and Gatti 1999). Taking into account the observed levels of educational gender inequality in Africa, the selection-distortion effect itself could restrict economic growth by up to 0.3 percent yearly (Klasen 2000).

We observe that the size of the regression coefficients for the educational gender gap variable is larger for the early birth cohorts but decreases considerably for the cohorts born in the second half of the 20th century. The reason for this may primarily lie in the increased relevance of other factors during the rise of globalization including for example foreign direct investments (FDIs), international trade, and technological innovation, relative to educational gender inequality. In addition to the emergence of new important aspects influencing economic development, we also observe an overall decline in gender disparities coming along with educational expansion in sub-Saharan African countries after the 1950s. This decline is demonstrated by the educational gender Kuznets curve, representing an inverse U-relationship between the educational gender gap and educational expansion (Baten et al. 2021). Our results further show that an increase in female education for each birth cohort analyzed in this study (1920-1979) is associated with an increase in regional GDP per capita. We argue, based on our findings that an early initial investment in girls' education would very likely have been of benefit for the present-day economic performance in sub-Saharan Africa. As discussed above, a decline in the educational gender gap, which translates into more female education at each level of male education, is likely to exert positive externalities on the quality of overall education. Evidence has shown that female education has a positive impact on the educational outcomes of future generations since educated mothers are able to provide a supportive environment for their children's education (Klasen 2002). Hence, the promotion of girls' education may, via a higher quality of human capital, also positively contribute to a higher economic output per capita.

Besides examining the potential direct effects of gender disparities and female education on economic development, we also apply a mediation analysis to explore potential indirect externality effects operating via demographic effects. Our results show that part of this negative correlation between the gender gap in education and regional GDP per capita (around 19 percent) can be explained by the mediating influence of fertility rates. This finding is in line with Lagerloef (1999) who applies the overlapping generations model (OLG) to explore the interaction between gender inequality in education, high fertility rates, and low overall investments in human capital and economic growth. He argues that initial gender disparities in education can result in a poverty trap by boosting fertility rates and consequently keeping existing gender gaps high, leading to lower economic growth. Working towards educational gender parity, i.e., an increase in female education could contribute to a decline in fertility rates, affecting economic output per capita through the following mechanisms: First reduced population growth promotes economic growth via increased investments that can be used for capital deepening rather than capital widening. This means that the capital-labor ratio increases, allowing for more capital per worker instead of equipping new workers with capital, leading to increased economic output per capita. Second, lower fertility rates lead to a decline in the dependency burden and consequently to higher savings in an economy. Third, over a limited period of time, the working-age population will represent a larger share of the overall population, resulting from previously high fertility rates. This will foster the demand for investment since higher domestic savings are available due to a lower dependency burden. This expansion of investment is also likely to boost economic growth. Fourth, if an economy has the capacity to absorb the growing labor force and offers increased employment opportunities, economic output per capita will increase, even though productivity does not change, and wages remain the same. This can be explained by the fact that a larger proportion of the working-age population shares their income with a relatively smaller number of dependents, resulting in higher per capita income. As previously mentioned, Bloom and Williamson (1998) refer to these last two mechanisms as a “demographic gift”, since they have substantially contributed to fast economic expansion in East and Southeast Asia (Young 1995; Bloom and Williamson 1998). However, these effects are only temporary and fade once the working-age population retires and the dependency ratio starts to increase once again since the employment to population ratio will decrease due to lower fertility rates. Even though we do not quantitatively evaluate the effectiveness of each of these mechanisms, it is still important to have clarified the different ways in which lower fertility rates, obtained by an increase in female education, may positively affect economic development.

6. Robustness test

Even though nighttime light data have been extensively used in economic studies, typically to measure economic activity, these data are not entirely without shortcomings. One of the main issues that NOAA nighttime light data poses to our study is that nighttime lights in rural areas and in low-density settlements are not easily detectable from space. It is true that nighttime lights measure better economic activity in urban areas, first because of the type of lights required (i.e., high-pressure sodium lamps) in order to be detected by satellites, and second because higher population densities in cities produce more concentrated sources of lights. Since we are unable to account for these conditions and because we want to make sure that our results are robust, we perform a sensitivity analysis where we use real GDP per capita data, collected by Gennaioli et al. (2013). Based on an aggregated database including 1,569 sub-national regions from a total of 110 countries, which are mostly available at the first-level administrative division[8], Gennaioli et al. (2013) construct regional GDP data. Since data on regional GDP are not available for all countries, the authors use data on income (six countries), expenditure (eight countries), wages (three countries), gross value added (two countries), and consumption, investment, and government expenditure (one country). For our robustness test, we hence derive the regional GDP[9] per capita variable from this database. Because regions are aggregated to the highest administrative subdivision and not all our countries studied are available[10], our dataset declines to 626 observations.

Replacing our dependent variable with real GDP per capita, we perform our repeated cross-sectional regression analysis. From Table 7 we infer that our main variable of interest, the educational gender gap remains significant at a 5 percent level for most birth cohorts, except for individuals born in the 1930s and 1940s. Table 8 shows positive regression coefficients for female education, significant at a 1 percent level throughout all birth decades, confirming the positive correlation with economic development that we find in our main analysis.

[8] The first-level administrative division used by Gennaioli et al. (2013) mostly comprises states and provinces.

[9] An overview of the type and source of regional GDP data for the countries included in our sample can be found in the Appendix B, Table B4. Gennaioli et al. (2013) obtain data on regional population from Thomas Brinkhoff: City Population, http://www.citypopulation.de/

[10] 7 countries are missing including Botswana, Ethiopia, Guinea, Liberia, Mali, Rwanda, and Sierra Leone

7. Conclusion

Though there is no doubt that Africa underwent a substantial schooling revolution during the 20^{th} century, it remains not only the least educated but also became the most gender unequal continent in terms of educational provision by the 1980s, showing poor economic performance. While the impact of human capital formation on economic growth has been widely studied, the effects of educational gender disparities have been addressed in a far too limited manner. Knowing that two-third of the world's countries, which have not achieved gender parity in primary education are located in sub-Saharan Africa (UNESCO 2020), we considered it important to investigate the consequences of long-standing gender gaps in education on current economic outcomes in this part of the world. While we do not claim causality, our results show sufficient evidence for a significant negative relationship between prevailing educational gender inequality in sub-Saharan African regions throughout the 20^{th} century and present-day economic performance, leading us to the conclusion that path dependency matters. We also go beyond analyzing the direct relationship between historical gender disparities and economic development by carrying out a mediation analysis. Our findings show that part of this negative correlation is mediated by fertility. Bearing in mind that better educated women tend to have lower fertility rates, we examine whether sub-Saharan African regions could have benefited economically from an early initial investment into girls' education, and we can answer this question with a clear yes. Again, we do not make causal claims but rather emphasize the strong positive correlation we detect between female education during the past century and current regional GDP per capita output, suggesting that sub-Saharan African regions actually miss out on economic gains when keeping girls' education at low levels. Therefore, it is essential to find and tackle the roots of educational gender gaps. Depending on whether gender gaps are dynamic or structural, the approach to remedy diverges. In the case of dynamic gender gaps, an overall investment in education may be a useful policy implication. Structural gender disparities in schooling, on the other hand, are often at the source of region-specific biases prevailing against female education that need to be tackled. While this study has merely focused on the implications of educational gender inequality and female education on economic performance in African regions, it is essential to point out that working towards gender parity in education should be a priority in itself, independent of economic outcomes. Female education plays an important role in many other development fields, besides the economic sector, notably in social development, and therefore investment into the education of girls may come with many social benefits including the empowerment of women. This may likewise lead to positive spillover effects, not only reducing gender inequality at a household level but also affecting the employment sector, the gender wage gap, and female participation in various spheres including politics, which may be subject to further studies.

Acknowledgements

I am grateful to Joerg Baten, Jutta Bolt, Markus Pudelko, Sarah Ferber and Laura Radatz for their constructive and detailed feedback. A big thank you goes also to all participants of the 2021 Baden-Wuerttemberg conference, the 2021 AEHN meeting in Lund and the 2021 ICEA Virtual Conference who provided me with further valuable, insightful comments and suggestions on my work. This research did not receive any specific grant from funding agencies in the public, commercial, or not-for-profit sectors.

References

Abu-Ghaida, D., & Klasen, S. (2004). The costs of missing the Millennium Development Goal on gender equity. *World Development*, *32*(7), 1075-1107.

Acemoglu, D., Johnson, S., & Robinson, J. A. (2002). Reversal of fortune: Geography and institutions in the making of the modern world income distribution. *The Quarterly journal of economics, 117*(4), 1231-1294.

Addison, D. M., & Stewart, B. (2015). Nighttime lights revisited: the use of nighttime lights data as a proxy for economic variables. *World Bank Policy Research Working Paper,* (7496).

Alsan, M., & Wanamaker, M. (2018). Tuskegee and the health of black men. *The quarterly journal of economics, 133*(1), 407-455

Baliamoune-Lutz, M., & McGillivray, M. (2009). Does gender inequality reduce growth in sub-Saharan African and Arab countries?. *African Development Review, 21*(2), 224-242.

Baliamoune–Lutz, M., & McGillivray, M. (2015). The impact of gender inequality in education on income in Africa and the Middle East. *Economic Modelling, 47,* 1-11.

Barro, R. J., & Lee, J. W. (1994). Sources of economic growth. *In Carnegie-Rochester conference series on public policy* (*Vol. 40,* pp. 1-46). North-Holland.

Barro, R. J., & Lee, J. W. (2015). *Education matters: Global schooling gains from the 19th to the 21st century.* Oxford University Press

Barro, R. J., & Sala-i-Martin, X. (1995). *Economic Growth.* McGraw-Hill. New York.

Basu, A. M. (2002). Why does education lead to lower fertility? A critical review of some of the possibilities. *World Development*, *30*(10), 1779-1790.

Baten, J., & de Pleijt, A. (2018). Female autonomy generates superstars in long-term development: Evidence from 16th to 19th century Europe. *Available at SSRN 3295006*.

Baten, J., De Haas, M., Kempter, E., & Meier zu Selhausen, F. (2021). Educational Gender Inequality in Sub-Saharan Africa: A Long-Term Perspective. *Population and Development Review*, *47*(3), 813-849.

Blackden, M., Canagarajah, S., Klasen, S., & Lawson, D. (2007). Gender and growth in Sub-Saharan Africa: issues and evidence. *In Advancing Development* (pp. 349-370). Palgrave Macmillan, London.

Bloom, D. E., & Williamson, J. G. (1998). Demographic transitions and economic miracles in emerging Asia. *The World Bank Economic Review*, *12*(3), 419-455.

Bruederle, A., & Hodler, R. (2018). Nighttime lights as a proxy for human development at the local level. *PloS one, 13*(9), e0202231.

Bundervoet, T., Maiyo, L., & Sanghi, A. (2015). Bright lights, big cities: measuring national and sub-national economic growth in Africa from outer space, with an application to Kenya and Rwanda. *World Bank Policy Research Working Paper*, (7461).

Cappelli, G., & Quiroga Valle, G. (2021). Female teachers and the rise of primary education in Italy and Spain, 1861–1921: evidence from a new dataset. *The Economic History Review, 74*(3), 754-783.

Chen, X., & Nordhaus, W. (2015). A test of the new VIIRS lights data set: Population and economic output in Africa. *Remote Sensing, 7*(4), 4937-4947.

Chen, X., & Nordhaus, W. D. (2011). Using luminosity data as a proxy for economic statistics. *Proceedings of the National Academy of Sciences, 108*(21), 8589-8594.

Cremin, P., & Nakabugo, M. G. (2012). Education, development and poverty reduction: A literature critique. International Journal of Educational Development, 32(4), 499-506.

Dell, M., Lane, N., & Querubin, P. (2018). The historical state, local collective action, and economic development in Vietnam. *Econometrica*, *86*(6), 2083-2121.

Doll, C. N., Muller, J. P., & Elvidge, C. D. (2000). Night-time imagery as a tool for global mapping of socioeconomic parameters and greenhouse gas emissions. *Ambio*, 157-162.

Doll, C. N., Muller, J. P., & Morley, J. G. (2006). Mapping regional economic activity from night- time light satellite imagery. *Ecological Economics, 57*(1), 75-92.

Dollar, D., & Gatti, R. (1999). *Gender inequality, income, and growth: are good times good for women?* (Vol. 1). Washington, DC: Development Research Group, The World Bank.

Duflo, E. (2012). Women empowerment and economic development. *Journal of Economic literature, 50*(4), 1051-79.

Elvidge, C. D., Baugh, K. E., Anderson, S. J., Sutton, P. C., & Ghosh, T. (2012). The Night Light Development Index (NLDI): a spatially explicit measure of human development from satellite data. *Social Geography, 7*(1), 23-35

Elvidge, C. D., Sutton, P. C., Ghosh, T., Tuttle, B. T., Baugh, K. E., Bhaduri, B., & Bright, E. (2009). A global poverty map derived from satellite data. *Computers & Geosciences,* 35(8), 1652-1660.

Esteve-Volart, B. (2000). *Sex discrimination and growth.* IMF Working Paper WP/00/84, International Monetary Fund, African Department, Washington, D.C

Gennaioli, N., La Porta, R., Lopez-de-Silanes, F., & Shleifer, A. (2013). Human capital and regional development. *The Quarterly journal of economics, 128*(1), 105-164.

Ghosh, T., Anderson, S. J., Elvidge, C. D., & Sutton, P. C. (2013). Using nighttime satellite imagery as a proxy measure of human well-being. *sustainability, 5*(12), 4988-5019.

Harari, M. (2020). Cities in bad shape: Urban geometry in India. *American Economic Review, 110*(8), 2377-2421.

Henderson, J. V., Storeygard, A., & Weil, D. N. (2012). Measuring economic growth from outer space. *American economic review, 102*(2), 994-1028.

Henderson, V., Storeygard, A., & Weil, D. N. (2011). A bright idea for measuring economic growth. *American Economic Review, 101*(3), 194-99.

Hicks, R., & Tingley, D. (2011). Causal mediation analysis. *The Stata Journal, 11*(4), 605-619.

Hill, M. A., & King, E. (1995). Women's education and economic well-being. *Feminist Economics, 1*(2), 21-46.

Hodler, R., & Raschky, P. A. (2014a). Regional favoritism. *The Quarterly Journal of Economics, 129*(2), 995-1033.

Hodler, R., & Raschky, P. A. (2014b). Economic shocks and civil conflict at the regional level. *Economics Letters, 124*(3), 530-533.

Hu, Y., & Yao, J. (2022). Illuminating economic growth. *Journal of Econometrics, 228*(2), 359-378.

Kelly, M. (2019). The standard errors of persistence. *CEPR Discussion Paper* No. 13783.

King, E. M., & Hill, M. A. (Eds.). (1993). *Women's education in developing countries: Barriers, benefits, and policies*. World Bank Publications.

King, E., & Mason, A. (2001). *Engendering development: Through gender equality in rights, resources, and voice.* The World Bank.

Klasen, S. (2000). Does gender inequality reduce growth and development? Evidence from cross- country regressions.

Klasen, S. (2002). Low schooling for girls, slower growth for all? Cross-country evidence on the effect of gender inequality in education on economic development. *The World Bank Economic Review, 16*(3), 345-373.

Klasen, S., & Lamanna, F. (2009). The impact of gender inequality in education and employment on economic growth: new evidence for a panel of countries. *Feminist economics, 15*(3), 91- 132.

Knowles, S., Lorgelly, P. K., & Owen, P. D. (2002). Are educational gender gaps a brake on economic development? Some cross-country empirical evidence. *Oxford economic papers, 54*(1), 118-149.

Kohiyama, M., Hayashi, H., Maki, N., Higashida, M., Kroehl, H. W., Elvidge, C. D., & Hobson, V. R. (2004). Early damaged area estimation system using DMSP-OLS night-time imagery. *International Journal of Remote Sensing, 25*(11), 2015-2036.

Lagerlöf, N. (1999). Gender inequality, fertility, and growth. *Mimeographed. Department of Economics, University of Sydney.*

LandScan population distribution database (2013), retrieved from https://landscan.ornl.gov/documentation

Letu, H., Hara, M., Yagi, H., Naoki, K., Tana, G., Nishio, F., & Shuhei, O. (2010). Estimating energy consumption from night-time DMPS/OLS imagery after correcting for saturation effects. *International journal of remote sensing, 31*(16), 4443-4458.

Li, X., & Li, D. (2014). Can night-time light images play a role in evaluating the Syrian Crisis?. *International Journal of Remote Sensing, 35*(18), 6648-6661.

Lorgelly, P. K., & Owen, P. D. (1999). The effect of female and male schooling on economic growth in the Barro-Lee model. *Empirical economics, 24*(3), 537-557.

Lowes, S., & Montero, E. (2021). The legacy of colonial medicine in Central Africa. *American Economic Review*, *111*(4), 1284-1314.

Mellander, C., Lobo, J., Stolarick, K., & Matheson, Z. (2015). Night-time light data: A good proxy measure for economic activity?. *PloS one, 10*(10), e0139779.

Michalopoulos, S., & Papaioannou, E. (2013). Pre-colonial ethnic institutions and contemporary African development. *Econometrica*, *81*(1), 113-152.

Michalopoulos, S., & Papaioannou, E. (2014). National institutions and sub-national development in Africa. *The Quarterly journal of economics*, *129*(1), 151-213.

NOAA (2020): National Oceanic and Atmospheric Administration. Version 4 DMSP-OLS Nighttime Lights, Time Series, Stable Lights. URL:https://ngdc.noaa.gov/eog/dmsp/downloadV4composites.html; downloaded April 3, 2020.

Noor, A. M., Alegana, V. A., Gething, P. W., Tatem, A. J., & Snow, R. W. (2008). Using remotely sensed night-time light as a proxy for poverty in Africa. *Population Health Metrics, 6*(1), 5.

Nunn, N. (2008). The long-term effects of Africa’s slave trades. *The Quarterly Journal of Economics*, *123*(1), 139-176.

Pinkovskiy, M., & Sala-i-Martin, X. (2016). Lights, camera,.income! illuminating the national accounts-household surveys debate. *Quarterly Journal of Economics, 131*(2), 579–631.

Riddell, W. C., & Song, X. (2017). The role of education in technology use and adoption: Evidence from the Canadian workplace and employee survey. ILR Review, 70(5), 1219-1253.

Stokey, N. (1994). Comments on Barro and Lee. In *Carnegie-Rochester Conference Series on Public Policy* (Vol. 40, No. 1, pp. 47-57). Elsevier.

Thévenon, O., & Del Pero, A. S. (2015). Gender equality (f) or economic growth? Effects of reducing the gender gap in education on economic growth in OECD countries. *Annals of Economics and Statistics/Annales d’Économie et de Statistique,* (117/118), 353-377.

Tilak, J. B. (2007). Post-elementary education, poverty and development in India. International journal of educational development, 27(4), 435-445.

UNESCO (2015), Gender and EFA 2000-2015: achievements and challenges; EFA global monitoring report 2015

UNESCO (2020), Institute for Statistics (UIS) Database. Accessed December 16, 2020. http://data.uis.unesco.org

Young, A. (1995). The tyranny of numbers: confronting the statistical realities of the East Asian growth experience. *The Quarterly Journal of Economics, 110*(3), 641-680.

Zhang, Q., & Seto, K. C. (2011). Mapping urbanization dynamics at regional and global scales using multi-temporal DMSP/OLS nighttime light data. *Remote Sensing of Environment, 115*(9), 2320-2329.

Figures and tables

Figure 1: Correlation between nighttime light intensity per capita and GDP

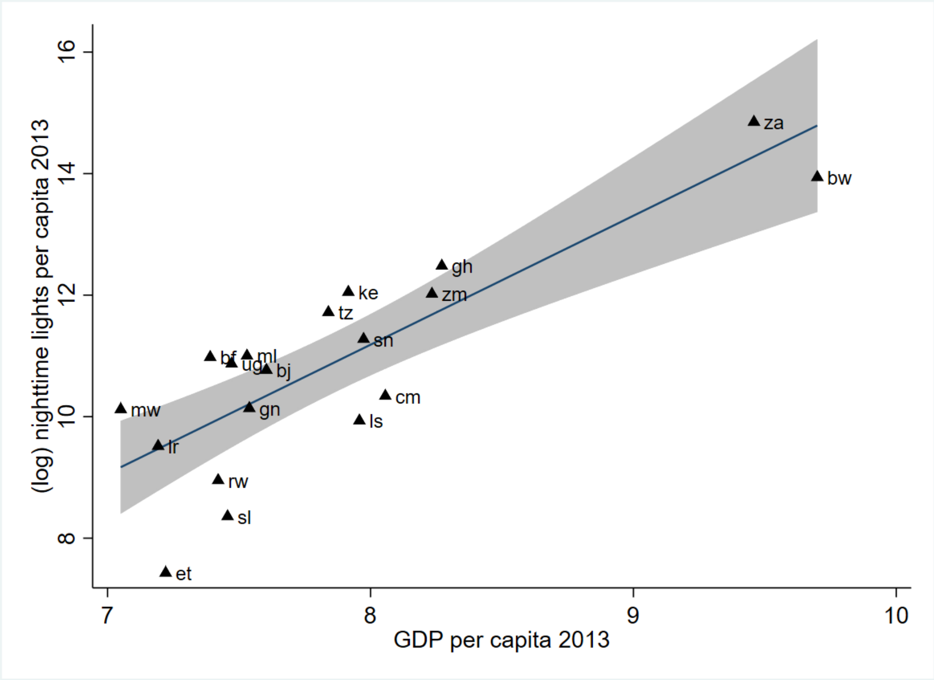

Figure 2: Correlation between nighttime light intensity per km^2 and GDP

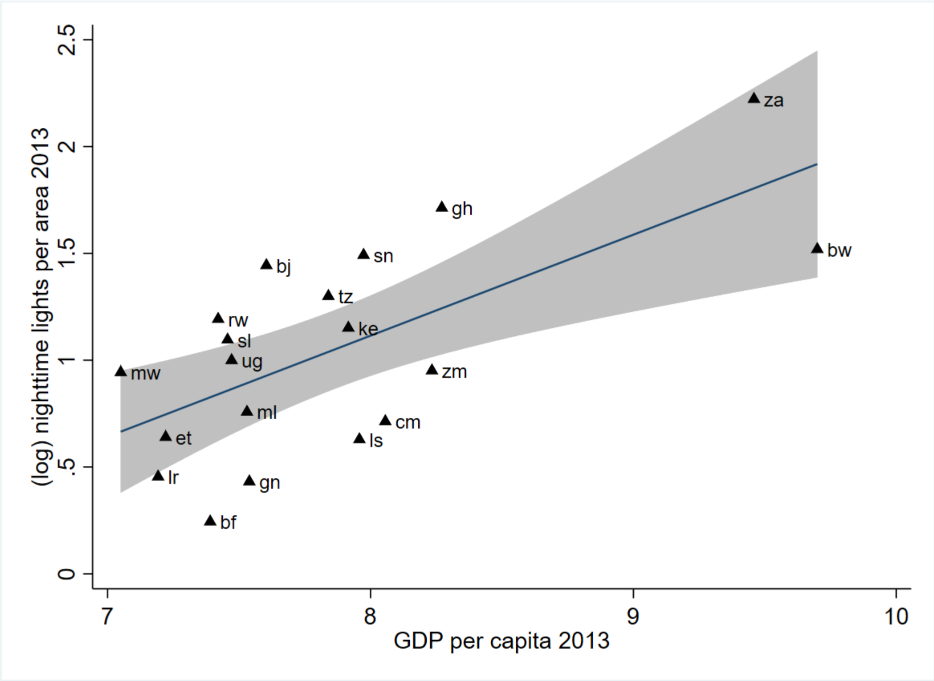

Figure 3: Distribution of GDP data (2013) at the country level

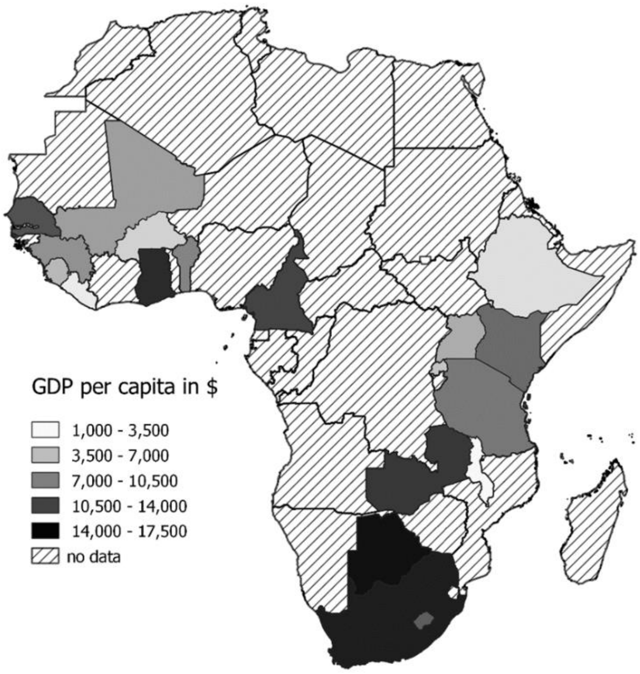

Figure 4: Distribution of nighttime light data (2013) at the country level

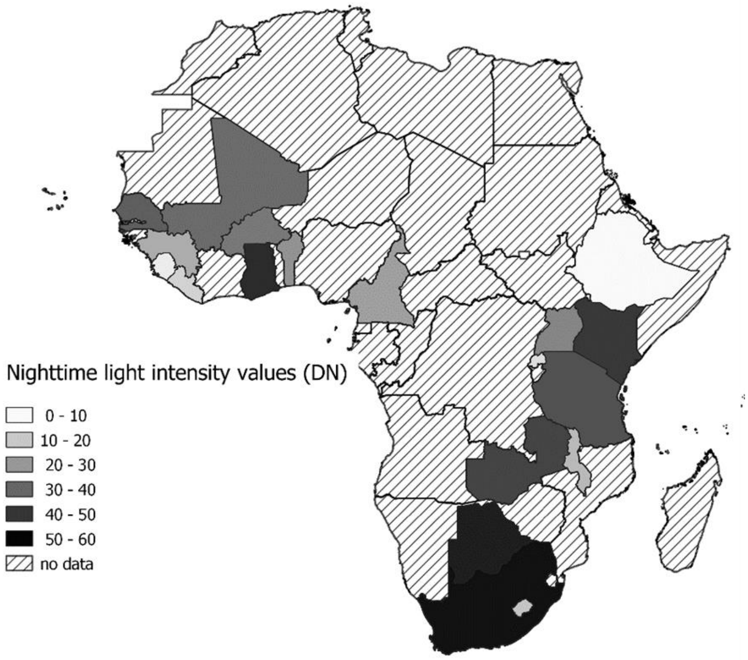

Figure 5: Distribution of nighttime light data at the sub-national level

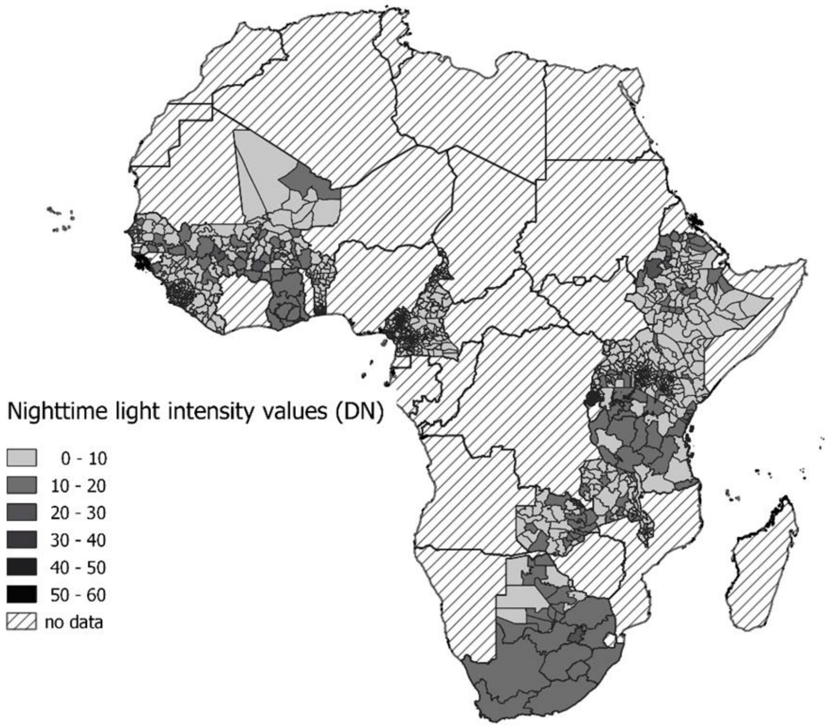

Figure 6: Correlation between the gender gap in education and nighttime light intensity

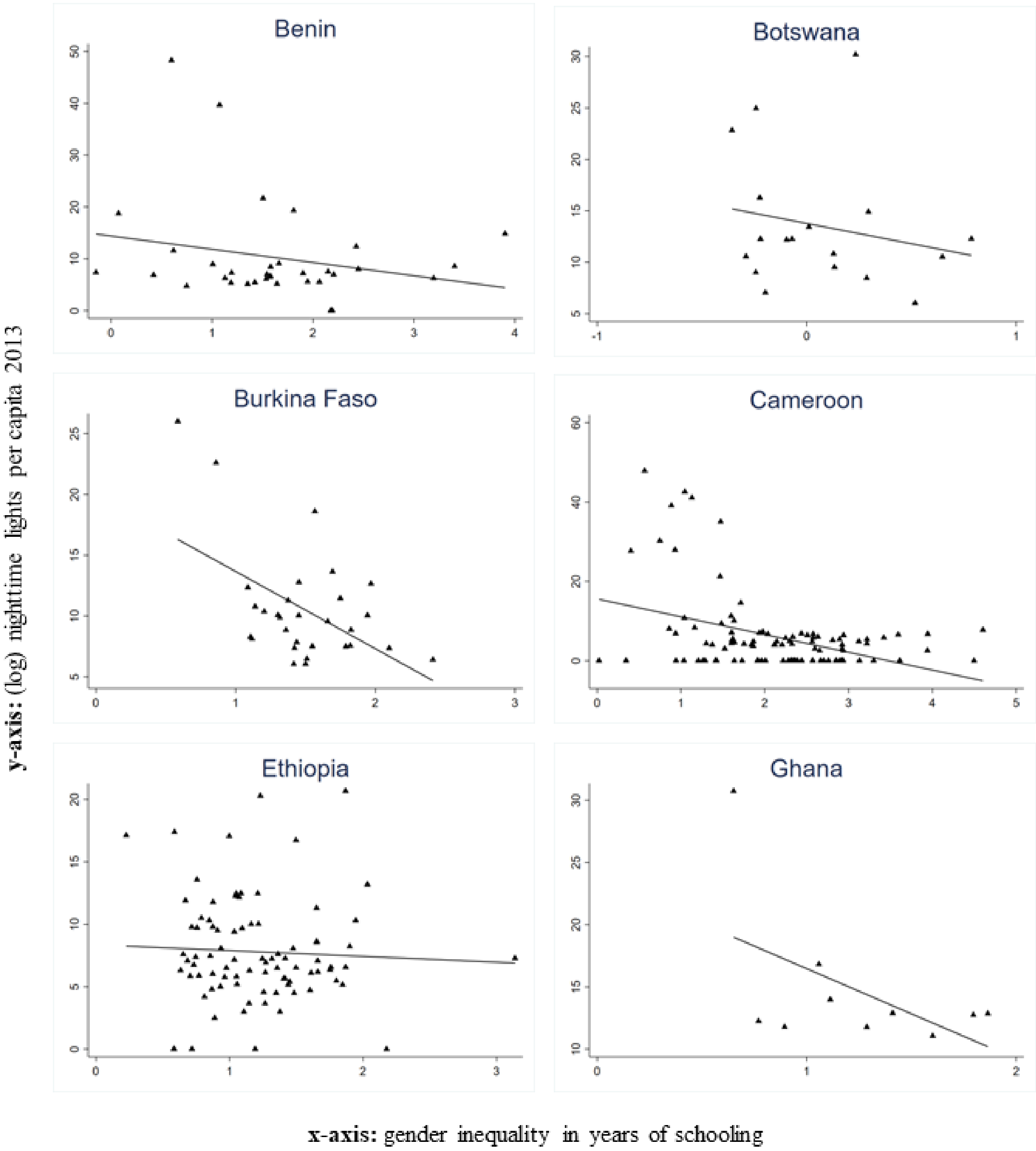

Figure 6 (cont.): Correlation between the gender gap in education and nighttime light intensity

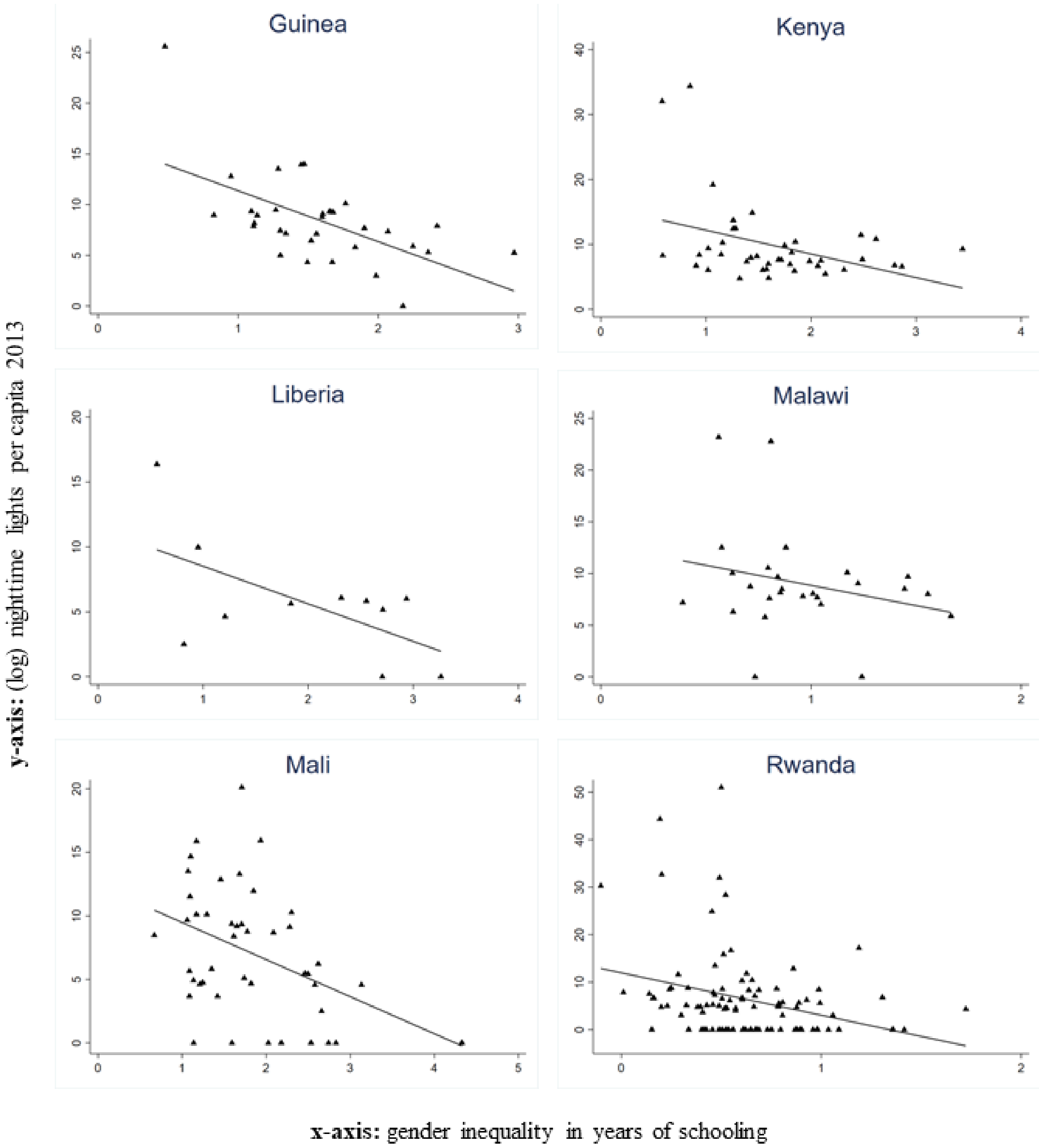

Figure 6 (cont.): Correlation between the gender gap in education and nighttime light intensity

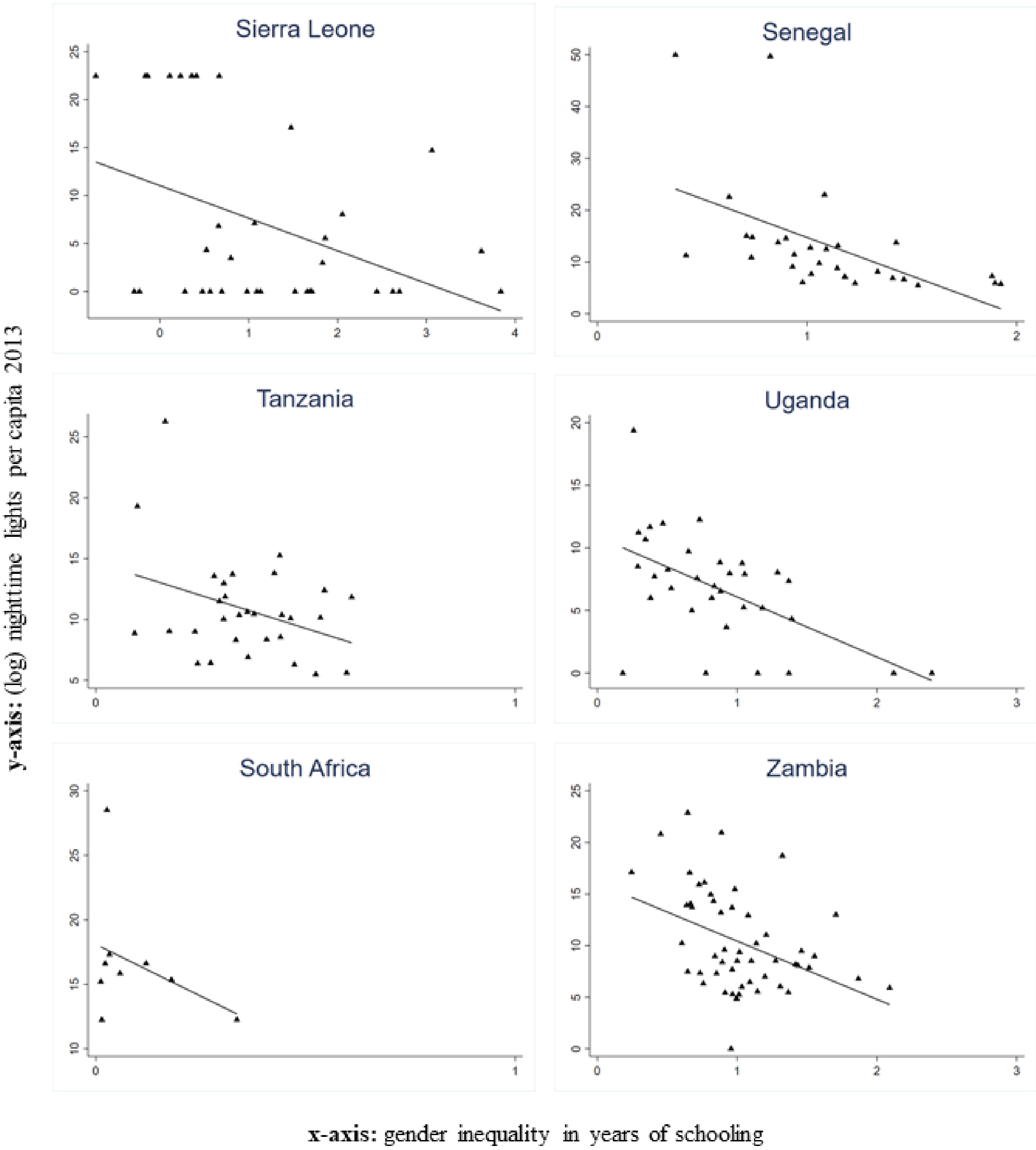

Figure 7: Correlation between the female education and nighttime light intensity

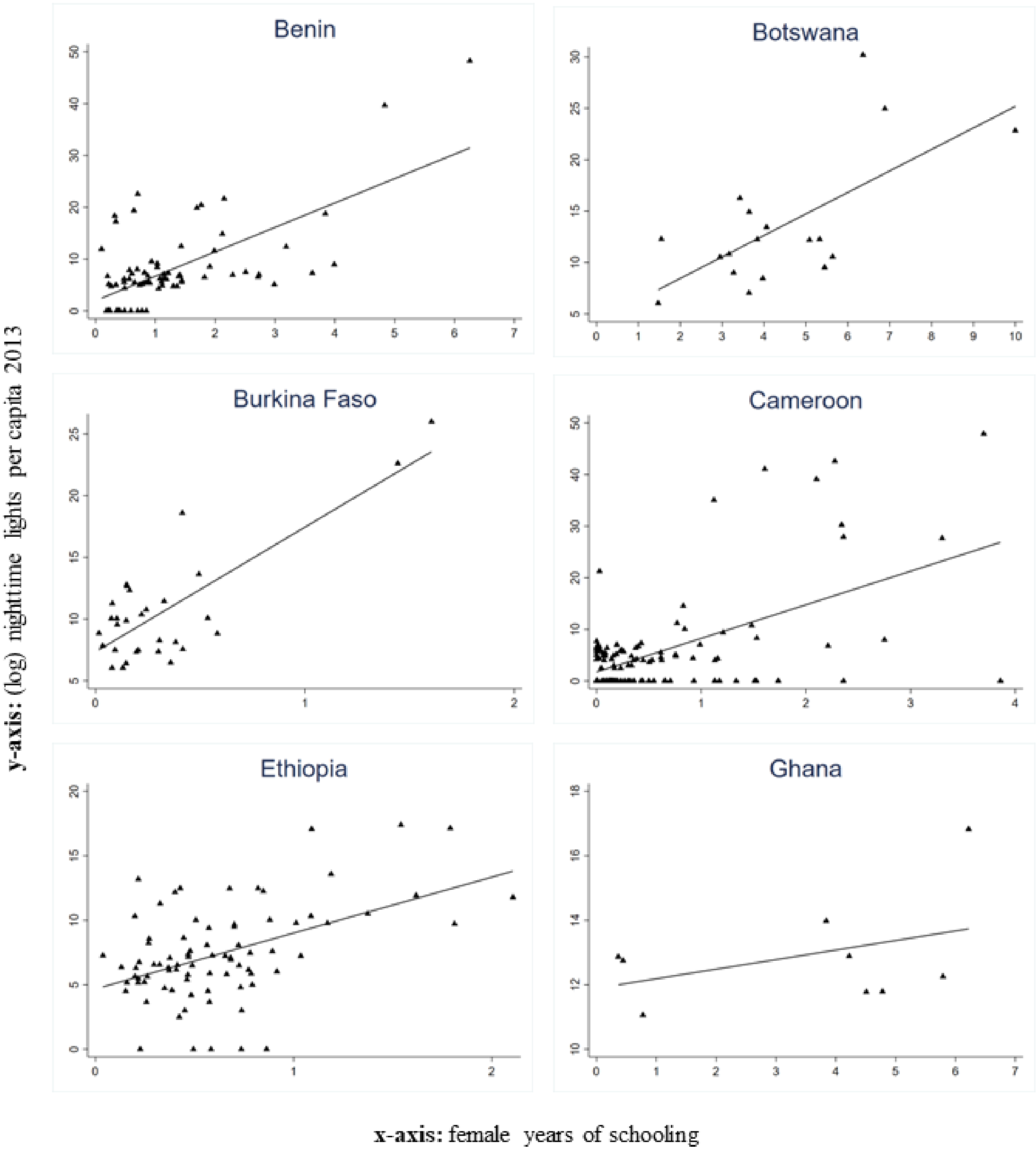

Figure 7 (cont.): Correlation between the female education and nighttime light intensity

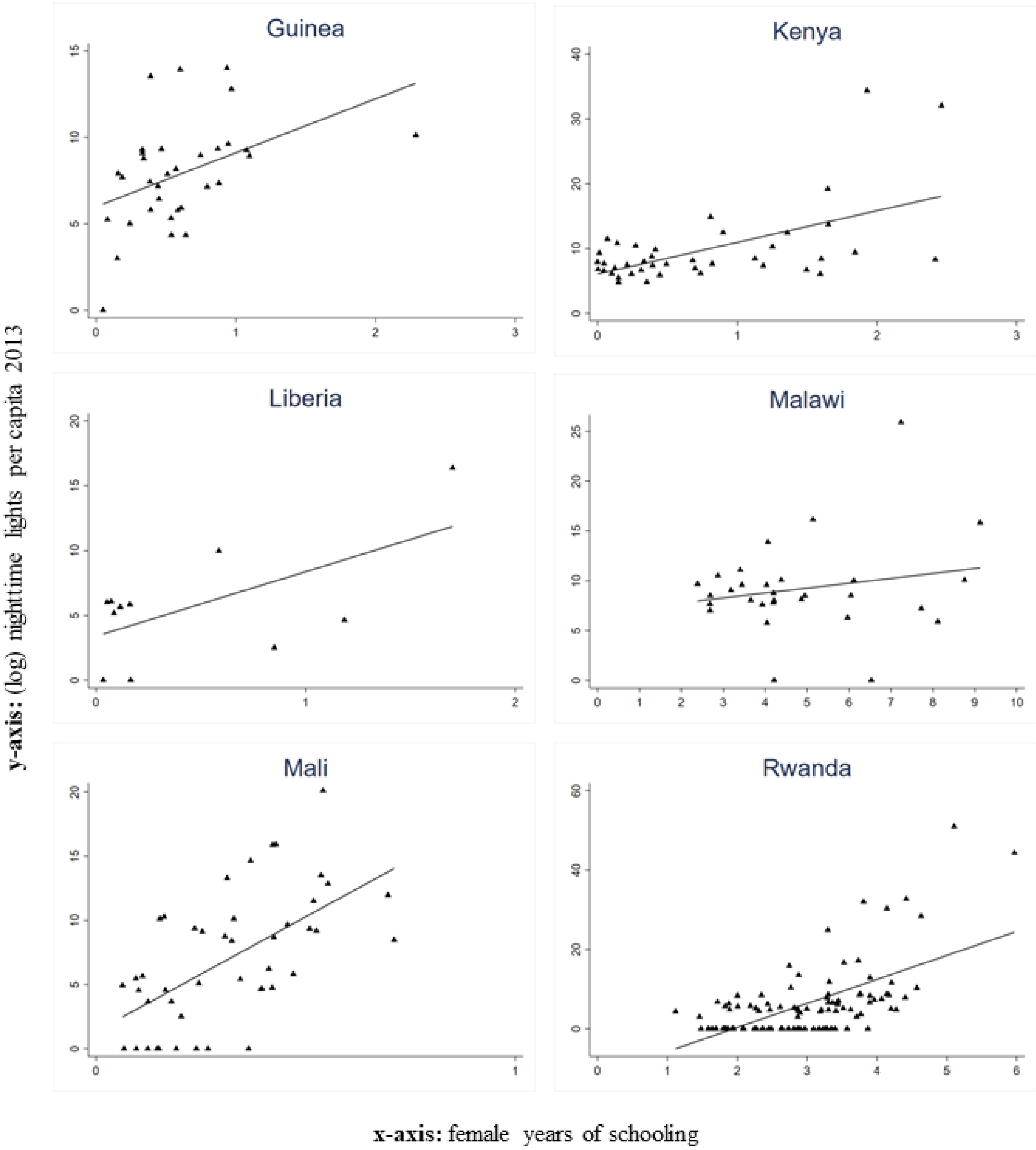

Figure 7 (cont.): Correlation between the female education and nighttime light intensity

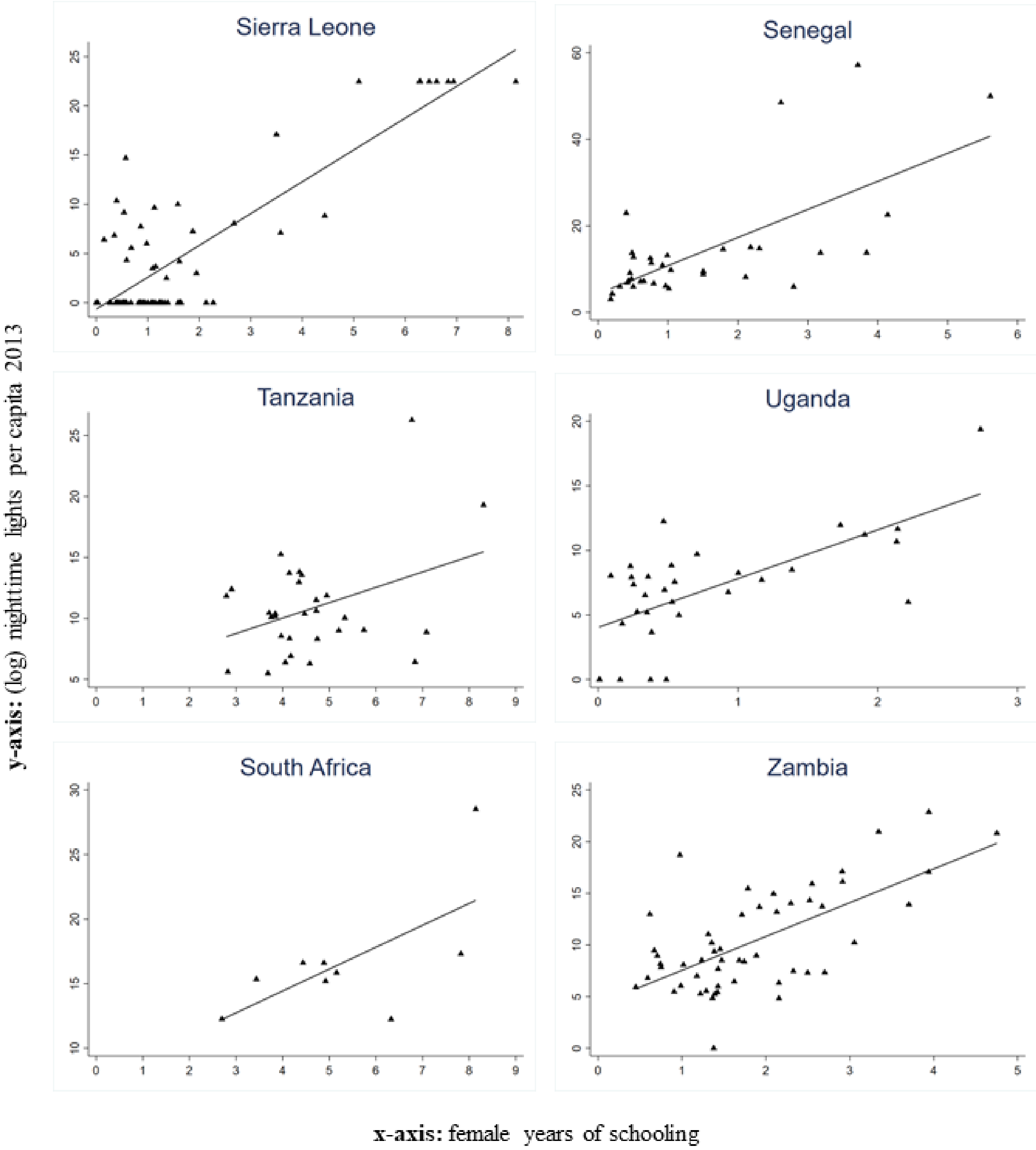

Figure 8: Mediation model

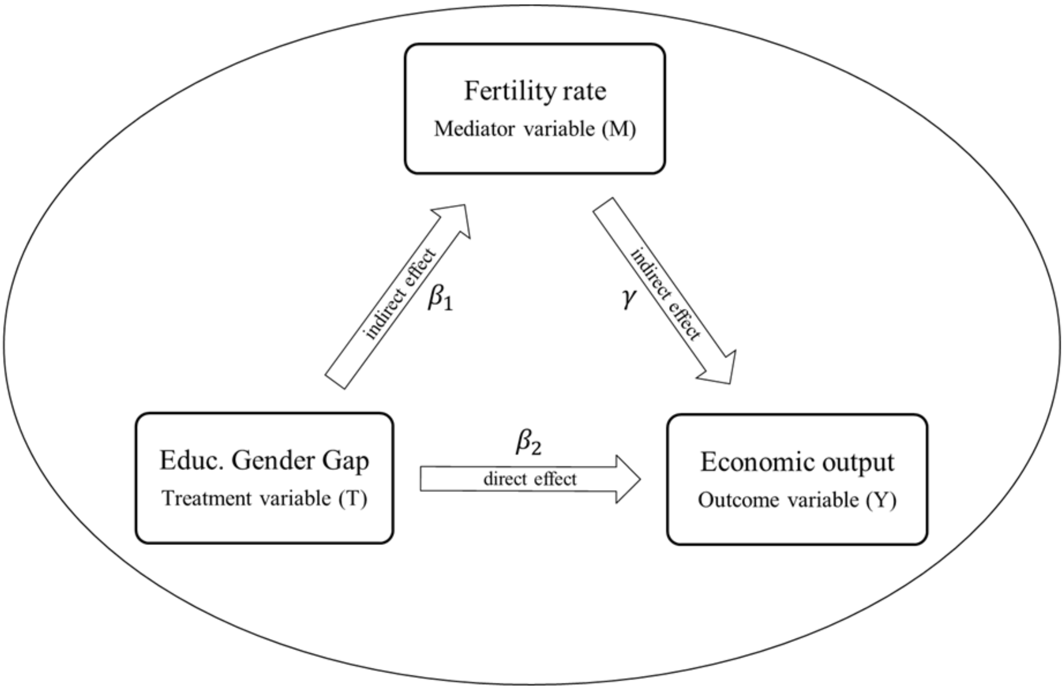

Table 1: Descriptive statistics of variables

	1920-1929					1930-1939					1940-1949				
Variables	Obs.	Mean	SD	Min	Max	Obs.	Mean	SD	Min	Max	Obs.	Mean	SD	Min	Max
Nighttime lights p.c. (log)	803	8.067	7.580	0.000	51.000	804	8.078	7.582	0.000	51.000	805	8.096	7.595	0.000	51.000
Educational gender gap	803	0.895	0.949	-3.600	6.500	804	1.367	1.112	-1.993	6.417	805	1.824	1.241	-1.525	5.368
Female years of education	803	0.367	0.908	0.000	8.250	804	0.553	0.910	0.000	7.534	805	1.079	1.317	0.000	8.141
Male years of education	803	1.262	1.407	0.000	11.000	804	1.921	1.636	0.000	9.105	805	2.903	2.127	0.051	9.333
Dummy if coast	803	0.096	0.294	0.000	1.000	804	0.096	0.294	0.000	1.000	805	0.096	0.294	0.000	1.000
French colonies	803	0.306	0.461	0.000	1.000	804	0.307	0.462	0.000	1.000	805	0.308	0.462	0.000	1.000
British colonies	803	0.267	0.442	0.000	1.000	804	0.266	0.442	0.000	1.000	805	0.266	0.442	0.000	1.000
Mandated territories	803	0.296	0.457	0.000	1.000	804	0.296	0.457	0.000	1.000	805	0.296	0.457	0.000	1.000
Independent countries	803	0.131	0.337	0.000	1.000	804	0.131	0.337	0.000	1.000	805	0.130	0.337	0.000	1.000
Cash crops p.c. (log)	782	0.571	1.237	0.000	5.945	783	0.528	1.051	0.000	4.900	784	0.593	1.090	0.000	4.532
Minerals p.c. (log)	803	0.029	0.326	0.000	4.866	804	0.053	0.567	0.000	7.877	805	0.051	0.547	0.000	7.299
Dummy if railroad	803	0.167	0.373	0.000	1.000	804	0.210	0.408	0.000	1.000	805	0.245	0.430	0.000	1.000
Dummy if main mission 1924	803	0.248	0.432	0.000	1.000	804	0.248	0.432	0.000	1.000	805	0.247	0.431	0.000	1.000
Tsetse suitability index	736	-0.011	0.648	-1.587	1.495	737	-0.012	0.648	-1.587	1.495	737	-0.012	0.648	-1.587	1.495
Population density (log)	803	0.098	1.582	-5.579	4.781	804	0.660	1.590	-4.747	5.113	805	0.985	1.599	-4.763	5.462
Cities 1920	803	0.133	0.495	0.000	6.000	804	0.133	.495	0.000	6.000	805	0.133	0.495	0.000	6.000
Migration of workers (no)	803	0.573	0.495	0.000	1.000	804	0.573	0.495	0.000	1.000	805	0.574	0.495	0.000	1.000
Migration of workers (little)	803	0.133	0.340	0.000	1.000	804	0.133	0.340	0.000	1.000	805	0.133	0.340	0.000	1.000
Migration of workers (extensive)	803	0.294	0.456	0.000	1.000	804	0.294	0.456	0.000	1.000	805	0.293	0.455	0.000	1.000

Table 1 (cont.): Descriptive statistics of variables

	1950-1959					1960-1969					1970-1979				
Variables	Obs.	Mean	SD	Min	Max	Obs.	Mean	SD	Min	Max	Obs.	Mean	SD	Min	Max
Nighttime lights p.c. (log)	752	8.042	7.698	0.000	51.000	1,092	6.898	7.982	0.000	57.158	1,062	6.795	8.033	0.000	57.158
Educational gender gap	752	1.818	1.081	-3.000	6.107	1,092	1.664	1.022	-2.100	5.245	1,062	1.303	0.947	-1.814	5.394
Female years of education	752	1.978	1.888	0.000	10.000	1,092	3.670	2.658	0.016	10.882	1,062	4.533	2.976	0.082	11.720
Male years of education	752	3.796	2.288	0.073	10.000	1,092	5.335	2.775	0.101	11.338	1,062	5.836	2.715	0.252	11.828
Dummy if coast	752	0.085	0.279	0.000	1.000	1,092	0.079	0.269	0.000	1.000	1,062	0.081	0.273	0.000	1.000
French colonies	752	0.275	0.447	0.000	1.000	1,092	0.375	0.484	0.000	1.000	1,062	0.386	0.487	0.000	1.000
British colonies	752	0.285	0.452	0.000	1.000	1,092	0.202	0.402	0.000	1.000	1,062	0.180	0.384	0.000	1.000
Mandated territories	752	0.315	0.465	0.000	1.000	1,092	0.400	0.490	0.000	1.000	1,062	0.411	0.492	0.000	1.000
Independent countries	752	0.125	0.331	0.000	1.000	1,092	0.022	0.147	0.000	1.000	1,062	0.023	0.149	0.000	1.000
Cash crops p.c. (log)	742	0.714	1.348	0.000	6.594	1,082	1.141	1.945	0.000	8.109	1,052	1.449	2.377	0.000	9.295
Minerals p.c. (log)	752	0.008	0.074	0.000	1.176	1,092	0.004	0.048	0.000	0.995	1,062	0.003	0.027	0.000	0.550
Dummy if railroad	752	0.235	0.425	0.000	1.000	1,092	0.232	0.422	0.000	1.000	1,062	0.237	0.426	0.000	1.000
Dummy if main mission 1924	752	0.227	0.419	0.000	1.000	1,092	0.222	0.416	0.000	1.000	1,062	0.228	0.420	0.000	1.000
Tsetse suitability index	687	-1.001	0.663	-1.587	1.495	994	0.070	0.684	-2.136	1.495	964	0.077	0.693	-2.136	1.495
Population density (log)	752	1.133	1.681	-4.169	6.504	1,092	1.703	1.704	-5.635	6.921	1,062	2.121	1.710	-5.443	7.309
Cities 1920	752	0.133	0.501	0.000	6.000	985	0.139	0.520	0.000	6.000	955	0.139	0.527	0.000	6.000
Migration of workers (no)	752	0.614	0.487	0.000	1.000	1,092	0.365	0.482	0.000	1.000					
Migration of workers (little)	752	0.128	0.334	0.000	1.000	1,092	0.112	0.315	0.000	1.000					
Migration of workers (extensive)	752	0.258	0.438	0.000	1.000	1,092	0.523	0.500	0.000	1.000					
Polity2						1,092	-1.936	3.465	-9.000	6.000	1,062	-6.681	2.204	-9.000	6.000
Polity2 sq.						1,092	15.745	22.175	0.160	81.000	1,062	49.495	13.664	11.560	81.000
Magnitude of civil war						1,092	0.248	0.517	0.000	1.800	1,062	0.212	0.894	0.000	4.000
Life expectancy at birth						1,092	3.690	0.095	3.453	3.895	1,062	3.793	0.103	3.537	3.973

Table 2: Educational gender gap and other correlates of regional GDP per capita, measured by nighttime light intensity per capita 2013

Dependent variable:	Nighttime lights p.c. (log)			Nighttime lights p.c. (log)		
	1920-1929	1930-1939	1940-1949	1950-1959	1960-1969	1970-1979
	(1)	(2)	(3)	(4)	(5)	(6)
Educational gender gap	-0.089***	-0.098***	-0.067***	-0.060***	-0.030**	-0.029**
	(0.026)	(0.020)	(0.015)	(0.012)	(0.012)	(0.013)
Male years of education	0.088***	0.072***	0.042***	0.035***	0.034***	0.031***
	(0.022)	(0.016)	(0.010)	(0.008)	(0.007)	(0.007)
Dummy if coast	0.086**	0.097***	0.098***	0.107***	0.092***	0.083**
	(0.035)	(0.035)	(0.035)	(0.041)	(0.035)	(0.036)
French colonies	-0.142***	-0.114***	-0.109***	-0.126***	-0.268***	-0.143**
	(0.033)	(0.034)	(0.034)	(0.036)	(0.057)	(0.064)
Mandated territories	-0.027	0.037	0.017	-0.001	0.108	-0.149
	(0.061)	(0.063)	(0.062)	(0.073)	(0.074)	(0.110)
Independent countries	-0.094	-0.055	-0.060	-0.027	-0.393***	-0.260***
	(0.064)	(0.065)	(0.064)	(0.076)	(0.088)	(0.086)
Cash crop p.c. (log)	-0.001	-0.005	-0.009	-0.009	-0.002	-0.002
	(0.007)	(0.008)	(0.008)	(0.007)	(0.005)	(0.004)
Minerals p.c. (log)	0.309***	0.230***	0.238***	1.469***	1.817***	3.320***
	(0.023)	(0.014)	(0.015)	(0.119)	(0.148)	(0.271)
Dummy if railroad	0.080***	0.085***	0.104***	0.114***	0.091***	0.091***
	(0.023)	(0.022)	(0.021)	(0.024)	(0.023)	(0.024)
Dummy if main mission 1924	-0.016	-0.018	-0.021	-0.039	-0.002	0.009
	(0.024)	(0.024)	(0.024)	(0.027)	(0.026)	(0.026)
Tsetse suitability index	0.002	0.002	-0.006	-0.026	-0.067***	-0.058***
	(0.018)	(0.019)	(0.019)	(0.021)	(0.022)	(0.022)
Population density (log)	-0.023***	-0.025***	-0.023***	-0.016**	-0.006	-0.0110
	(0.006)	(0.006)	(0.006)	(0.007)	(0.007)	(0.007)
Cities 1920	0.096***	0.094***	0.087***	0.099***	0.059**	0.064**
	(0.023)	(0.024)	(0.023)	(0.026)	(0.027)	(0.028)
Immigration of workers (little)	-0.042	-0.043	-0.049*	-0.036		
	(0.026)	(0.027)	(0.027)	(0.029)		
Immigration of workers (extensive)	0.091**	0.109**	0.090**	0.106**		
	(0.042)	(0.043)	(0.042)	(0.045)		
Polity2					0.081***	0.080***
					(0.010)	(0.012)
Polity2 sq.					0.011***	0.004***
					(0.001)	(0.002)
Magnitude of civil war					-0.057	-0.011
					(0.037)	(0.018)
Life expectancy at birth (log)					2.196***	0.288
					(0.263)	(0.258)
Constant	-0.020	-0.060	-0.034	-0.100	-8.259***	-0.687
	(0.099)	(0.101)	(0.100)	(0.114)	(0.995)	(1.124)
Rho	1.077***	0.801***	1.180*	1.061	1.143	1.317
	(0.215)	(0.280)	(0.656)	(4.037)	(4.040)	(6.395)
Observations	716	717	717	678	985	955
R-squared	0.386	0.490	0.498	0.453	0.513	0.494
Region FE	Yes	Yes	Yes	Yes	Yes	Yes

Note: Repeated cross-sectional regressions, 6 decades respectively using the SAR model. Regression models are corrected for spatial autocorrelation. Rho indicates the spatial autocorrelation coefficient. Dependent variable: (log) nighttime lights per capita (multiplied by 100 for readability); Main independent variable: educational gender gap; Reference categories: British colonies, no immigration of workers; Robust standard errors (in parentheses) and regional fixed effects. Significance codes: *** p<0.01, ** p<0.05, * p<0.1. See Appendix for data construction and sources.

Table 3: Educational gender gap and other correlates of regional GDP per capita, std. coef

Dependent variable:	Nighttime lights p.c. (log)			Nighttime lights p.c. (log)		
	1920-1929	1930-1939	1940-1949	1950-1959	1960-1969	1970-1979
	(1)	(2)	(3)	(4)	(5)	(6)
Educational gender gap	-0,084	-0,084	-0,083	-0.065	-0.031	-0,027
Male years of education	0.124	0.118	0.089	0.080	0.094	0.084
Dummy if coast	0.025	0.029	0.029	0.030	0.025	0.025
French colonies	-0.065	-0.053	-0.050	-0.056	-0.130	-0.070
Mandated territories	-0.017	0.011	0.008	-0.0004	0.050	0.073
Independent countries	0,032	-0.019	-0.020	-0.009	-0.058	-0.039
Cash crop p.c. (log)	-0,001	-0,006	-0,003	-0,003	-0,0002	-0,002
Minerals p.c. (log)	0,101	0,130	0,130	0,109	0,087	0,090
Dummy if railroad	0,013	0,035	0,044	0,061	0,038	0,039
Dummy if main mission 1924	-0,007	-0,008	-0,009	-0,016	-0,001	0,004
Tsetse suitability index	0,001	0,001	-0,004	-0,017	-0,046	-0,025
Population density (log)	-0,036	-0,040	-0,037	-0,027	-0,010	-0,019
Cities 1920	0.048	0.047	0.043	0.050	0.042	0.039
Immigration of workers (little)	-0,014	-0,015	-0,017	-0,012		
Immigration of workers (extensive)	0,041	0,050	0,050	0,041		
Polity2					0,281	0,176
Polity2 sq.					0,244	0,055
Magnitude of civil war					-0,029	0,010
Life expectancy at birth (log)					0,209	0,030
Observations	716	717	717	678	985	955
Region FE	Yes	Yes	Yes	Yes	Yes	Yes

Note: Standardized coefficients from Table 2.

Table 4: Mediated fertility effects

Dependent variable:	Nighttime lights p.c. (log)	Nighttime lights p.c. (log)
	1960-1969	1970-1979
	(1)	(2)
Educational gender gap	-0.165***	-0.162***
	(0.024)	(0.026)
Fertility rates (log)	-0.048*	-0.215***
	(0.029)	(0.037)
Constant	0.817***	1.944***
	(0.206)	(0.270)
Observations	1,092	1,062
R-squared	0.044	0.054
ACME	0.003	0.026
Direct effect	-0.165	-0.162
Total effect	-0.162	-0.136
% Total effect mediated	-0.019	-0.189

Note: Causal Mediation Analysis (Hicks and Tingley, 2011). Treatment variable: educational gender gap; Outcome variable: nighttime lights per capita (log); Mediator variable: fertility rates (log) Significance codes: *** p<0.01, ** p<0.05, * p<0.1.

Table 5: Female education and other correlates of regional GDP per capita, measured by nighttime light intensity per capita 2013

Dependent variable:	Nighttime lights p.c. (log)			Nighttime lights p.c. (log)		
	1920-1929	1930-1939	1940-1949	1950-1959	1960-1969	1970-1979
	(1)	(2)	(3)	(4)	(5)	(6)
Female years of education	0.088***	0.066***	0.036***	0.037***	0.034***	0.031***
	(0.022)	(0.016)	(0.010)	(0.008)	(0.007)	(0.007)
Dummy if coast	0.086**	0.096***	0.094***	0.096**	0.094***	0.084**
	(0.035)	(0.036)	(0.035)	(0.041)	(0.035)	(0.036)
French colonies	-0.142***	-0.132***	-0.131***	-0.144***	-0.267***	-0.140**
	(0.033)	(0.033)	(0.033)	(0.036)	(0.057)	(0.062)
Mandated territories	-0.027	0.009	-0.001	-0.005	0.106	-0.146
	(0.061)	(0.062)	(0.061)	(0.073)	(0.074)	(0.110)
Independent countries	-0.094	-0.077	-0.083	-0.060	-0.382***	-0.259***
	(0.064)	(0.065)	(0.064)	(0.075)	(0.083)	(0.086)
Cash crop p.c. (log)	-0.001	-0.005	-0.010	-0.008	-0.002	-0.002
	(0.007)	(0.008)	(0.008)	(0.007)	(0.005)	(0.004)
Minerals p.c. (log)	0.309***	0.228***	0.235***	1.451***	1.816***	3.319***
	(0.023)	(0.014)	(0.015)	(0.119)	(0.148)	(0.271)
Dummy if railroad	0.080***	0.078***	0.100***	0.111***	0.091***	0.091***
	(0.023)	(0.022)	(0.021)	(0.024)	(0.023)	(0.024)
Dummy if main mission 1924	-0.017	-0.022	-0.025	-0.042	-0.003	0.009
	(0.024)	(0.024)	(0.024)	(0.027)	(0.026)	(0.026)
Tsetse suitability index	0.002	-0.005	-0.013	-0.036*	-0.065***	-0.0569***
	(0.018)	(0.018)	(0.018)	(0.020)	(0.022)	(0.021)
Population density (log)	-0.023***	-0.026***	-0.025***	-0.017**	-0.005	-0.011
	(0.006)	(0.006)	(0.006)	(0.007)	(0.007)	(0.007)
Cities 1920	0.095***	0.089***	0.084***	0.094***	0.060**	0.063**
	(0.023)	(0.024)	(0.024)	(0.026)	(0.027)	(0.028)
Immigration of workers (little)	-0.043	-0.046*	-0.050*	-0.039		
	(0.026)	(0.027)	(0.027)	(0.029)		
Immigration of workers (extensive)	0.091**	0.093**	0.077*	0.094**		
	(0.042)	(0.043)	(0.042)	(0.045)		
Polity2					0.081***	0.080***
					(0.010)	(0.011)
Polity2 sq.					0.011***	0.004***
					(0.001)	(0.002)
Magnitude of civil war					-0.060*	-0.011
					(0.036)	(0.018)
Life expectancy at birth (log)					2.195***	0.304
					(0.263)	(0.240)
Constant	-0.020	-0.062	-0.057	-0.142	-8.243***	-0.751
	(0.099)	(0.101)	(0.100)	(0.113)	(0.995)	(1.062)
Rho	1.078***	1.178**	1.133	1.055	1.150	1.378
	(0.216)	(0.464)	(1.395)	(6.277)	(3.700)	(5.759)
Observations	716	717	717	678	985	955
R-squared	0.386	0.486	0.495	0.449	0.512	0.494
Region FE	Yes	Yes	Yes	Yes	Yes	Yes

Note: Repeated cross-sectional regressions, 6 decades respectively using the SAR model. Regression models are corrected for spatial autocorrelation. Rho indicates the spatial autocorrelation coefficient. Dependent variable: (log) nighttime lights per capita (multiplied by 100 for readability); Main independent variable: female years of education; Reference categories: British colonies, no immigration of workers; Robust standard errors (in parentheses) and regional fixed effects. Significance codes: *** p<0.01, ** p<0.05, * p<0.1. See Appendix for data construction and sources.

Table 6: Female education and other correlates of regional GDP per capita, std. coef

Dependent variable:	Nighttime lights p.c. (log)			Nighttime lights p.c. (log)		
	1920-1929	1930-1939	1940-1949	1950-1959	1960-1969	1970-1979
	(1)	(2)	(3)	(4)	(5)	(6)
Female years of education	0.080	0.060	0.047	0.070	0.090	0.092
Dummy if coast	0,025	0.028	0.028	0.027	0.025	0.023
French colonies	-0.065	-0.061	-0.061	-0.064	-0.129	-0.068
Mandated territories	-0.012	0.004	0.0004	0.002	0.052	0.072
Independent countries	-0.032	-0.026	-0.028	-0.020	-0.056	-0.039
Cash crop p.c. (log)	-0.001	-0.005	-0.011	-0.011	-0.004	-0.005
Minerals p.c. (log)	0.101	0.129	0.129	0.107	0.087	0.090
Dummy if railroad	0.030	0.032	0.043	0.047	0.038	0.039
Dummy if main mission 1924	-0.007	-0.010	-0.010	-0.018	-0.001	0.004
Tsetse suitability index	0.001	-0.003	-0.008	-0.024	-0.044	-0.040
Population density (log)	-0.036	-0.041	-0.040	-0.029	0.009	-0.019
Cities 1920	0.047	0.044	0.042	0.047	0.031	0.033
Immigration of workers (little)	-0.015	-0.016	-0.017	-0.013		
Immigration of workers (extensive)	0.041	0.042	0.035	0.041		
Polity2					0.281	0.176
Polity2 sq.					0.244	0.055
Magnitude of civil war					-0.031	0.010
Life expectancy at birth (log)					0.209	0.031
Observations	716	717	717	678	985	955
Region FE	Yes	Yes	Yes	Yes	Yes	Yes

Note: Standardized coefficients from Table 5

Table 7: Educational gender gap and other correlates of real GDP per capita

Dependent variable:	Real GDP p.c. (log)			Real GDP p.c. (log)		
	1920-1929	1930-1939	1940-1949	1950-1959	1960-1969	1970-1979
	(1)	(2)	(3)	(4)	(5)	(6)
Educational gender gap	-0.530**	-0.256	-0.138	-0.136**	-0.175**	-0.154**
	(0.245)	(0.155)	(0.104)	(0.058)	(0.068)	(0.063)
Male years of education	0.540***	0.299***	0.160***	0.120***	0.125***	0.113***
	(0.176)	(0.093)	(0.047)	(0.030)	(0.040)	(0.040)
Dummy if coast	-0.023	-0.018	0.013	0.164	0.219	0.147
	(0.225)	(0.269)	(0.280)	(0.154)	(0.197)	(0.225)
French colonies	-0.698***	-0.888***	-0.862***	-0.842***	-7.036*	-0.209
	(0.258)	(0.244)	(0.247)	(0.143)	(4.102)	(0.379)
Mandated territories	0.350	0.145	0.149	0.155	-1.020	0.734**
	(0.229)	(0.209)	(0.225)	(0.116)	(0.728)	(0.343)
Independent countries	-	-	-	-	-	-
Cash crop p.c. (log)	-0.039	-0.086	-0.109	-0.070	-0.037	-0.045
	(0.063)	(0.085)	(0.095)	(0.042)	(0.039)	(0.039)
Minerals p.c. (log)	0.035	0.006	-0.004	-0.111	-0.392	-1.085
	(0.062)	(0.040)	(0.043)	(0.351)	(0.714)	(1.417)
Dummy if railroad	0.388***	0.218	0.271*	0.189**	0.293***	0.448***
	(0.144)	(0.156)	(0.136)	(0.090)	(0.102)	(0.145)
Dummy if main mission 1924	0.334	0.379	0.411	0.053	0.139	0.147
	(0.271)	(0.324)	(0.324)	(0.243)	(0.251)	(0.274)
Tsetse suitability index	-0.039	-0.029	-0.022	0.037	-0.021	-0.057
	(0.102)	(0.097)	(0.107)	(0.087)	(0.130)	(0.142)
Population density (log)	0.013	0.019	0.029	-0.0003	-0.019	-0.032
	(0.037)	(0.038)	(0.039)	(0.025)	(0.036)	(0.042)
Immigration of workers (little)	-0.591**	-0.569**	-0.596***	-0.317		
	(0.229)	(0.221)	(0.204)	(0.214)		
Immigration of workers (extensive)	0.212	0.306	0.278	0.273**		
	(0.206)	(0.202)	(0.216)	(0.106)		
Polity2					0.853*	-0.716*
					(0.486)	(0.392)
Polity2 sq.					0.163	-0.068*
					(0.099)	(0.036)
Magnitude of civil war					2.759	0.059
					(1.925)	(0.059)
Life expectancy at birth (log)					41.45	-2.228
					(26.68)	(2.324)
Constant	6.832***	6.836***	6.791***	6.854***	-143.9	13.42
	(0.046)	(0.051)	(0.071)	(0.057)	(97.18)	(8.463)
Observations	79	79	79	71	79	66
R-squared	0.680	0.663	0.645	0.767	0.734	0.749
Region FE	Yes	Yes	Yes	Yes	Yes	Yes

Note: Repeated cross-sectional (RCS) design: Ordinary Least Squares (OLS) estimator, 6 decades respectively. Dependent variable: (log) GDP per capita; Main independent variable: educational gender gap; Reference categories: British colonies, no immigration of workers; Robust standard errors (in parentheses) and regional fixed effects. Significance codes: *** p<0.01, ** p<0.05, * p<0.1. See Appendix for data construction and sources.

Table 8: Female education and other correlates of real GDP per capita

Dependent variable:	Real GDP p.c. (log)			Real GDP p.c. (log)		
	1920-1929	1930-1939	1940-1949	1950-1959	1960-1969	1970-1979
	(1)	(2)	(3)	(4)	(5)	(6)
Female years of education	0.550***	0.322***	0.169***	0.118***	0.127***	0.119***
	(0.137)	(0.079)	(0.045)	(0.029)	(0.038)	(0.035)
Dummy if coast	-0.022	-0.017	0.019	0.153	0.169	0.116
	(0.226)	(0.261)	(0.277)	(0.146)	(0.222)	(0.231)
French colonies	-0.694**	-0.855***	-0.845***	-0.849***	-8.028*	-0.192
	(0.265)	(0.277)	(0.275)	(0.142)	(4.429)	(0.394)
Mandated territories	0.357	0.196	0.174	0.146	-1.188	0.789**
	(0.242)	(0.220)	(0.222)	(0.110)	(0.778)	(0.369)
Independent countries	-	-	-	-	-	-
Cash crop p.c. (log)	-0.038	-0.080	-0.106	-0.070*	-0.041	-0.047
	(0.066)	(0.093)	(0.102)	(0.041)	(0.040)	(0.039)
Minerals p.c. (log)	0.036	0.012	0.0003	-0.104	-0.360	-1.235
	(0.059)	(0.035)	(0.035)	(0.350)	(0.709)	(1.360)
Dummy if railroad	0.389***	0.238*	0.274**	0.191**	0.307***	0.474***
	(0.139)	(0.130)	(0.130)	(0.089)	(0.109)	(0.143)
Dummy if main mission 1924	0.341	0.433	0.428	0.050	0.139	0.128
	(0.239)	(0.266)	(0.294)	(0.240)	(0.247)	(0.260)
Tsetse suitability index	-0.038	-0.019	-0.016	0.032	-0.041	-0.075
	(0.098)	(0.090)	(0.095)	(0.084)	(0.125)	(0.134)
Population density (log)	0.013	0.019	0.031	-0.001	-0.028	-0.040
	(0.036)	(0.038)	(0.039)	(0.024)	(0.032)	(0.037)
Immigration of workers (little)	-0.588**	-0.560**	-0.600***	-0.325		
	(0.228)	(0.211)	(0.200)	(0.210)		
Immigration of workers (extensive)	0.213	0.303	0.279	0.268**		
	(0.201)	(0.201)	(0.214)	(0.108)		
Polity2					0.978*	-0.726*
					(0.524)	(0.402)
Polity2 sq.					0.189*	-0.071*
					(0.107)	(0.038)
Magnitude of civil war					3.277	0.057
					(2.026)	(0.058)
Life expectancy at birth (log)					47.97	-2.651
					(28.77)	(2.464)
Constant	6.832***	6.841***	6.798***	6.842***	-167.7	14.96*
	(0.045)	(0.049)	(0.062)	(0.042)	(104.8)	(8.885)
Observations	79	79	79	71	79	66
R-squared	0.680	0.660	0.645	0.767	0.731	0.748
Region FE	Yes	Yes	Yes	Yes	Yes	Yes

Note: Repeated cross-sectional (RCS) design: Ordinary Least Squares (OLS) estimator, 6 decades respectively. Dependent variable: (log) GDP per capita; Main independent variable: female years of education; Reference categories: British colonies, no immigration of workers; Robust standard errors (in parentheses) and regional fixed effects. Significance codes: *** p<0.01, ** p<0.05, * p<0.1. See Appendix for data construction and sources.