WARWICK

ECONOMICS

Education and Polygamy: Evidence from Cameroon

Pierre André and Yannick Dupraz

(This paper also appears as CAGE Discussion paper 435)

August 2019 No: 1219

Warwick Economics Research Papers

ISSN 2059-4283 (online)

ISSN 0083-7350 (print)

Education and Polygamy: Evidence from Cameroon *

Pierre André[†]& Yannick Dupraz[‡]

2019

Abstract. — We take advantage of a wave of school constructions in Cameroon after World War II and use variations in school supply at the village level to estimate labor and marriage market returns to education in the 1976 population census. Education increases the likelihood to be in a polygamous union for men and for women, as well as the overall socioeconomic status of the spouse. We argue that education increases polygamy for women because it allows them to marry more educated and richer men, who are more likely to be polygamists. To show this, we estimate a structural model of marriage with polygamy. The positive affinity between a man's polygamy and a woman's education is mostly explained by the affinity of education.

JEL classification: J12, I20, O12.

Keywords: polygamy, education, marriage, matching models.

*We want to thank, in alphabetical order, Denis Cogneau, Esther Duflo, Alfred Galichon, Cecilia Garcia-Peñalosa, Marc Gurgand, James Fenske, Sylvie Lambert, Omer Moav, Jean-Laurent Rosenthal, Katia Zhuravskaia, Roberta Ziparo, and participants of seminars at Paris School of Economics, University of Cergy-Pontoise, Aix-Marseille School of Economics, and Warwick University.

[†]University of Cergy-Pontoise, THEMA. Contact: pierre.andre@u-cergy.fr

[‡]University of Warwick, CAGE. Contact: Y.Dupraz@warwick.ac.uk

1. Introduction

On top of labor market returns, education has marriage market returns: it affects who you marry, and bargaining power within marriage. In developing countries, where participation of women in the formal labor market is still low, marriage is an extremely important economic decision in a woman's life. An individual's education will affect the characteristics of their spouse. In regions where polygamy is practiced, education will also affect the number of wives (for men), and the number of co-wives (for women).

Polygamy is still very important in a number of African countries, but it has been declining in recent decades. The expansion of education might have played a role — because of the transmission of different cultural norms by colonial schools and religious missions, because education increased the bargaining power of women, or because education made men more interested in having few educated children rather than many children (Gould et al., 2008). However, while education has been found to impact women's fertility choices (Osili and Long, 2008; Keats, 2018; Chicoine, 2016, 2012), attitudes towards domestic violence (Friedman et al., 2016), and sexual behavior (Dupas, 2011), Fenske (2015) finds that a variety of educational shocks that increased women education did not decrease their likelihood to be in a polygamous union. At the same time, the regions that received a lot of missionaries or government schools during the colonial period have lower rates of polygamy today (Fenske, 2015). The discrepancy between the two results might stem from a difference between colonial and current education in the content of schooling, or in the quality of education.

In this paper, we study the returns to education on the labor and marriage markets focusing on a late-colonial era wave of school constructions in Cameroon. After World War II, the colonial governments of British and French Cameroon considerably increased education expenditure, which resulted in a large increase in school supply. Though these schools opened during the colonial period, we can observe the individuals who attended them in Cameroonian census microdata from 1976, geolocated at the village level. Combining these data with recent administrative data on the universe of schools in Cameroon with their date of opening, we use variation in the timing of public school openings in different villages to iden-

tify labor and marriage market returns to education. Our event study shows that the opening of a school in a village does not predict the education of individuals too old to go to that school, which validates the common trend assumption. In a quasi-difference in differences setting, we instrument an individual's education by the stock of public schools in their village when they were of school-age conditional on village and cohort fixed effects, and cohort trends interacted with village observables.

Since the work of Duflo (2001) in Indonesia, using variations in school constructions to study labor market returns to education has been a well known technique. However, identifying marriage market returns presents two additional challenges. The first one is that, in a village, potential husbands and wives are subject to the same educational shock. The fact that, in Cameroon in 1976, the average age difference between husband and wife was ten years does not completely solve the problem: if the opening of a school in a village increases the education of a cohort of men, it will also increase the education of their potential wives. The second challenge is that the reduced form effect of education on a particular spousal variable (say, whether your husband is a polygamist) is affected by the effect of education on the choice of other spousal characteristics (income, age, education), and the correlation between these variables. Tackling these two challenges requires, we argue, a structural approach.

We extend the model of marriage with transfers of Choo and Siow (2006) to allow men to marry several women, and we borrow the parametrization of the joint utility function of marriage of Dupuy and Galichon (2014). This allows us to estimate "affinities" between different characteristics of husbands and wives. These affinities are the second derivatives of the joint utility of the union, and they describe the likelihood that a man with a given characteristic will be matched to a woman with a given characteristic, *taking into account the affinity between all other characteristics*. We show that the affinity parameters can be recovered by estimating a multinomial logit on pairs of couples within the same village. We use a control function approach to take into account the endogeneity of education.

Our reduced-form difference in differences results show that one additional year of education increases the probability to be a wage earner (be formally employed) by 3.3 percentage points for women and 10.4 percentage points for men. Education

reduces slightly the likelihood of marriage for women, and increases it for men, but not in a statistically significant way. In the sample of married people, education increases the socioeconomic outcomes of one's spouse (education and formal employment). One additional year of schooling also increases the likelihood to be in a polygamous union by 9.9 percentage points for men and 6.6 percentage points for women. While the result for women might appear counter-intuitive, we argue it is explained by the other dimensions of matching on the marriage market: more educated women marry richer and more educated men, and these men are also more often polygamists.

Turning to the structural model, we first estimate the affinity between a husband's number of wives and a wife's education, taking into account the matching on age, but not the matching on education. We replicate our reduced-form result, that is we estimate a positive affinity between the number of wives of the husband and the education of the wife. When adding to the affinity matrix the education of the husband to take into account the matching on education, the affinity between the husband's number of wives and the wife's education is divided by 3 and loses statistical significance. This shows matching on education is important to understand the effect of female education on polygamy. Because educated women can marry more educated men, who are richer and more likely to take a second wife, they are more likely to end up in a polygamous marriage.

We also provide suggestive evidence that the type of schooling matters, especially for women. While our main specification uses the variation in *public, secular* schools to obtain exogenous variation in education, we find that women who were exposed to a larger number of *private, Christian* schools in the village when they were of school age are less likely to be in a polygamous union in 1976. With the caveat that our parallel trend test fails when we consider private schools, this is consistent with the fact that Christians missions in Africa in general, and Cameroon in particular, were explicitely fighting polygamy and trying to impose a monogamous model of marriage (Walker-Said, 2015, 2018; Tsoata, 1999).

Contributions. Our paper contributes to the literature on the economics of polygamy. In societies allowing polygamy, men and women face different incentives than in monogamous societies and adopt different behaviors; this has impli-

cations for saving rates and economic growth (Tertilt, 2005), for intra-household cooperation (Barr et al., 2019; Rossi, 2019), and for child mortality (Arthi and Fenske, 2018).

Our paper contributes more specifically to the literature aiming at understanding the existence of polygamy, and its decline. A first group of works tries to explain the existence of polygamous and monogamous societies. Becker (1973) makes the point that the existence of polygamous unions is the equilibrium outcome when there is inequality among males. Boserup (1970) proposes that polygamy is explained by female productivity in agriculture, an idea tested by Jacoby (1995) in Cote d'Ivoire. Dalton and Leung (2014) argue that the greater prevalence of polygamy in West Africa is explained by the effect of the Atlantic slave trade on sex ratios.

A second group of works aims at explaining the dynamics of polygamy. In Lagerlöf (2005), societies become monogamous as inequality among men falls. In Lagerlöf (2010), monogamy is modeled as a pacifying institution established by the elite to avoid the rebellion of poorer men. In such a framework, the relationship between inequality and polygamy is hump-shaped. De La Croix and Mariani (2015) propose a unified model of the transition from monogamy to polygamy, and then to serial monogamy (divorce and remarriage), where income inequality among men and women plays a key role. Explanations relating the dynamics of polygamy to the dynamics of inequality are maybe more suited to Europe than to the recent decline of polygamy in Africa. Indeed, all available evidence points towards inequality remaining stable (at a high level) in Africa in the last forty years (Ravaillon, 2014; Alvaredo et al., 2018). Gould et al. (2008) build a model where the dynamics of economic development, rather than the dynamics of inequality, explain the decrease in polygamy, as men substitute educated children and wives for a large number of children and wives.

To the best of our knowledge, the only attempt besides ours to estimate the causal relationship between education and polygamy for women is Fenske (2015). We add to it by considering a wave of school constructions during the colonial period, by considering the effect of education on polygamy for men, and by taking into account assortative matching on education and the consequence it could have on reduced-form estimates of the effect of education on polygamy for women.

We also contribute to the literature on the interplay of labor and marriage market returns to education for women. Goldin (1993) studies the changing meaning of college in the lives of American women over the 20th century. Chiappori et al. (2015) develop a model where education has both marriage market and labor market returns. Fewer papers focus on developing countries, but Zha (2019) studies the role of education in the marriage market in Indonesia, and Ashraf et al. (forthcoming) study the role of the bride price custom in explaining whether parents send their daughters to school in response to a school expansion program. In Cameroon (where the majority of ethnic groups have some form of bride price) we find that women's education increased in response to school constructions and that education had labor as well as marriage market returns.

Our paper contributes, more generally, to the literature on women empowerment and economic development (Duflo, 2012), more specifically the literature estimating the effect of education on the attitudes and behavior of women. Osili and Long (2008), Keats (2018), Chicoine (2012) and Chicoine (2016) use schooling expansion reforms in Nigeria, Uganda, Kenya, and Ethiopia to show that education decreases fertility. In Keats (2018), Chicoine (2012) and Chicoine (2016), this decrease is partly explained by increased use of contraceptive methods. Dupas (2011) finds that Kenyan girls informed about the relative risks of HIV infection by age substitute away from older partners. Friedman et al. (2016) find, also in Kenya, that girls who prolonged their education as a result of a merit scholarship program are less likely to accept domestic violence. Like Fenske (2015), we do not find that women who received education following a wave of public school constructions are less likely to be in a polygamous union. In fact, in our context, we find they are *more likely* to be in a polygamous union, and we show the role of assortative matching on education in the marriage market in explaining this result. More generally, we show that taking into account matching is important when studying the returns to education on the marriage market.

Finally, our paper contributes to the literature on matching models of the marriage market, particularly the branch of this literature concerned with empirical estimation. Matching models of the marriage market are hard to estimate on data because prices are typically not observed. Chiappori et al. (2012) estimate a model where individuals match on a single index aggregating all the characteristics of a

mate. Choo and Siow (2006) estimate a model of matching on several discrete attributes of men and women, while Dupuy and Galichon (2014) extend the model to continuous attributes. We extend Choo and Siow (2006) to a setting where men are allowed to marry several women and we show that, for a given distribution of female characteristics and a given joint distribution of male characteristics and their number of spouses, we can identify the second derivatives of the joint utility function of a match with respect to the characteristics of men and women.

In the rest of the paper, we present the data (section 2), the difference in differences strategy and the estimated returns to education (section 3), and finally the model of marriage and the results of the structural estimation (section 4).

2. Data

In order to identify the effect of education on the marriage market in Cameroon, we use full-count, geolocated population census data from 1976 and geolocated administrative school data from 2016.

Our main data source is the Cameroonian population census of 1976, for which we have the whole population, except for 3 districts out of 138 that were missing in the raw data.[1] For each individual, the census gives us sex, age (with some imprecision in the form of age heaping), education (last grade attended), marital status (whether an individual is single, divorced, widowed or married — and the number of wives for men), and some very scarce information about occupation.

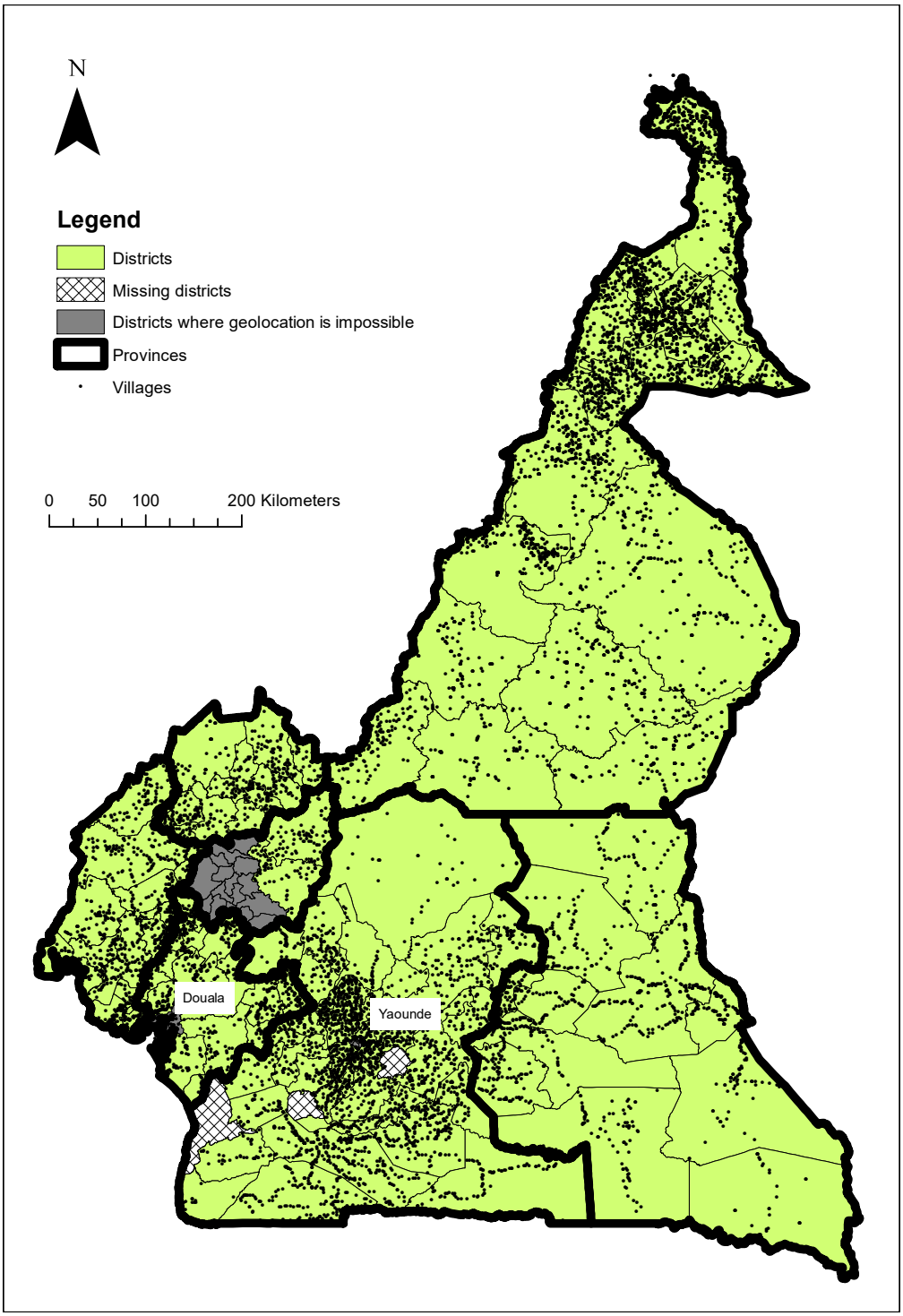
Our data does not directly give the line identifier of the spouse for married individuals, but we were able to match 91.7% of married women with their husband living in the same household from information on marital status (including the number of wives for men) and relationship to the household head.[2]

To obtain information on the stock and flow of schools in every village of

[1] The districts of Mvengue, Dzeng and Kribi, see figure 1.

[2] In most households, there was no ambiguity about the pairing of spouses (for instance, a household with one household head, two spouses of the household head, one married son of the household and one married other member of the household); however, in large, complex households, we were not always able to match all spouses (for instance when there were several married men and several married women listed as "other household members"). This also means that we were not able to match spouses living in separate households.

Figure 1: Villages, districts and provinces in the 1976 census



Authors' map from 1976 Cameroonian population census data.

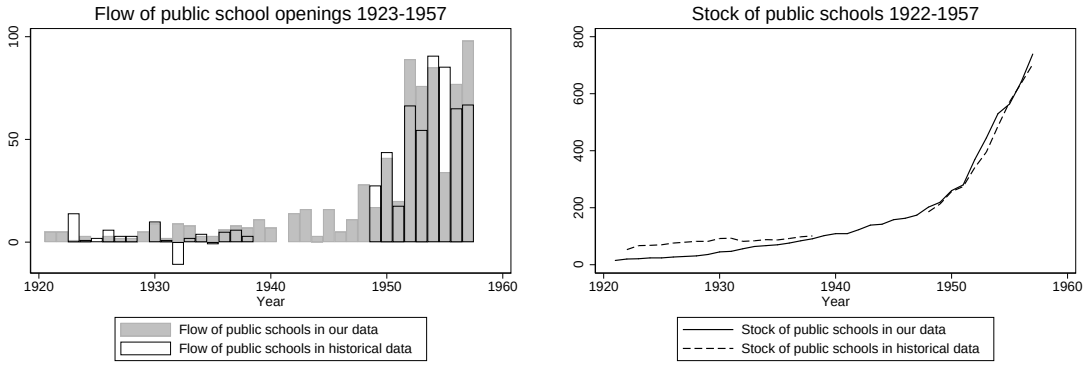
Cameroon over the 20th century, we use an administrative database of all Cameroonian schools in 2016 with their status (public or private), their date of opening, and the name of the locality. Because this is not historical data, it gives us information about historical school supply insofar as there was no attrition, that is schools, once opened, did not close down.

In a period of rapid population growth (Cameroon's population increased sevenfold between 1900 and 2014) and ever-expanding school supply, this assumption seems reasonable, at least for public schools. To show that attrition is not too much of a problem, we cross validate our source with historical data for the colonial period. We could not find historical data giving the yearly supply of schools at the sub-national level, let alone at the village level, but the reports sent by France and Britain to the League of Nations/United Nations give the total number of schools in Cameroon for the period 1922—1938 and 1948–1957.[3] Figure 2 shows the total flow and stock of public schools in Cameroon between 1923 and 1957, according to 2016 administrative data and to historical data. Though there is some discrepancy, especially before World War II, the two series are reasonably close to one another. Reassuringly, from the middle of the 1930s onwards, the two sources agree on the total stock of public schools in Cameroon. If attrition were a major problem and a large number of public schools had closed between their opening date and 2016, then the total stock of school given by 2016 administrative data would be lower than the stock given by historical sources, but it is not the case. For private (missionary) schools, attrition is much more of a problem: historical data always give far more private schools than what can be inferred from 2016 administrative data. For instance, in 1955, we count 564 private schools in Cameroon while there were more than 2,000 private schools according to historical data. That said, the source for the number of private schools in historical data is the missions themselves, and their figures might be inflated (Dupraz, 2019). However, while 2016 administrative data seem to give us a reasonably accurate measure of the historical stock and flow of *public* schools, we need to think of the *private* schools in these data as the ones that were high-quality enough to stay open until

[3]Sources: Great Britain, Colonial office (1922–1938, 1949–1959); France, Ministère des Colonies (1921–1938, 1947–1957). French reports also give the number of schools in 1921 and 1947. Between 1948 and 1959, British reports give only the total number of students; to infer the total number of schools, we use the average number of students per school in 1938 (110).

2016.[4] This is one of the reasons why we will be using only the variation in the number of public schools to identify the effects of education on marriage markets.

Figure 2: Comparison of 2016 administrative data with historical data



Sources: Great Britain, Colonial office (1922–1938, 1949–1959); France, Ministère des Colonies (1921–1938, 1947–1957).

We geolocated villages and schools from each database from the name of the locality, using a variety of gazetteers.[5] In the 16 districts of the Bamiléké region, village-level geolocation was impossible, we therefore excluded from our estimations individuals born in these districts.[6] We also excluded from our estimations individuals born in Yaoundé (the administrative capital) and Douala (the economic capital) because of the difficulty to precisely geolocate enumeration areas within these agglomerations.[7] We were able to geolocate 99.9% of the remaining village in the census and 98.3% of individuals — even though we geolocated almost

[4]The French report to the UN in 1949 gives the number of private schools with three classes or more; at about 119, it is reasonably close to the number of private schools that opened before 1949 in 2016 administrative data (79).

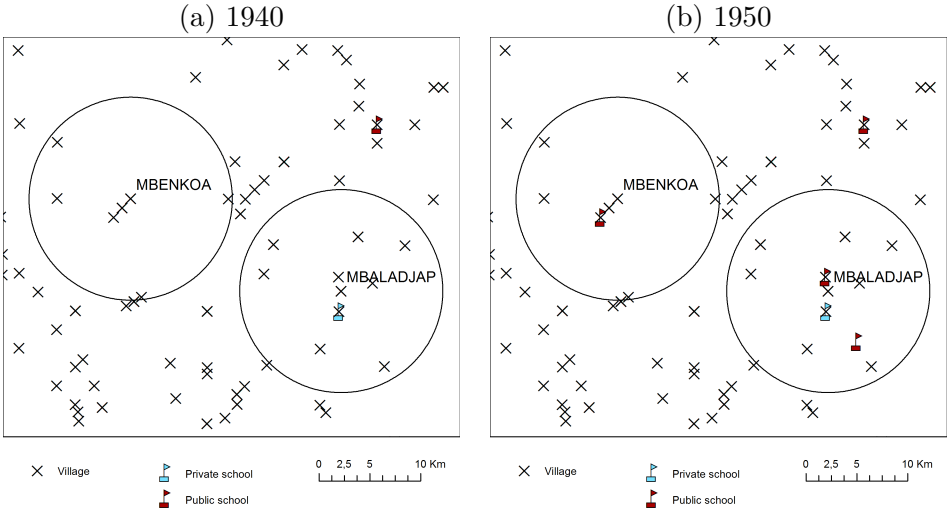
[5]We used the Fallingrain Global Gazetteer (`http://www.fallingrain.com`), the GeoNames geographical database (`http://www.geonames.org`), the website of the Cameroonian Ministry of Energy and Water (`http://www.mng-cameroon.org/SIG/`)) and the Wiki World Map OpenStreetMap (`https://openstreetmap.org`). Geographical information about non-located villages was inferred by taking the mean of located villages in the same canton (a canton is a group of about 10 villages).

[6]These districts represent about 14% of the population. In the Bamilékés, village codes in the raw data did not match village codes in the locality file. The 16 districts districts are Mbouda, Batcham, Galim, Bafang, Bana, Bandja, Kekem, Dcshang, Penka-Michel, Bafoussam, Bandjoun, Bamendjou, Bangou, Bazou, Tonga and Bangangte.

[7]These cities represent 8 districts, corresponding to roughly 5% of the population in 1976.

every village, errors in village code entry prevented geolocation for some individuals. Figure 1 maps these villages as well as the districts where geolocation was impossible. We geolocated all 3,765 schools in the administrative school database opened before 1976 from the name of the locality.[8] For 40 schools (1.1%) that could not be geolocated from the name of the locality, we used the centroid of the district.

Figure 3: Construction of the school supply variable: example



Note: A circle represents a 10-km radius around a given village. In 1940, the village of Mbenkoa has zero schools in a radius of 10 km and the village of Mbaladjap has one (private) school. In 1950, the village of Mbenkoa has 1 (public) school and the village of Mbaladjap has 3 schools (1 private, 2 public).

Finally, we combined both geolocated sources in a GIS software to build the stock and flows of schools (total, public and private) in a radius of 10 km around each village at each date. Figure 3 gives a graphical illustration of the procedure.

The census gives the name of the village of residence and of the district of birth, but not the name of the village of birth.[9] For individuals still residing in their district of birth, we assume that they were schooled in the village in which they were living in 1976. We can therefore, for non-migrants, compute the stock of schools, and the number of school openings at each age. Out-of-district

[8] We were able to locate the village 3,333 schools. For 392 schools, we use the location of the town ("ville"), a geographical division larger than the village.

[9] There were 12,125 villages and 138 districts in Cameroon in 1976, see figure 1.

migrants, representing roughly a third of the sample, are excluded from our main specification. Education, our independent variable of interest, is likely to affect the decision to migrate: for this reason, we also present results estimated on the full sample (migrants and non-migrants) where education is instrumented by the district average number of available schools for non-migrants (see appendix table C.3).

Table 1 presents some descriptive statistics for the sample of men and women older than 15 in 1976: men have 3 years of education on average, versus 1.4 for women; 17% of men are wage earners, versus only 1% for women. Because of polygyny, the percentage of married men (56%) is lower than the percentage of married women (67%). Married women are on average 10 years younger than their husband. This is important for our identification strategy, because it means that the opening of a school in a village does not necessarily affect both groups of potential mates in the same way (see below). This large average age difference explains why the percentage of widows is much higher among women than men (14% vs 2%). 44% of married women are in a polygamous union, versus 24% of men. 71% of polygamists have 2 wives, 19% have 3 wives and 10% have 4 wives or more. People born before 1940 had on average 0.26 schools in a radius of 10 km around their village when they were 7 (0.12 public and 0.14 private). People born after 1940 had on average 1.5 public school and 1.25 private school.[10]

Appendix figure B.1 gives an idea of the geographical repartition of polygamy. Although there is somewhat of a north/south gradient, polygamy is prevalent in every district. The share of married women in a polygamous union is below 20% only in a handful of districts around the economic capital (Douala) and the administrative capital (Yaoundé).

On top of these population census and administrative school data, we use a variety of other geographical and historical data sources to build village level controls. These data sources are described in greater detail in the data appendix.

[10]The slight discrepancy between men and women is due to differences in gender composition across villages explained by different migration patterns: these figures are computed for non-migrant only, and men tend to migrate more than women.

Table 1: Descriptive statistics

	Women older than 15		Men older than 15	
	Mean	Observations	Mean	Observations
		Full sample		
Age	35.13	1,974,625	35.86	1,754,334
Years of schooling	1.37	1,964,294	2.97	1,747,632
Wage earner	0.01	1,941,572	0.17	1,711,810
Out-of-district migrant	0.30	1,975,117	0.33	1,754,807
Married	0.67	1,966,349	0.56	1,740,155
Single	0.16	1,966,349	0.39	1,740,155
Widow	0.14	1,966,349	0.02	1,740,155
Divorced	0.03	1,966,349	0.03	1,740,155
		Married sample		
Age	33.12	1,310,614	42.98	975,344
In a polygamous union	0.44	1,184,845	0.24	975,468
# of wives			1.36	970,940
		Sample in a polygamous union		
# of wives			2.46	236,263
2 wives			0.71	236,263
3 wives			0.19	236,263
4 wives or more			0.10	236,263
		Non-migrant sample (excluding Yaounde, Douala, and the Bamilekes)		
Schools in 10-km radius at 7				
born before 1940				
public	0.12	453,701	0.11	464,053
private	0.14	453,701	0.11	464,053
born after 1940				
public	1.48	689,018	1.57	551,207
private	1.25	689,018	1.34	551,207

Sample: all men and women older than 15 in 1976.

3. Difference in differences estimation

We are interested in the labor market and marriage market returns to education. The endogeneity concerns in estimating labor market returns to education are well known. As for marriage market returns, it is extremely likely that a number of cultural characteristics and personal unobservables determine both educational choices and marriage market outcomes, especially the probability to be in a polygamous union (Fenske, 2015). Like a number of papers following Duflo (2001), we take advantage of an expansion in school supply, the wave of primary school constructions that started in Cameroon after World War II.

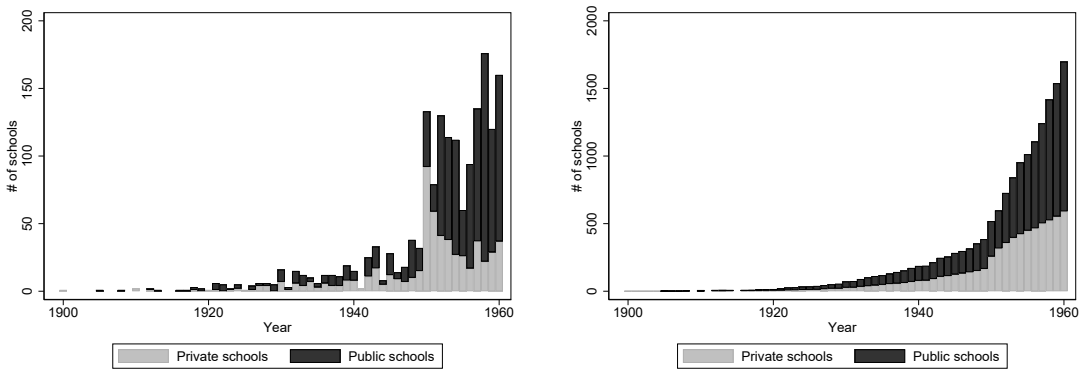
3.1. Historical background

After World War I, German Cameroon was divided between the British and the French and administered under mandates of the League of Nations. In both parts, before World War II, public expenditure for education was low and Christian missionaries (Protestant and Catholic) were the main providers of education (Dupraz, 2019). After World War II, education expenditure increased massively in both parts. In British Cameroon, real expenditure per school-age child was increased fourfold between 1937 and 1955. In French Cameroon, it was multiplied by 30 (Dupraz, 2019). As the stated goal of education policy went from educating a small elite to universal primary education, the colonial governments of British and French Cameroon increased subsidies to missionary schools and started building more public schools. School constructions continued after both parts of Cameroon gained independence in 1960 and were reunited in 1961.

The first panel of figure 4 displays the yearly number of school openings in Cameroon for each year between 1900 and independence in 1960 according to our administrative data. The yearly number of school openings started increasing around 1950, going from an average of 16 from 1930 to 1949 to an average of 119 in the 1950s. As a result, the total number of schools in Cameroon was multiplied by 6 from 1945 (283) to 1960 (1,699) — second panel of figure 4. The yearly number of *public* school openings went from an average of 9 from 1930 to 1949 to an average of 81 in the 1950s, and the total number of public schools in Cameroon

Figure 4: Stock and flow of public and private schools in Cameroon, 1900-1960

(a) Flow of school openings (b) Stock of schools



Note: the bars representing public schools are stacked on the bars representing private schools so that the graph shows the total number of schools.

was multiplied by 7 from 1945 (158) to 1960 (1,107).

Our analysis will always distinguish between public and private schools. There are several reasons for this; first, as discussed above, it is likely that our data are incomplete for private schools, giving us only the schools that were high quality enough to survive until 2016; second, we have every reason to expect heterogeneous effects of public and private education on the marriage market, and especially on polygamy. Before the 1980s, private schools in Cameroon were quasi-exclusively Christian schools.[11] There is ample evidence that African missions were targeting polygamy specifically and putting a lot of effort in promoting the Christian, monogamous model of marriage. Though the French colonial government also sought to change marriage customs, the African clergy was particularly active in criticizing elements of marital customs such as bridewealth and polygamy (Walker-Said, 2015, 2018). In Cameroon, Catholic missionaries established "sixas" or "bride schools" to prepare young girls to a Christian wedding (Tsoata, 1999).

[11]Non-denominational private schools started opening during the economic crisis of the 1980s in response to the decreasing quality of public schools, while Islamic primary schools are a more recent phenomenon.

3.2. Event study and common trend assumption

To obtain plausibly exogenous variation in the education of men and women, we use local, village-level variation in the number of schools over time. Our main estimation strategy is a quasi difference in differences, presented in section 3.3 below. Difference in differences estimates are sensitive to the common trend assumption, which we test with an event study. This event study estimates the effect of school openings at different ages. This checks that school constructions increased enrollment only for the children of school age at the date of the school opening. To put it differently, this checks that school constructions did not take place in areas with different trends in education (conditional on controls). Estimating a positive correlation between years of schooling and the opening of a school at age 25 would indicate that the common trend assumption does not hold and that schools were more likely to open in villages with an increasing trend in education. We estimate the following equation:

$$E_{ivc} = \alpha_v + \delta_c + \delta_c \times BR + \sum_{a=-10}^{a=30} \left(\beta_{public,a} n_{vc}^{public,a} + \beta_{private,a} n_{vc}^{private,a} \right) + x'_{vc}\theta + e_{ivc} \quad (1)$$

E_{ivc} is the education (in years) of individual i, born in village v in year c (for cohort). α_v and δ_c are village and cohort fixed effects. To allow the trend in education to be different in British Cameroon, we interact the cohort fixed effects with a dummy BR equal to one in the two Western provinces, which were part of British Cameroon until independence. $n_{vc}^{public,a}$ is the number of public schools that opened in village v when an individual born in year c was age a (negative numbers are years before birth). $n_{vc}^{public,-10}$ is the stock of public schools 10 years before birth.[12] $n_{vc}^{private,a}$ is the same for private schools. For example, for individual i born in 1940 in village v where the only school, public, opened in 1947, $n_{v,1940}^{public,7} = 1$, and all other school opening variables are equal to zero. We do not consider $a > 30$,

[12] We do not consider schools built more than 10 years before birth to make the graph more readable, which is why $n_{vc}^{public,-10}$ is the stock, rather than the flow, of schools in the village 10 years before birth: it takes into account all schools opening more than 10 years before birth.

individuals who had a school opening after 30 serve as the reference.[13] x_{vc} is a vector of time invariant village controls interacted with a quartic cohort trend (see below for a more detailed discussion). We estimate equation (1) separately for men and women. Like in the rest of the paper, standard errors are clustered at the village level.

Equation (1) is similar to an event study specification, with a couple of differences: the date of the event (the opening of a school) is not the same in each village, there can be several events per village, and the effect of the event is estimated for different age cohorts rather than at different time periods. In theory, Cameroonian children were supposed to attend primary school from 7 to 12, but the colonial authorities were flexible regarding school entry age: according to a 1950 decree, children could start primary school as late as 10 and enter the final grade as late as 16.[14] Furthermore, parents might have bypassed official regulations to allow their children to benefit from the opening of a school in their village.[15] There is also some error in age in the census, notably in the form of age heaping (see appendix figure B.2). We therefore expect school openings to have a positive effect on education before age 7, but also to a certain extent between 8 and 16 (because of late school entry, and because the opening of an additional school can alleviate capacity constraints in an existing school). However, school openings after 17 should not be correlated with education. Because individuals who had a school opening after 30 serve as the reference group, this is similar to a test of parallel trend in a more classical difference in differences setting.

In estimating equation (1), and in the rest of the paper, we consider only the schools that opened during the colonial period, before 1960. These are the schools that mattered for the individuals we consider in the rest of the paper (older than 25 in 1976, born before 1951). All results of the paper are barely affected when we also consider schools that opened after 1960, but the parallel trend test fails for schools built after independence (see below).

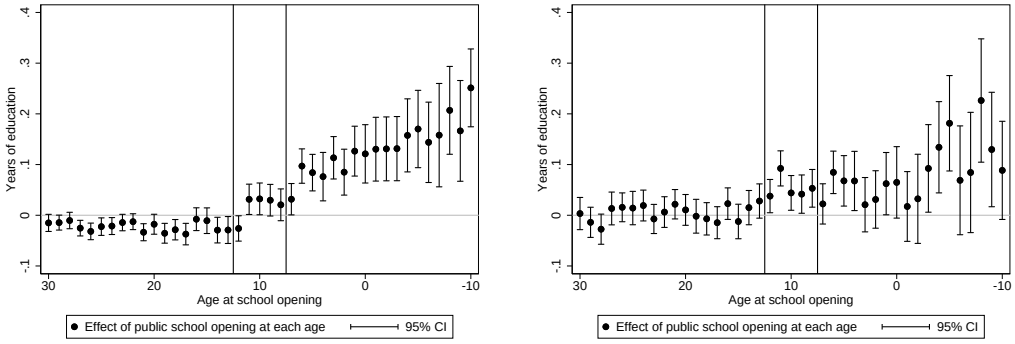
[13] If we were to consider all $a > 30$, the sum of every $n_{vc}^{public,a}$ would be the number of public schools, a constant at the village level, and would be captured by the village fixed effects.

[14] *Arrêté du 27 juillet 1950* reproduced in France, Ministère des Colonies (1950). *Rapport annuel du Gouvernement Français à l'Assemblée Générale des Nations Unies sur l'administration du Cameroun placé sous la tutelle de la France.*

[15] In the 1976 census, 46% of boys and 38% of girls in the first year of primary are older than 10.

Figure 5: Event study graphs: effect of public school openings on education

(a) Women (b) Men



Note: Both figures display the β_{public} coefficients of equation (1), estimated separately for men and women. The $\beta_{private}$ are estimated jointly, but presented on a different graph for readability (appendix figure C.1). Standard errors are clustered at the village level.

Figure 5 displays the β associated with public education, for men and women separately. Schools opening before 7 increase education of both men and women. The effect is larger and more precisely estimated for women than for men. If, when a public school opened in a village, some boys were already attending private school while girls were not, we would expect the opening of a public school to matter more for girls' education. Schools opening between 8 and 12 also increase education, but the magnitude is lower for women. Schools opening after 12 have no positive effect on education. The estimated effect is very slightly negative for women (see discussion below). The picture is similar for private schools (appendix figure C.1).

Appendix figure C.2 displays event study graphs for men and women when we also consider post-colonial schools (opened after 1960). These graphs are very similar to figure 5, but there is a significant (though small) correlation between years of education and the number of public schools built in the village when an individual was between 20 and 30. This is likely because, in the postcolonial period, school supply reacted to local demand and educated parents of school age children were able to lobby for more schools. For this reason, we never consider schools built after 1960 in the rest of the paper. This hardly matters for our results

because we only consider individuals older than 25, who were born before 1951.

Next, we present event study results in a more compact way and we test more formally the parallel trend assumption that schools opening after 17 are not positively correlated with education or labor/marriage market outcomes. We estimate the following equation:

$$\begin{aligned} E_{ivc} &= \gamma_1 N_{vc}^{public,7} + \gamma_2 n_{vc}^{public,8-12} + \gamma_3 n_{vc}^{public,13-16} + \gamma_4 n_{vc}^{public,17-22} \\ &+ \phi_1 N_{vc}^{private,7} + \phi_2 n_{vc}^{private,8-12} + \phi_3 n_{vc}^{private,13-16} + \phi_4 n_{vc}^{private,17-22} \\ &+ \alpha_v + \delta_c + \delta_c \times BR + x'_{vc}\theta + e_{ivc} \end{aligned}$$

where $N_{vc}^{public,7}$ is the stock of public schools in village v when individual i was 7, and $n_{vc}^{public,a-b}$ is the number of public school openings between ages a ad b.[16] γ_4 and ϕ_4 test the parallel trend assumption for, respectively, public and private schools. If $\gamma_4 = 0$, then individuals aged 17–22 at the opening of a school were not more educated than in a village where no school opened. γ_3 and ϕ_3 should be small, but might be positive if there is late school entry and measurement error in age. We estimate equation (2) not only for education, but also for a labor market outcome (the probability to be a wage earner) and for the number of spouses (for men) and co-spouses (for women). It should be noted that, for marriage market outcomes, we might estimate γ_4 and ϕ_4 different from zero even if the parallel trend assumption is valid because of general equilibrium effects on local marriage markets. If the building of a school makes women who were young enough to attend school relatively more attractive on the local marriage market, it also makes women who were too old to attend school relatively less attractive.[17]

Table 2 displays the coefficients of equation (2) for women. An additional public school in the village at 7 increases schooling by 0.11 years and the probability to be a wage earner by 0.46 percentage points. It also increases the number of co-spouses by 0.02. This is the central result of the paper: a positive education shock makes women *more*, not *less* likely to enter a polygamous union. Public

[16] $N_{vc}^{private,7}$ and $n_{vc}^{private,a-b}$ are the same for private schools.

[17] The same general equilibrium argument can be applied to labor market outcomes, but labor markets are typically larger than marriage markets, which makes the problem less important.

Table 2: Effect of school constructions after 17, women

	(1) Years of schooling	(2) Wage earner	(3) Nb. of co-spouses
# public schools at 7	0.1110***	0.0046***	0.0185**
	(0.0167)	(0.0013)	(0.0081)
# public sch. openings 8-12	0.0331***	0.0020**	-0.0014
	(0.0122)	(0.0009)	(0.0064)
# public sch. openings 13-16	-0.0087	-0.0001	0.0029
	(0.0094)	(0.0006)	(0.0065)
# public sch. openings 17-22	-0.0166***	-0.0002	-0.0055
	(0.0057)	(0.0004)	(0.0057)
# private schools at 7	0.1019***	0.0038***	-0.0515***
	(0.0171)	(0.0012)	(0.0135)
# private sch. openings 8-12	0.0166	0.0016*	-0.0410***
	(0.0119)	(0.0008)	(0.0132)
# private sch. openings 13-16	-0.0183**	0.0011	-0.0320***
	(0.0091)	(0.0006)	(0.0121)
# private sch. openings 17-22	-0.0167**	0.0005	-0.0324***
	(0.0071)	(0.0005)	(0.0110)
Village F.E.	✓	✓	✓
Cohort F.E.	✓	✓	✓
Cohort F.E. × Br. Cameroon	✓	✓	✓
Village controls × cohort quartic trend	✓	✓	✓
Observations	700,986	388,424	492,816

Sample: in column (1), all non-migrant women aged 25–60 in 1976; in column (2), all non-migrant working women 25–60; in column (3), all non-migrant married women 25–60. Standard errors clustered at the village level in parentheses. $^{*}p < 0.1$, $^{**}p < 0.05$, $^{***}p < 0.01$.

schools did not open in villages that already had a positive trend in education: the coefficient on the number of public school openings between 17 and 22 is actually negative, though small (-0.016), which might be the sign that public schools were opening in villages with a slight negative trend in female education. This does not threaten our identification in an economically significant way. Though this means the coefficient of the first stage might be attenuated, the attenuation bias would be small (-0.016 years is only 1/7th of the effect of public schools at 7). Besides, public schools did not open in villages that had a positive trend in polygamy (the effect of school openings between 17 and 22 on the number of co-spouses is

negative, small, and not statistically significant). The coefficient of the reduced form on polygamy has therefore no reason to be biased, but the coefficient of the IV-estimation might be biased upwards for women (because the first stage might be biased), but by no more than a few percent.

Results for the opening of a private school are remarkably similar for education and the probability of being a wage earner, but they are very different for the number of co-spouses. An additional private school in the village at 7 *decreases* the number of co-spouses by 0.5. Given that Christian schools in Cameroon were fighting polygamy actively (Walker-Said, 2015, 2018; Tsoata, 1999), one natural interpretation of this result is that Christian and secular education have very different effects on the marriage market. However, we find evidence that the parallel trend assumption does not hold in the case of private, Christian schools. The opening of a Christian school in the village between 17 and 22 is associated with 0.3 fewer co-wives, which means that Christian schools were opening in village were polygamy was already declining, probably because these were already Christianized villages.

Table 3 displays the coefficients of equation (2) for men. Results are similar as for women, with a couple of important differences: an additional public school in the village at 7 increases education by 0.6 years (versus 0.11 for women), maybe because boys were more likely to be already enrolled in a private school; the number of schools opening between 13 and 16 increases education and the number of co-spouses, maybe because boys were more likely than girls to start school late.[18] Men who had access to a private school at 7 have more spouses, not less, but the parallel trend assumption seems to be violated: private schools opened in villages with a positive trend in wage labor (column 2).

[18]The magnitude of the effect on the number of spouses is important (0.06 wives). This might be explained by the fact that, in the cohort of boys theoretically too old to enter school when a new school opened, the few who attended school enjoyed a particularly big advantage on the marriage market later in life, while those who obtained education along with the rest of their cohort had to compete with other educated men.

Table 3: Effect of school constructions after 17, men

	(1) Years of schooling	(2) Wage earner	(3) Nb. of co-spouses
# public schools at 7	0.0572***	0.0109***	0.0112**
	(0.0158)	(0.0027)	(0.0047)
# public sch. openings 8-12	0.0524***	0.0014	0.0096***
	(0.0112)	(0.0014)	(0.0036)
# public sch. openings 13-16	0.0143	0.0019	0.0066**
	(0.0103)	(0.0015)	(0.0033)
# public sch. openings 17-22	0.0012	0.0006	0.0018
	(0.0085)	(0.0011)	(0.0031)
# private schools at 7	0.0847***	0.0134***	0.0170**
	(0.0200)	(0.0022)	(0.0071)
# private sch. openings 8-12	0.1005***	0.0123***	0.0065
	(0.0202)	(0.0022)	(0.0058)
# private sch. openings 13-16	0.0330**	0.0063***	0.0077
	(0.0167)	(0.0019)	(0.0063)
# private sch. openings 17-22	0.0233	0.0081***	0.0078
	(0.0146)	(0.0017)	(0.0062)
Village F.E.	✓	✓	✓
Cohort F.E.	✓	✓	✓
Cohort F.E. × Br. Cameroon	✓	✓	✓
Village controls × cohort quartic trend	✓	✓	✓
Observations	608,454	560,301	471,841

Sample: in column (1), all non-migrant men aged 25–60 in 1976; in column (2), all non-migrant working men 25–60; in column (3), all non-migrant married men 25–60. Standard errors clustered at the village level in parentheses. $^{*}p < 0.1$, $^{**}p < 0.05$, $^{***}p < 0.01$.

3.3. First stage and reduced form

To estimate the labor and marriage market returns to education, we use the stock of public schools in the village when an individual was of school age as an instrument for education. In a first stage, we estimate the following equation:

$$E_{ivc} = \alpha_v + \delta_c + \delta_c \times BR + \gamma N_{vc}^{public,a} + x'_{vc}\theta + \varepsilon_{ivc} \tag{2}$$

where the excluded instrument $N_{vc}^{public,a}$ is the stock of public schools in village v when individual i was age a. We choose the age a that maximizes the first stage

F-test of the excluded instrument. This age is 7 for women, and 13 for men (see appendix figure C.3). As discussed above, the reason why schools opening after 7 seem to matter more for men than for women is that late school entry is a more common phenomenon for men.[19] As a robustness, we also present results where we use the same excluded instruments for men and women: the stock of schools at 7, and the number of schools opening between 8 and 12 (see appendix tables C.1 and C.2 and discussion below). Like in equation 1 α_v and δ_c are village and cohort fixed effects, and BR is a binary equal to one in the two Western provinces, which were part of British Cameroon until independence. x_{vc} is a vector of time invariant village controls interacted with a quartic cohort trend.

The village fixed effects capture any village characteristic correlated with both education and school constructions. One might be worried, for example, that more schools are built in urban areas where the returns to education are larger. Controlling for village fixed effects will be perhaps even more important in the second stage, when we will put marriage market outcomes on the left-hand side. Fenske (2015) shows that, in a number of African surveys, the negative correlation between polygamy and education is largely explained by geographical controls correlated negatively with education and positively with polygamy. The cohort fixed effects ensure that we will not interpret a spurious correlation between an increasing trend in education (or a declining trend in polygamy) and an increasing trend in school supply. The cohort fixed effects are interacted with the British Cameroon binary to allow for a different trend in regions subjected to a different colonial rule. Because of the village fixed effects, our identification comes from within-village differences between age groups. However, villages sharing similar observable characteristics may have similar histories, and this may be related to trends in school construction. This is why our specification includes the vector x_{vc} of time-invariant village controls interacted with cohort trends.[20] The village-level controls are precipitation, temperature, elevation, ruggedness, a malaria stability index and agricultural suitability, distance to the nearest 1922 railroad, river,

[19] In the 1976 census, 46% of boys in the first year of primary are older than 10 versus 38% for women.

[20] We use a quartic cohort polynomial, which is less computationally demanding than interacting the village controls with the vector of cohort fixed effects (but we show below that the two approaches give very similar results).

1922 town, Roome mission station, 1913 German mission school, and 1913 German government school (see data appendix).[21] The vector x_{vc} also contains the number of private, Christian schools in the village at a. The stock of private schools is not used as an excluded instrument, because the parallel trend assumption is less credible for private schools, but we include it as control to take into account potential complementarity or substitution between private and public schools.[22]

Equation (2) is a quasi difference in differences specification. It would be a DD specification if $N_{vc}^{public,a}$ were a binary variable. Our estimate of interest would then be the difference in the education gap of young and old cohorts between villages where a school opened and villages where no school opened. In equation (2), we also use the difference in the education gap of young and old cohorts between villages where N schools opened and villages where only $N-1$ schools opened.[23]

Table 4: First stage and reduced form for women

	Dep. var.: years of education				Dep. var.: # of co-wives			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
# public schools at 7	0.1344***	0.1102***	0.1068***	0.1084***	0.0167***	0.0178***	0.0169**	0.0196***
	(0.0163)	(0.0143)	(0.0144)	(0.0131)	(0.0063)	(0.0067)	(0.0069)	(0.0068)
# private schools at 7	0.1376***	0.1095***	0.1096***	0.0956***	-0.0290***	-0.0295***	-0.0303***	-0.0259***
	(0.0140)	(0.0157)	(0.0156)	(0.0141)	(0.0083)	(0.0087)	(0.0087)	(0.0087)
Village F.E.	✓	✓	✓	✓	✓	✓	✓	✓
Cohort F.E.	✓	✓	✓	✓	✓	✓	✓	✓
Cohort F.E. × Br. Cameroon	✓	✓	✓		✓	✓	✓	
Village ctrls × cohort trend	✓				✓			
Village ctrls × cohort quartic		✓		✓		✓		✓
Village ctrls × cohort F.E.			✓				✓	
Cohort F.E. × province F.E.				✓				✓
Observations	700,986	700,986	700,986	700,986	492,816	492,816	492,816	492,816

Sample: in columns (1) to (4), all non-migrant women aged 25–60 in 1976; in columns (5) to (8), all non-migrant married women 25–60. Standard errors clustered at the village level in parentheses. $^{*}p < 0.1$, $^{**}p < 0.05$, $^{***}p < 0.01$.

Table 4 displays the results of the first stage and of the reduced form on the

[21] Jedwab et al. (2018) have shown that historical mission atlases such as Roome (1925) tend to report only selected mission locations, hence the importance of also using the data on mission schools in Schlunk (1914), digitized by Dupraz (2019).

[22] If public and private schools are substitutes, the government might build less public schools in villages that already have private schools. The government might also build more public schools in villages that already have private schools and where the demand for education is high.

[23] In our sample of women, 72% had no school in the village at 7, 20% had 1 school, 5% had 2 schools, and 3% had 3 schools or more, with a maximum of 11 schools. In our sample of men, 62% had no school in the village at 13, 22% had 1 school, 8% had 2 schools, and 8% had 3 schools or more, with a maximul of 12 schools.

number of co-wives for women. Column (1) is a simplified specification, where the village controls are interacted with a linear, rather than quartic, cohort trend. One additional school in the village at 7 increases education by 0.13 years of education. Column (2) is our preferred specification, where we interact the village controls with a quartic cohort trend: the coefficient drops slightly, to 0.11 years of education. It then remains very similar when we interact the village controls with the full vector of cohort fixed effects in column (3), which shows that this computationally demanding estimation is not required. In column (4), we interact the vector of cohort fixed effects with a vector of province fixed effects (there were 7 provinces in Cameroon in 1976, see figure 1), and the coefficient on the stock of public schools at 7 is barely affected. This reassures us that our first stage is capturing the causal effect of school supply on education rather than a spurious correlation between trends in education and province specific trends in school constructions. Columns (5) to (8) display the results of the reduced form: an additional public school in the village at 7 increases the number of co-wives by about 0.02 (while an additional private school decreases the number of co-wives by about 0.03). Table 5 displays the results of the first stage and of the reduced form on the number of wives for men. An additional public school at 13 increases education by about 0.05 years and the number of wives by about 0.01.

Table 5: First stage and reduced form for men

	Dep. var.: years of education				Dep. var.: # of wives			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
# public schools at 13	0.0464***	0.0510***	0.0504***	0.0560***	0.0081***	0.0089***	0.0090***	0.0120***
	(0.0100)	(0.0098)	(0.0099)	(0.0089)	(0.0027)	(0.0029)	(0.0029)	(0.0029)
# private schools at 13	0.0831***	0.0790***	0.0781***	0.0655***	0.0097**	0.0101**	0.0100**	0.0116***
	(0.0156)	(0.0155)	(0.0155)	(0.0144)	(0.0046)	(0.0048)	(0.0048)	(0.0044)
Village F.E.	✓	✓	✓	✓	✓	✓	✓	✓
Cohort F.E.	✓	✓	✓	✓	✓	✓	✓	✓
Cohort F.E. × Br. Cameroon	✓	✓	✓		✓	✓	✓	
Village ctrls × cohort trend	✓				✓			
Village ctrls × cohort quartic		✓		✓		✓		✓
Village ctrls × cohort F.E.			✓				✓	
Cohort F.E. × province F.E.				✓				✓
Observations	608,454	608,454	608,454	608,454	471,841	471,841	471,841	471,841

Sample: in columns (1) to (4), all non-migrant men aged 25–60 in 1976; in columns (5) to (8), all non-migrant married men 25–60. Standard errors clustered at the village level in parentheses. $^{*}p < 0.1$, $^{**}p < 0.05$, $^{***}p < 0.01$.

3.4. 2SLS results

We use our first stage to instrument for education in the following equation:

$$y_{ivc} = \alpha_v + \delta_c + \delta_c \times BR + \tau E_{ivc} + x'_{vc}\phi + \nu_{ivc} \tag{3}$$

where y_{ivc} can be an individual's own labor market outcome (like the probability to be in the labor force or be a wage earner) or marriage market outcome (like the number of wives/co-wives, or education of the spouse).

As emphasized in sections 3.2 and 3.3, these estimations solve most endogeneity issues: our event study shows that the effect of school construction is not explained by pre-trends in education, and our estimation controls for a potential correlation between age trends and observable village characteristics. However, two additional concerns remain.

First, for the exclusion restriction to be met, it must be the case that school constructions affect outcome y_{ivc} only through the own education of individual i. But when we estimate assortative matching on education (does your own education causes you to choose a more educated spouse), we need to bear in mind that the construction of a school in your village also affects the education of your potential mates. If husbands and wives always had the same age, then we could not disentangle the effect of assortative mating from the effect of school construction on education. In Cameroon around independence, individuals did not typically marry within the same age group — husbands were on average 10 years older than their wives (see table 1). However, the stock of schools when an individual was of school age and the stock of schools when their potential mates were of school age are very correlated. This is one additional motivation to use a structural model: the model we present and estimate in section 4 below allows us to estimate the affinity between polygamy and education taking into account assortative mating on age.

Second, selective migrations are another threat to the validity of the exclusion restriction. In equations (2) and (3), $N_{vc}^{public,a}$ is the stock of public schools at age a in the village where the person *lives in 1976*. As we know the district of birth of individuals, we can exclude out-of district migrants from the sample (about 30% of men and women). However, if education affects the decision to migrate,

then our sample might be selected. To alleviate these concerns, we also present a specification on the full sample, including migrants, with an instrument at the district level (see appendix table C.3 and discussion in section 3.5 below).

We start by estimating labor market returns to education, as well as the effect of education on the extensive margin of marriage (this is crucial because we run our main results on polygamy are obtained on the sample of married individuals only). In table 6, panels A and B (for men and for women), we present both the results of an OLS estimation with cohort and village fixed effects and the results of our 2SLS estimation. Unfortunately, the census does not give information on income, but it gives information on employment status. We do not estimate statistically significant effects of education on the probability to be in the labor force (column 1). Conditional on being in the labor force, education increases the likelihood to be employed in the formal sector and earn a wage by 3 percentage points for women and 10 percentage points for men, which seems to indicate that labor market returns to education are higher for men (table 6, column 2). Education seems to slightly decrease the likelihood to have ever been married for women (-0.02) and increase it for men (0.04), but these effects are not statistically different from zero in the 2SLS specification (column 3). Surprisingly, educated men seem more likely to be widowed, but the small coefficient of 0.014 is significant at the 10% level only (column 4). Finally, education seems to make women 2.6 percentage points less likely to have divorced, but the effect is, again, barely statistically significant (columns 5).

We then focus on the sample of married individuals (table 7). Education increases the socioeconomic status of a spouse. For women, one additional year of education increases their husband's education by 0.56 years and the likelihood that their husband is a wage earner by 7.7 percentage points (panel A, columns 1 and 2).[24] For men, one additional year of education increases the average education of their wives by 1.34 years (panel B, column 1). These might be the combined result of matching and the school construction shock affecting the education of potential mates. This is one reason for wanting to estimate assortative mating on education in a structural model that also takes into account matching on age.

[24] We do not present the result on whether wives are wage-earners because only 1% of women are wage earners (see table 1).

Table 6: Results of 2sls estimation: labor market and extensive margin of marriage

	(1)	(2)	(3)	(4)	(5)
			Panel A: women		
	In labor force	Wage earner	Ever married	Widow	Divorced
			OLS (with cohort and village fixed effects)		
Years of schooling	-0.001	0.020***	-0.023***	-0.007***	0.003***
	(0.001)	(0.002)	(0.001)	(0.000)	(0.000)
			2SLS (instrument=# public schools at 7)		
Years of schooling	-0.028	0.033***	-0.018	-0.030	-0.026*
	(0.033)	(0.008)	(0.014)	(0.021)	(0.015)
K-P F-stat	59.20	86.44	59.59	59.59	59.59
Observations	696,119	386,450	698,736	698,736	698,736
# clusters	9,213	7,307	9,214	9,214	9,214
			Panel B: men		
	In labor force	Wage earner	Ever married	Widow	Divorced
			OLS (with cohort and village fixed effects)		
Years of schooling	0.003***	0.037***	0.009***	-0.002***	-0.002***
	(0.000)	(0.001)	(0.001)	(0.000)	(0.000)
			2SLS (instrument=# public schools at 13)		
Years of schooling	0.024	0.104***	0.040	0.014*	-0.003
	(0.015)	(0.034)	(0.037)	(0.007)	(0.011)
K-P F-stat	26.45	29.68	28.43	28.43	28.43
Observations	604,931	558,430	604,670	604,670	604,670
# clusters	9,203	9,166	9,201	9,201	9,201

Sample: all non-migrant men/women aged 25-60 in 1976. Standard errors clustered at the village level in parentheses. $^{*}p < 0.1$, $^{**}p < 0.05$, $^{***}p < 0.01$.

One additional year of schooling increases the likelihood to be in a polygamous union by 9.9 percentage points for men, and by 6.6 percentage points for women (column 4). Men's number of wives increases by 0.18 while women's number of co-wives increases by 0.22 (column 4). Interestingly, there is no effect of education on a wife's rank within marriage (column 5).[25] It could indicate that educated women are not entering marriages as second or third wives, but are marrying as first wives men who then go on to marry more women. Women who received one additional year of education are married to younger men (by one and a half year), but there is no effect of education on average spousal age for men (column 6).

For men, the result on polygamy is not too surprising: if education increases the attractiveness of men on the marriage market (if only because of very large labor market returns), then it should give men the opportunity to marry more women in a society allowing polygamy. Even without instrumenting for education, the correlation between education and polygamy conditional on village and cohort fixed effects is positive and statistically significant for men, tough small (0.3 percentage points, panel B, column 3).

The fact that education increases the likelihood to be in a polygamous union for women is more surprising. If education makes women more attractive on the marriage market, and if women prefer to marry men with fewer co-wives, then we would expect education to decrease polygamy for women. But what we estimate with our 2sls strategy is a reduced form result, which is the combined effect of matching on many characteristics. If educated women marry more educated men and educated men are more likely to be polygamous, then our positive reduced form effect might mask a negative affinity between female education and polygamy. In order to explore this possibility, we turn to a structural model of the marriage market in section 4 below. A structural model also has the advantage of taking matching on age into account.

Before turning to the structural model, we present a couple of robustness exercises. Appendix tables C.1 and C.2 display results obtained by using the same instruments for men and women: the stock of schools in the village at 7, and the number of schools opening between 8 and 12. Results are overall very similar, but

[25] The rank within marriage is not given by the census directly: we infer it from age. Therefore, a women is given rank one if she is the oldest co-wife, rank 2 if she is the second oldest, etc.

Table 7: Results of 2sls estimation: sample of married individuals

	(1)	(2)	(3)	(4)	(5)	(6)
			Panel A: women			
	Husband's education	Husband wage earner	Husband polygamous	Husband's # of wives	Wife rank	Husband's age
			OLS (with cohort and village fixed effects)			
Years of schooling	0.603***	0.033***	-0.011***	-0.018***	-0.029***	-0.539***
	(0.009)	(0.001)	(0.001)	(0.003)	(0.003)	(0.017)
			2SLS (instrument=# public schools at 7)			
Years of schooling	0.558***	0.077***	0.066**	0.221***	-0.003	-1.613***
	(0.112)	(0.016)	(0.030)	(0.083)	(0.075)	(0.581)
K-P F-stat	79.29	86.36	79.03	79.03	80.53	80.05
Observations	491,152	451,030	490,045	490,045	498,101	491,806
# clusters	9,040	8,985	9,039	9,039	9,074	9,042
			Panel B: men			
	Wife(s)'s education		Polygamous	Number of wives		Wife(s)'s age
			OLS (with cohort and village fixed effects)			
Years of schooling	0.286***		0.003***	0.008***		-0.336***
	(0.004)		(0.001)	(0.001)		(0.013)
			2SLS (instrument=# public schools at 13)			
Years of schooling	1.339***		0.099**	0.181**		0.344
	(0.246)		(0.039)	(0.070)		(0.549)
K-P F-stat	26.24		25.89	25.71		25.85
Observations	438,328		472,341	470,247		439,070
# clusters	9,041		9,093	9,091		9,043

Sample: all non-migrant men/women aged 25-60 in 1976. Standard errors clustered at the village level in parentheses. *$p < 0.1$, **$p < 0.05$, ***$p < 0.01$.

the K-P F-stat of the excluded instruments is lower than in tables 6 and 7.

3.5. Migration

In our main specification, we instrument education by the stock of public schools at age a in the village where the individual lives in 1976, excluding people who migrated out of their district of birth (about 30% of the sample). If education affects the decision to migrate, then our sample might be selected. More precisely, we might be worried that the men and women who decide to migrate when they receive education have specific preferences with respect to, for example, polygamy. If women and men with a strong distaste for polygamy migrate when they obtain education, then part of the positive effect of education on polygamy could be explained by migration. In appendix table C.3, we present the results of a specification where we use as an instrument the district average number of available schools at a in the district of birth. More precisely, our first stage becomes

$$E_{idc} = \alpha_d + \delta_c + \delta_c \times BR + \gamma \bar{N}_{dc}^{public,a} + x'_{dc}\phi + e_{idc} \tag{4}$$

α_d are district fixed effects. $\bar{N}_{dc}^{public,a}$ is the average at the district level of $N_{vc}^{public,a}$ on the sample of non-migrants (a is 7 for women and 13 for men). The vector x_{dc} contains all variables in the vector x_{vc} averaged at the district level (there are 112 district). Standard errors are clustered at the district level. Because the census gives the district of birth of everyone, migrants and non-migrants, we can estimate this model on the sample of non-migrants and on the full sample. This is shown in appendix table C.3. The first thing to note is that an additional year of education greatly increases the likelihood to migrate (by 7 percentage points for women and 31 percentage points for men — column 1). However, our main IV estimates are remarkably similar in the full sample and in the selected sample of non-migrants. For example, the effect of education on the number of co-wives is slightly lower in the full sample (0.17) than in the sample of non-migrants only (0.21), but the two coefficients are not statistically different from one another (column 6). For men, we obtain very similar effects in both samples (and in line with our benchmark village-level results) but they are very imprecisely estimated, and the K-P F-stat of the excluded instrument is always lower than 10.

4. Structural estimation of marriage market returns to education

In Cameroon in the late colonial period, receiving public, non-religious education increased a woman's likelihood to be in a polygamous union. But women who had the opportunity to go to school also married men with a higher socio-economic status (more educated, more likely to be wage earners). Men with a higher socio-economic status were more likely to be polygamous: is this why educated women were more likely to be polygamous? We also want to take into account matching on age and the fact that the educational shock we use to instrument for education also affects the education of potential mates. To disentangle all these effects, we want to estimate marriage market returns to education on a given characteristic of the marriage taking all other characteristics of the marriage as given. To do so, we consider a matching model of marriage whose parameters can be estimated on data. We extend the model of Choo and Siow (2006) to polygamous marriages and we adopt the joint utility parametrization of Dupuy and Galichon (2014). We estimate "affinities" between the characteristics of husbands and wives in a match. These affinities describe the likelihood of observing a match where a husband and a wife have certain attributes (for example, the man is a polygamist, the woman is educated) taking into account the matching between all other attributes.

We show that the strong affinity between a man's polygamy and a wife's education is almost entirely explained by assortative matching on education. The positive affinity between a wife education and her husband's number of wives becomes insignificant when we allow for matching on education.

4.1. A matching model of the marriage market

In the standard structural model of matching with transferable utility of Choo and Siow (2006) or Dupuy and Galichon (2014), men with a set of attributes x marry women with a set of attributes y. We generalize the model of Choo and Siow (2006) to the polygamous case.[26]

[26] In Choo and Siow (2006), the attributes of men and women are discrete. Dupuy and Galichon (2014) show a generalization to continuous attributes in the monogamous case.

Our model has women and men choosing partners to maximize their utility. In reality, in the context of Cameroon before 1976, it might be more realistic to envision marriage as a match between two families. The weight of her family in a woman's marriage market decisions was likely particularly important. One can understand the utility functions in our model as applying to the whole family of the man or woman — but we do not explicitly model the strategic interactions within the bride or groom's families.

A man m of characteristics $x_m = x$ marrying a set of women $W = \{w_1, \ldots, w_{n_Y+1}\}$ of characteristics $Y = \{y_1, \ldots, y_{n_Y+1}\}$ gets utility[27]

$$\mathcal{U}(m, W) = U(x, Y) + \varepsilon_{mY} = \sum_{y \in Y} u(x, y, n_Y) + \varepsilon_{mY} \tag{5}$$

$U(x, Y)$ is the systematic part of the utility, and is assumed to be additively separable in the utility given by each match with a woman of characteristics y. The utility of a match with a given wife is also allowed to depend on the number of co-wives n_Y. The model has transferable utility: husband and wife can transfer utility to one another to compensate for some characteristics. These utility transfers play the role of prices, but are unobserved by the econometrician.[28] $U(x, Y)$ is the utility post transfers. ε_{mY} is a randomly drawn "sympathy shock" for each set of spouses Y. Each man m is therefore allowed to have idiosyncratic preferences for his wives' characteristics Y, but not preferences for individual women. ε_{mY} follows a Gumbel distribution, and is independent between Y.

A woman w with characteristics $y_w = y$ marries a man m of characteristics $x_m = x$ and n_Y other wives. She gets utility:

$$\mathcal{V}(m, n_Y, w) = v(x, n_Y, y) + \eta_{wxn_Y} \tag{6}$$

$v(x, n_Y, y)$ is the systematic part of the utility which depends on the characteristics of the man x, of the woman y, and on the number of co-wives. η_{wxn_Y} is a randomly drawn "sympathy shock" of woman w for men of type x with n_Y co-spouses. η_{wxn_Y}

[27] We will later use the notation n_Y for the number of co-wives, so $n_Y + 1$ is the total number of wives. In a monogamous marriage, $n_Y = 0$.

[28] In the context of Cameroon, marriage is associated with an actual price, the bride price, but we do not observe it.

follows a Gumbel distribution and is independent between (x, n_Y). Each woman w is therefore allowed to have idiosyncratic preferences for the husband's characteristics x and the number of co-wives n_Y, but *not for the characteristics of the co-wives*. This explains why v depends on n_Y but not on the characteristics of the co-wives. If the systematic part of utility v depended on the characteristics of the co-wives while the sympathy shock η did not, then every woman of a given type y would prefer the same type of marriage (x, n_Y, Y), and women of type y would never choose other marriages (x, n_Y, Y'). Therefore at equilibrium, v depends only on n_Y (and x) if η depends only on n_Y (and x). Though, to the best of our knowledge, no paper has investigated the importance of the characteristics of co-wives in a woman's choice of a husband, recent work has studied strategic interactions between co-wives in polygamous marriages: Barr et al. (2019) use public good games in Nigerian households to show that polygynous husbands and wives and co-wives, one with another, are less cooperative than monogamous husbands and wives. Rossi (2019) shows that, in Senegal, women in a polygamous union strategically increase fertility in response to an increase by a co-wife. Our model does not prevent women to have preferences over the characteristics of co-wives (women might prefer to enter a marriage with a co-wife who is older, or more educated), but it does prevent women to have *idiosyncratic* preferences over the characteristics of co-wives. This is a crucial simplifying assumption that allows us to extend the model to polygamy.

Because the sympathy shocks ε_{mY} and η_{wxn_Y} are i.i.d. and follow a Gumbel distribution, the distribution of men's wives $\pi(Y|x)$ and the distribution of women's husbands $\pi(x, n_Y|y)$ both follow a mulitnomial logit at the equilibrium (McFadden, 1974):

$$\pi(Y|x) = \frac{\exp\left(U(x, Y)\right)}{\sum_{Y' \in \mathcal{Y}} \exp\left(U(x, Y')\right)} \tag{7}$$

$$\pi(x, n_Y|y) = \frac{\exp\left(v(x, y, n_Y)\right)}{\sum_{x' \in \mathcal{X}, n'_Y \in \mathbb{N}} \exp\left(v(x', y, n_Y)\right)} \tag{8}$$

Equations (7) and (8) are compatible. To show this, we follow the literature and define an equilibrium as a situation where for every (x, y, n_Y), the number of men

of type x who choose to marry a spouse of type y with n_Y other spouses equals the number of women willing to accept this situation. In other words, if f and g are the distribution of men's types and of women's types, for every (x, y, n):

$$g(x) \sum_{Y|n_Y=n, y\in Y} \pi(Y|x) = f(y)\pi(x, n_Y|y) \tag{9}$$

Theorem 1. *For any (implicitly transferable) utility functions following (5) and (6), and for any distribution of female and males attributes, there is an equilibrium following both (7) and (8).*

The proof of theorem 1 is given in appendix D. We then characterize the equilibrium:

Lemma 1. *If we assume the chances to marry a spouse of type y are small for any number of spouses n_Y, the matching function can be written*

$$\pi(x, y, n_Y) = \exp\left(\frac{\Phi(x, y, n_Y) - b(y) - a(x, n_Y)}{2}\right) \tag{10}$$

where $\Phi(x, y, n_Y) = u(x, y, n_Y) + v(x, y, n_Y)$ is the total systematic utility generated by a match (x, y, n_Y).

The proof of lemma 1 is given in appendix D.

Unlike in the monogamous case, we do not prove fully the unicity of the equilibrium. Theorem 2 (proof in appendix D) shows that for a given distribution of female characteristics, and male characteristics and their number of spouses, there can be no more than one equilibrium, which follows (10).[29]

Theorem 2. *For every distribution of female types $g(y)$ and for every joint distribution of males types and of their number of spouses $f(x, n_Y)$, there is at most one equilibrium, which is the unique distribution following the density* (10).

Observing the distribution of marriages allows identification of the joint utility Φ up to two separatively additive functions $b(y)$ and $a(x, n_Y)$. What can be identified

[29] Theoretically, there might be several possible distributions of the number of spouses at equilibrium, though we did not find any theoretical examples of multiple equilibria.

here are the second derivatives of Φ with respect to the characteristics of men and women. Because it appears in the function $a(x, n_Y)$ but not in the function $b(y)$, the number of co-wives can be considered as a husband characteristic. To make this clearer, we adopt the notation $\mathbf{x} = (x, n_Y)$. We then adopt the simple parametrization of Dupuy and Galichon (2014): $\Phi(\mathbf{x}, y) = \mathbf{x}' A y$, where A is a $d_{\mathbf{x}} \times d_y$ matrix ($d_{\mathbf{x}}$ and d_y are respectively the number of attributes of $\mathbf{x}$ and y). A is the Hessian of Φ: $\frac{\partial^2 \Phi}{\partial \mathbf{x} \partial y} = A$.

What can be identified from observing the distribution of marriages are the elements $a_{\mathbf{x}y}$ of the affinity matrix A. Let us consider as an example $a_{\mathbf{x}_E, y_E}$, the affinity between the education of husband and wife. It is the second derivative of the joint utility of the match with respect to education of the husband and education of the wife. If we assume that education of the wife increases the joint utility of the match, then $a_{\mathbf{x}_E, y_E} > 0$ means that the increase in utility brought by the education of the wife is higher in marriages where the husband is educated. Because individual are maximizing their utility, it also means that we are more likely to observe a match between an educated man and an educated woman than a match between an educated man and an uneducated woman.[30] Each affinity takes as given the affinity between all other characteristics of the match.

Only the distribution of marriages is used for identification, and singles do not contribute to the estimation. This is because the multinomial logit framework used by Dupuy and Galichon (2014) and Choo and Siow (2006) imposes independence of irrelevant alternatives (IIA).

4.2. Logit estimation of the model on pairs of couples

We propose a new way of estimating this matching model of the marriage market, following Charbonneau's (2014) approach to estimating logit models with two dimensions of fixed effects.

We consider a pair of couples, Mr 1 and Mrs 1, and Mr 2 and Mrs 2 and show that the probability that Mr 1 is with Mrs 1 and Mr 2 with Mrs 2 rather than the opposite can be written in a logistic form.

[30] If we assume that education of the wife decreases the joint utility, then a positive affinity means that it decreases utility more in marriage where the husband is uneducated. Our model does not allow us to identify the attractiveness of each type of individual on the marriage market.

Theorem 3. *Let's consider a pair of couples, two women $w = 1$ and $w = 2$ whose respective husbands $h(1) = h_1$ and $h(2) = h_2$ are (respectively or not) $m = 1$ and $m = 2$. if we assume that the fact that one particular man is already married does not affect the overall probability for a woman to get married, the probability that the couples are $(1, 1)$ and $(2, 2)$ rather that the opposite writes:*

$$\mathrm{P}(h_1 = 1|\{h_1, h_2\} = \frac{\exp\left(\Phi_{11} + \Phi_{22} - \Phi_{12} - \Phi_{21}\right)}{1 + \exp\left(\Phi_{11} + \Phi_{22} - \Phi_{12} - \Phi_{21}\right)} \tag{11}$$

where Φ_{mw} is the total systematic utility generated by a match between m and w.

The proof of theorem 3 is given in appendix D. Equation (11) is easy to interpret: Mrs 1 is more likely to be married with Mr 1 than with Mr 2 when $\Phi_{11} + \Phi_{22} > \Phi_{12} + \Phi_{21}$, that is the sum of the systematic utilities of matches is higher when woman 1 is married with man 1 and woman 2 with man 2.[31]

We adopt parametrization $\Phi(\mathbf{x}, y) = \mathbf{x}'Ay$ and apply it to equation (11), which gives, after simplification:

$$\mathrm{P}(h_1 = 1|\{h_1, h_2\} = \{1, 2\}) = \frac{\exp\left((\mathbf{x}_1 - \mathbf{x}_2)'A(y_1 - y_2)\right)}{1 + \exp\left((\mathbf{x}_1 - \mathbf{x}_2)'A(y_1 - y_2)\right)} \tag{12}$$

To estimate the affinity matrix A, we compute the sum of the log-likelihoods defined by (12) over a sample of potential pairs of couples — hence we estimate the affinity matrix by maximum of pseudo-likelihood.[32] Our dataset contains about $500,000$ couples: considering every possible pair of couples would mean considering more than 10^{11} potential pairs, which is not feasible. In each village, we randomly divide all couples into clusters of roughly 5 and we consider every possible pair of couples within each cluster (10 pairs of couples per cluster).[33] This procedure also eliminates village fixed effects from the equations.

The logit in equation (12) has no constant: when $\mathbf{x}_1 = \mathbf{x}_2$ or $y_1 = y_2$, $(h_1 =$

[31] As usual in logit models, this probability respects the property of independence of irrelevant alternatives.

[32] We only consider women with different husbands, that is, we never consider two couples such that one man is married to both women.

[33] The reason why the size of the cluster is not always exactly 5 is that the number of couples per village is not always a multiple of 5. Our results are robust to considering larger clusters of 10 couples.

$1, h_2 = 2)$ is as likely as $(h_1 = 2, h_2 = 1)$ (for the econometrician). The dependent variable of the logit is always 1, as man 1 is always the husband of woman 1. So the model is identified when the matching is imperfect. For example, assume education is the only dimension of $\mathbf{x}$ and y. If the assortative matching on education was perfect (the more educated man is always with the more educated woman), then $\mathbf{x}_1 - \mathbf{x}_2$ and $y_1 - y_2$ would always share the same sign, and increasing A would always increase the likelihood. However, if the matching is imperfect, there are some couples for which $\mathbf{x}_1 - \mathbf{x}_2$ and $y_1 - y_2$ have different signs, so that increasing A decreases the likelihood for these couples.

4.3. Endogeneity of education

Our structural model allows us to estimate the "affinity" between a certain number of characteristics of wives and husbands. These characteristics are what we can observe in the census: age, whether the husband is a polygamist, and education. We are interested in the exogenous part of education, the one we instrument using the stock of public schools in the village when the individual was of school age.

In order to take into account the endogeneity of education, we use a two-step control function approach. Rivers and Vuong (1988) prove the consistency of control function approaches in the probit case. We are not aware of any paper focusing on logit endogenous variables, but Wooldridge (2015) discusses control function approaches in econometrics along a large class of models, including nonlinear dependent variables in general. In this case, control function approaches require independence between the distribution of the error terms and of the instruments.

In a first step, we estimate:

$$\begin{aligned} \Delta E_{wjv} &= \Delta Q(A_{wjv}) + \gamma_w \Delta N_{wjv}^{public,7} \\ &+ \Delta Q(A_{wjv}) \times x_v' \theta_w + \phi_w \Delta N_{wjv}^{private,7} + \Delta e_{wjv} \end{aligned}$$

$\Delta E_{wjv} = E_{1jv} - E_{2jv}$ is the difference in female education for couple pair j in village v, $\Delta Q(A_{wjv})$ is the difference in a quartic polynomial in age,[34] $\Delta N_{wjv}^{public,7}$ is the difference in the number of public schools in the village at 7 (and $\Delta N_{wjv}^{private,7}$

[34] $q_1(A_{1jv} - A_{2jv}) + q_2(A_{1jv}^2 - A_{2jv}^2) + q_3(A_{1jv}^3 - A_{2jv}^3) + q_4(A_{1jv}^4 - A_{2jv}^4)$

the difference in the number of private schools). We also interact the quartic in age difference with a vector x_v of village characteristics.[35] This equation is intended to be as close as possible to the first stage in equation (2), with a couple of caveats: there are no village fixed effects because we consider only pairs of couples within the same village. There are no cohort fixed effects either. Because we consider the interactions between all characteristics of the wife and husbands, adding cohort fixed effects would require estimating thousands of additional coefficients (we consider 35 different cohorts). For this reason, cohort fixed effects are replaced by a quartic function of age.[36]

We estimate a similar first-step equation for men:

$$\begin{aligned}\Delta E_{mjv} &= \Delta Q(A_{mjv}) + \gamma_m \Delta N_{mjv}^{public,13} + \lambda \Delta P_{mjv} \\ &+ \Delta Q(A_{mjv}) \times x_v' \theta_m + \phi_m \Delta N_{mjv}^{private,13} + \Delta e_{mjv}\end{aligned}$$

$\Delta P_{mjv} = P_{1jv} - P_{2jv}$ is the difference between the number of wives of husband 1 and husband 2.[37]

In a second step, when estimating equation (12), we consider, instead of education of men and women, the predicted education and residuals from equations (13) and (13), $\Delta \hat{E}_w$ and $\Delta \hat{e}_w$, and $\Delta \hat{E}_m$ and $\Delta \hat{e}_m$.[38]

Finally, the precision of the estimated matrix A must take into account the two-stage procedure. The precision of A is estimated using a sandwich-like estimator with the hessian of the joint log-likelihood

$$l_j = \log \left\{ \Lambda[\Delta \mathbf{x}_j' A \Delta y_j] \ \varphi(\hat{e}_{mj}^2/\hat{\sigma}_m^2) \ \varphi(\hat{e}_{wj}^2/\hat{\sigma}_w^2) \right\}$$

where Λ is the cumulative of the logistic distribution, φ is the density of the normal

[35] Like in equation (2): a dummy for belonging to British Cameroon, precipitation, temperature, elevation, ruggedness and agricultural suitability, distance to the nearest 1922 railroad, river, 1922 town, Roome mission station, 1913 German mission school, and 1913 German government school.

[36] Results are robust to including a polynomial of degree 3 or 5 in age.

[37] Or, in another specification, the difference between a dummy equal to 1 if husband 1 is a polygamist and a dummy equal to 1 if husband 2 is a polygamist.

[38] We could also have actual education ΔE_m and ΔE_w and the residuals $\Delta \hat{e}_m$ and $\Delta \hat{e}_w$. This does not affect the affinity between education and the other characteristics, but it makes the affinity between wife and husband education and the residuals easier to interpret.

distribution; $\hat{\sigma}_m^2$ and $\hat{\sigma}_w^2$ are the estimated variances of $\hat{e}_m^2$ and $\hat{e}_w^2$.

Because we consider a dyadic dataset of possible pairs of couples, a given couple appears several times in the dataset and the pseudo-likelihood function, and this needs to be taken into account in the estimation of standard errors — this is discussed in Jochmans (2017). This does not really matter in our case because we opt to cluster standard errors by a larger unit, the village.

4.4. Results: affinity matrices

In this section, we estimate matrices A of affinity parameters between characteristics of husbands and wives. These matrices are $d_{\mathbf{x}}$ by d_y where $d_{\mathbf{x}}$ is the number of male attributes taken into consideration, and d_y the number of female attributes. Element a_{kl} of A is the affinity between husband's attribute $\mathbf{x}_k$ and wife's attribute y_ℓ. It is is the second derivative of the joint utility of a match with respect to $\mathbf{x}_k$ and y_ℓ.

In a first step, we estimate the affinity between a woman's education and the number of wives of her husband without taking into account the matching on education. In this way, we replicate in the structural framework the central result of the difference in differences estimation: educated women are more likely to be with polygamous men. On a sample of couple pairs indexed by j, we estimate the following equation:

$$\mathrm{P}_j = \Lambda\left[\Delta\mathbf{x}_j' A \Delta y_j\right]$$

where the vector $\Delta\mathbf{x}_j$ contains the difference between the number of wives of husband 1 and husband 2 ($\Delta P_{mjv} = P_{1jv} - P_{2jv}$), as well as a quartic polynomial in the age difference. Δy_j is a vector containing all the Δ variables in the first step equation (13), as well as the residual $\Delta\hat{e}_{wj}$ (the control function). The main difference with the non-structural approach is that we are able to take into account flexibly the matching on age by including a quartic polynomial in age for both husbands and wives. The wife's vector contains 58 characteristics and the husband's vector contains 5, so we estimate a total of 290 parameters, most of which have no meaningful interpretation as their role is to make the first step of the control function approach as close as possible to the first stage of our 2sls estimation. In table 8, we only display the meaningful affinity parameters.

The top panel of table 8 displays the matrix A not taking into account assortative matching on education. The first cell of the matrix displays the affinity between the education of a wife and the number of co-wives of her husband: the affinity is positive (0.15) and statistically significant at the 10% level. Our logit estimation procedure on pairs of couples helps us interpret the magnitude of this affinity, which is in fact an odds ratio (see equation 12). Let's imagine a pair of couples composed of a woman with zero years of education, a woman with one year of education, a monogamous man (with zero other wives) and a polygamous man with exactly one other wife. An affinity of 0.15 means that the educated woman is $\exp(0.15) = 1.16$ times more likely to be married to the polygamous man than to the monogamous man. This is, of course, when we do not take into account matching on education.

Table 8: Matrix A (husband's # of wives)

Matrix A w/o taking into account matching on education				
	Husband # of wives	Husband education	Husband education control function	Other husband characteristics
Wife education	0.15*			✓
	(0.08)			
Wife education control function	0.01**			✓
	(0.00)			
Other wife characteristics	✓			✓
Matrix A w/o taking into account matching on education				
	Husband # of wives	Husband education	Husband education control function	Other husband characteristics
Wife education	0.06	0.97***	0.03	✓
	(0.09)	(0.31)	(0.05)	
Wife education control function	0.01	-0.03	0.06***	✓
	(0.01)	(0.07)	(0.00)	
Other wife characteristics	✓	✓	✓	✓

Observations: 853,620. Each observation is a pair of couples within the same village (women 25-60 and their husband). Standard errors clustered at the village level in parentheses. $^{*}p < 0.1$, $^{**}p < 0.05$, $^{***}p < 0.01$. Other husband and wife characteristics are: number of private schools in the village at age 7 (for women) an 13 (for men), a quartic (4th degree) polynomial in age, and a quartic polynomial in age interacted with a vector of time-invariant village variables.

Next, we add to the vector of husbands' characteristics $\Delta \mathbf{x}_j$ all the Δ variables in equation (13) and the residual $\Delta \hat{e}_{mj}$ (the control function). Doing so, we take into account the matching between education of the husband and education of the wife.[39] We estimate a very strong affinity between husband and wife education (0.97, significant at the 1% level).[40] This very strong affinity reduces the affinity between wife education and the number of wives of the husband, which is divided by 3 and loses statistical significance. This shows that our reduced form results was in a very large part explained by assortative matching on education and the fact that educated men are more likely to be polygamous.

Appendix table C.4 is like table 8, but the number of wives of the husband is replaced by a binary variable equal to 1 if the husband is a polygamist, and to 0 if he has only one wife. Here again, the positive affinity of 0.35 we estimate between a woman's education and whether her husband is a polygamist is reduced (to 0.28) when we take into account the very strong matching on education (0.96), though it retains statistical significance at the 10% level.

Though the positive affinity between an wife's education and her husband's polygamy is reduced when we take into account assortative matching on education, it remains positive and does not fall to zero. However, because of data limitations, we are only taking into account a limited number of dimensions of matching on the marriage market. Notably, we have no information on income or wealth (which could play an important role in the matching) let alone on health or personality traits. We can only speculate on what would happen if we were able to take into account more dimensions of the matching, and we cannot exclude the possibility that the positive affinity between wife education and husband polygamy could inverse, revealing that educated women are in fact less likely to marry a polygamous man taking as given all other dimensions of the match. Further research with different data could tackle this question.

[39] The wife's vector contains 58 characteristics, and the husband's vector now contains 59 characteristics, so we estimate a total of 3,422 affinity parameters. Again, we only display the meaningful affinity parameters.

[40] Again, the logit estimation procedure on pairs of couples helps us interpret the magnitude of this affinity. Let's imagine a pair of couples composed of a man and a woman with zero years of schooling, and a man and a woman with one year of schooling. An affinity of 0.97 means that it is $\exp(0.97) = 2.64$ times more likely that schooling level are the same within each marriage rather than the opposite.

4.5. Informal estimation

In this section, we show the robustness of our structural results by reproducing them in an informal estimation using only well-known linear estimators. We want to show that the positive effect of a woman's education on the likelihood that she marries a polygamist are explained by her preference for other husband's characteristics, like education, that are correlated with being a polygamist. It is worth stressing that this cannot be shown by controlling for husband's education in equation (3), even using an instrument.[41] From the point of view of the woman, the attributes of the husband are not control variables, they are other dependent variables in the matching process.

Our informal solution to this estimation problem consists in decomposing the dependent variable (whether the husband is a polygamist) into the parts correlated with various other characteristics. We start by regressing a man's polygamy on education (instrumented by the number of public schools in the village at 13) and all the other dependent variables of equation (3), including the cohort fixed effects.[42] We then decompose the husband's polygamy between the residual ($\hat{\nu}_{ivc}$), the part of polygamy predicted by education ($\hat{\tau}E_{ivc}$), the part predicted by the cohort fixed effects ($\hat{\delta}_c$), and the part predicted by other variables ($\hat{\alpha}_v + x'_{vc}\hat{\phi}$). In a second step, we estimate equation (3) putting alternatively on the left-hand side, instead of polygamy, its different predicted components, as well as the residual.

The result of this procedure is shown in the first panel of table 9. In column (1), we replicate the result of table 7: one additional year of schooling increases the probability that a woman's husband is a polygamist by 8 percentage points.[43] The rest of the table shows that an additional year of education mostly increases the part of a husband polygamy predicted by his education. The coefficient of 0.08 decomposes between a coefficient of 0.03 (not statistically significant) when we put

[41] Because any characteristic of the husband is a choice of the wife (or her family), it is almost surely correlated with the error term in equation (3), even if education if exogenously received by the man.

[42] This is the 2SLS estimation of table 7, panel B, column 3, but on a slightly different sample, as we consider all married men regardless of their age.

[43] The estimate is slightly different from the estimate of table 7 because the sample is different: we drop women who married an out-of district migrant (because we cannot regress polygamy on the instrument for these men), and we drop the husbands whose age or years of schooling are missing.

the residual on the left-hand side and a coefficient of 0.05 (significant at the 1% level) when we put predicted polygamy on the left-hand side (columns 2 and 3). In columns (4) to (6), we decompose predicted polygamy into the parts predicted by education, the cohort fixed effects, and the rest. When we put on the left hand side the husband's polygamy predicted by his education, the coefficient on the wife's years of education is 0.06 (significant at the 1% level). When we put on the left hand side the husband's polygamy predicted by his age (the cohort dummies), the coefficient on years of education is actually negative (-0.02), likely because educated women prefer younger men, and polygamy is positively correlated with age. The bottom panel of table 9 displays the results of the exact same procedure when we replace husband's polygamy (a binary variable) with his number of wives. Results are consistent with the top panel, though an additional year of schooling seems to also increase the residual part of the husband's number of co-wives, that is not explained by education or age (column 2).

The results of this informal estimation procedure are fully consistent with our structural estimation: the effect of female education on polygamy is mostly accounted for by the assortative mating between female and male education. Women often marry polygamous men because they often marry educated men who are often polygamists — or will take additional wives at some point during the marriage.

Table 9: Results of informal estimation

	(1)	(2)	(3)	(4)	(5)	(6)
	Dependent variable: husband polygamous (0/1)					
	Husband polygamous	Husband polygamous: predicted by the IV estimation				
		Residual ($\hat{\nu}_{ivc}$)	Predicted polygamy			
			total	effect of education	effect of cohort F.E.	other variables
Years of schooling	0.08**	0.03	0.05***	0.06***	-0.02*	0.01
	(0.03)	(0.03)	(0.01)	(0.01)	(0.01)	(0.02)
Observations	460,124	460,124	460,124	460,124	460,124	460,124
	Dependent variable: husband's number of wives					
	Husband # wives	Husband # wives: predicted by the IV estimation				
		Residual ($\hat{\nu}_{ivc}$)	Predicted polygamy			
			total	effect of education	effect of cohort F.E.	other variables
Years of schooling	0.25***	0.15*	0.10***	0.12***	-0.05**	0.02
	(0.09)	(0.09)	(0.02)	(0.02)	(0.02)	(0.03)
Observations	460,124	460,124	460,124	460,124	460,124	460,124

Sample: non migrant couples excluding Yaoundé, Douala and the Bamiléké districts (women aged 25-60 and their husbands). The sample is not exactly the same as in table 7 because 1/we drop women who married an out-of-district migrant (because we cannot regress polygamy on the instrument for these men), 2/ we drop the husbands whose age or years of schooling are missing. These differences in sample explain why results are slightly different from table 7. Standard errors clustered at the village level in parentheses. $^{*}p < 0.1$, $^{**}p < 0.05$, $^{***}p < 0.01$.

5. Conclusion

Colonial education mattered for marriage markets: the wave of school constructions that occurred in Cameroon after World War II changed the marriage market outcomes of the girls who were young enough when a school opened in their village. Not only were they more likely to be formally employed, they were also able to marry men who were younger, more educated, and more likely to have formal employment. At the same time, their education did not allow them to escape polygamy. In fact, women who received public education were more likely to end up in a polygamous marriage. We have provided evidence that this was largely explained by assortative matching on education: educated women were able to marry more educated men, but these educated men, because they were doing well on the labor market, were then able to take a second wife. Though we do not observe the exact timing of marriages, the fact that education did not affect the age rank within marriage supports this interpretation, rather than the one where educated women entered polygamous marriages as second or third wives.

We show that the positive affinity between a wife's education and the number of wives of her husband decreases when we take into account the very strong matching on education, but our data does not allow us to take into account other dimensions of matching on the marriage market. In particular, we do not observe income or wealth, let alone health or personality traits. We cannot exclude the fact that, could we take these dimensions into account, the affinity between female education and male polygamy would turn negative. This has implications for the literature on education and polygamy, but also more generally for the literature on the marriage market returns to education, which needs to take into account the role of matching on the marriage market when interpreting reduced form estimates.

Like a number of papers before us, for example Ashraf et al. (forthcoming), we show that the effect of an educational reform is mediated by local cultural norms and customs. In a setting when polygamous unions are frequent, it is perhaps not that surprising that women who receive education and become more attractive on the marriage market end up marrying polygamous men. Norms and customs, however, can be changed by education if it is set up with the express aim of transforming them. In Africa in general, and in Cameroon in particular, Christian

missionaries set out the goal of promoting the monogamous model of marriage, and our paper provides some suggestive evidence that, contrary to public education, receiving private, Christian education decreased the likelihood for a woman to marry a polygamist. This points towards cultural change and religious conversion as an important channel for explaining the decline in African polygamy.

References

Alvaredo, F., Chancel, L., Piketty, T., Saez, E. and Zucman, G. (2018). The Elephant Curve of Global Inequality and Growth, *AEA Papers and Proceedings* **108**: 103–108.

Arthi, V. and Fenske, J. (2018). Polygamy and child mortality: Historical and modern evidence from Nigeria's Igbo, *Review of Economics of the Household* **16**(1): 97–141.

Ashraf, N., Bau, N., Nunn, N. and Voena, A. (forthcoming). Bride Price and Female Education, *Journal of Political Economy* .

Barr, A., Dekker, M., Janssens, W., Kebede, B. and Kramer, B. (2019). Cooperation in Polygynous Households, *American Economic Journal: Applied Economics* **11**(2): 266–83.

Becker, G. (1973). A Theory of Marriage: Part I, *Journal of Political Economy* **81**(4): 813–846.

Boserup, E. (1970). *Woman's Role in Economic Development*, Allen and Unwin.

Charbonneau, K. B. (2014). Multiple Fixed Effects in Binary Response Panel Data Models, *Staff working papers*, Bank of Canada.

Chiappori, P.-A., Iyigun, M. and Weiss, Y. (2015). Investment in Schooling and the Marriage Market, *American Economic Review* **99**(5): 1689–1713.

Chiappori, P.-A., Oreficce, S. and Quintana-Domeque, C. (2012). Fatter Attraction: Anthropometric and Socioeconomic Matching on the Marriage Market, *Journal of Political Economy* **120**(4): 659–695.

Chicoine, L. E. (2012). Education and Fertility: Evidence from a Policy Change in Kenya, *IZA Discussion Paper 6778*, IZA.

Chicoine, L. E. (2016). Free Primary Education, Schooling, and Fertility: Evidence from Ethiopia, *IZA Discussion Paper 10387*, IZA.

Choo, E. and Siow, A. (2006). Who Marries Whom and Why, *Journal of Political Economy* **114**(1): 175–201.

Dalton, J. T. and Leung, T. C. (2014). Why is Polygyny more Prevalent in Western Africa? An African Slave Trade Perspective, *Economic Development and Cultural Change* **62**(4): 599–632.

De La Croix, D. and Mariani, F. (2015). From Polygyny to Serial Monogamy: A Unified Theory of Marriage Institutions, *Review of Economic Studies* **82**: 565–607.

Duflo, E. (2001). Schooling and Labor Market Consequences of School Construction in Indonesia: Evidence from an Unusual Policy Experiment, *American Economic Review* **91**(4): 795–813.

Duflo, E. (2012). Women Empowerment and Economic Development, *Journal of Economic Literature* **50**(4): 1051–1079.

Dupas, P. (2011). Do Teenagers Respond to HIV Risk Information? Evidence from a Field Experiment in Kenya, *American Economic Journal: Applied Economics* **3**: 1–34.

Dupraz, Y. (2019). French and British Colonial Legacies in Education: Evidence from the Partition of Cameroon, *Journal of Economic History* .

Dupuy, A. and Galichon, A. (2014). Personality Traits and the Marriage Market, *Journal of Political Economy* **122**(6): 1271–1319.

Fenske, J. (2015). African Polygamy: Past and Present, *Journal of Development Economics* **117**: 58–73.

France, Ministère des Colonies (1921–1938). *Rapport à la S.D.N. sur l'administration sous mandat des territoires du Cameroun.*

France, Ministère des Colonies (1947–1957). *Rapport annuel du Gouvernement français à l'Assemblée générale des Nations Unies sur l'administration du Cameroun placé sous la tutelle de la France.*

Friedman, W., Kremer, M., Miguel, E. and Thornton, R. (2016). Education as Liberation?, *Economica* **83**(329): 1–30.

Goldin, C. (1993). The Meaning of College in the Lives of American Women: The Past One-Hundred Years, *Working Paper 899*, Queen's Economics Department.

Gould, E. D., Moav, O. and Simhon, A. (2008). The Mystery of Monogamy, *American Economic Review* **98**(1): 333–357.

Great Britain, Colonial office (1922–1938). *Report by H.M. Government in the United Kingdom of Great Britain and Northern Ireland to the Council of the League of Nations on the Administration of the British Cameroons*, H.M. Stationery Office.

Great Britain, Colonial office (1949–1959). *Report by H.M. Government in the United Kingdom to the General Assembly of the United Nations on the Administration of the Cameroons under United Kingdom Trusteeship*, H.M. Stationery Office.

Jacoby, H. G. (1995). The Economics of Polygyny in Sub-Sharan Africa: Female Productivity and the Demand for Wives in Côte d'Ivoire, *Journal of Political Economy* **103**(5): 938–971.

Jedwab, R., zu Selhausen, F. M. and Moradi, A. (2018). The Economics of Missionary Expansion: Evidence from Africa and Implications for Development, *CSAE Working Paper Series 2018-07*, Center for the Study of African Economies, University of Oxford.

Jochmans, K. (2017). Semiparametric Analysis of Network Formation, *Journal of Business & Economic Statistics* **36**(4): 705–713.

Keats, A. (2018). Women's Schooling, Fertility, and Child Health Outcomes: Evidence from Uganda's Free Primary Education Program, *Journal of Development Economics* **135**: 142–159.

Kiszweski, A., Mellinger, A., Spielman, A., Malaney, P., Sachs, S. and Sachs, J. D. (2004). A global index representing the stability of malaria transmission, *The American Journal of Tropical Medicine and Hygiene* **70**(5): 486–98.

Lagerlöf, N.-P. (2005). Sex, Equality, and Growth, *Canadian Journal of Economics* **38**(3): 807–831.

Lagerlöf, N.-P. (2010). Pacifying Monogamy, *Journal of Economic Growth* **15**(3): 235–262.

McFadden, D. (1974). The Measurement of Urban Travel Demand, *Journal of Public Economics* **3**(4): 303–328.

Nunn, N. (2010). Religious Conversion in Colonial Africa, *American Economic Review Papers and Proceedings* **100**(2): 147–152.

Osili, U. O. and Long, B. T. (2008). Does female schooling reduce fertility? Evidence from Nigeria, *Journal of Development Economics* **87**: 57–75.

Ravaillon, M. (2014). Income Inequality in the Developing World, *Science* **344**(6186): 851–855.

Rivers, D. and Vuong, Q. H. (1988). Limited Information Estimators and Exogeneity Tests for Simultaneous Probit Models, *Journal of Econometrics* **39**(3): 347–366.

Roome, W. R. M. (1925). *Ethnographic Survey of Africa: Showing the Tribes and Languages; also the Stations of Missionary Societies*, Edward Stanford Ltd.

Rossi, P. (2019). Strategic Choices in Polygamous Households: Theory and Evidence from Senegal, *Review of Economic Studies* **86**(3): 1332–1370.

Schlunk, M. (1914). *Die Schulen für Eingeborene in den deutschen Schutzgebieten am 1. Juni 1911*, L. Friedrichsen & Co., Hamburg.

Tertilt, M. (2005). Polygyny, Fertility, and Savings, *Journal of Political Economy* **113**(6): 1341–1371.

Tsoata, F. (1999). *La scolarisation dans les Bamboutos (Ouest-Cameroun) de 1909 à 1968, étude historique*, Master's thesis, Université de Yaoundé I, Ecole Normale Supérieure.

Walker-Said, C. (2015). Wealth and Moral Authority: Marriage and Christian Mobilization in Interwar Cameroon, *Journal of African Historical Studies* **48**(3).

Walker-Said, C. (2018). *Faith, Power, and Family: Christianity and Social Change in French Cameroon*, James Currey, Oxford.

Wooldridge, J. M. (2015). Control Function Methods in Applied Econometrics, *Journal of Human Resources* **50**(2): 420–445.

Zha, D. (2019). Schooling Expansion and the Female Marriage Age: Evidence from Indonesia, *Technical report*.

Appendix

A. Data appendix

Temperature and precipitation. Temperature and precipitation data are from WorldClim (`http://www.worldclim.org`). They are averages over the period 1950–2000.

Elevation and ruggedness. Elevation data come from NASA Shuttle Radar Topography Mission (`http://srtm.csi.cgiar.org`). Ruggedness is computed from elevation data using the slope tool in ArcGIS.

Malaria stability index. The malaria stability index comes from Kiszweski et al. (2004) and was downloaded from `https://sites.google.com/site/gordoncmccord/ /datasets`.

Agricultural suitability. Agricultural suitability is suitability for rainfed crops excluding forest ecosystems, an index ranging from 0 to 11. It comes from Global Agro-Ecological Zones: `http://webarchive.iiasa.ac.at/Research/LUC/GAEZ/ index.htm`.

Railroads in 1922. The main railroads in 1922 were a narrow-gauge line from Victoria (now Limbe) to Soppo in British Cameroon, the Northern railway from Douala to Nkongsamba and the Central railway from Douala to Eseka in French Cameroon. The exact delineation of railroads comes from `http://diva-gis.org`.

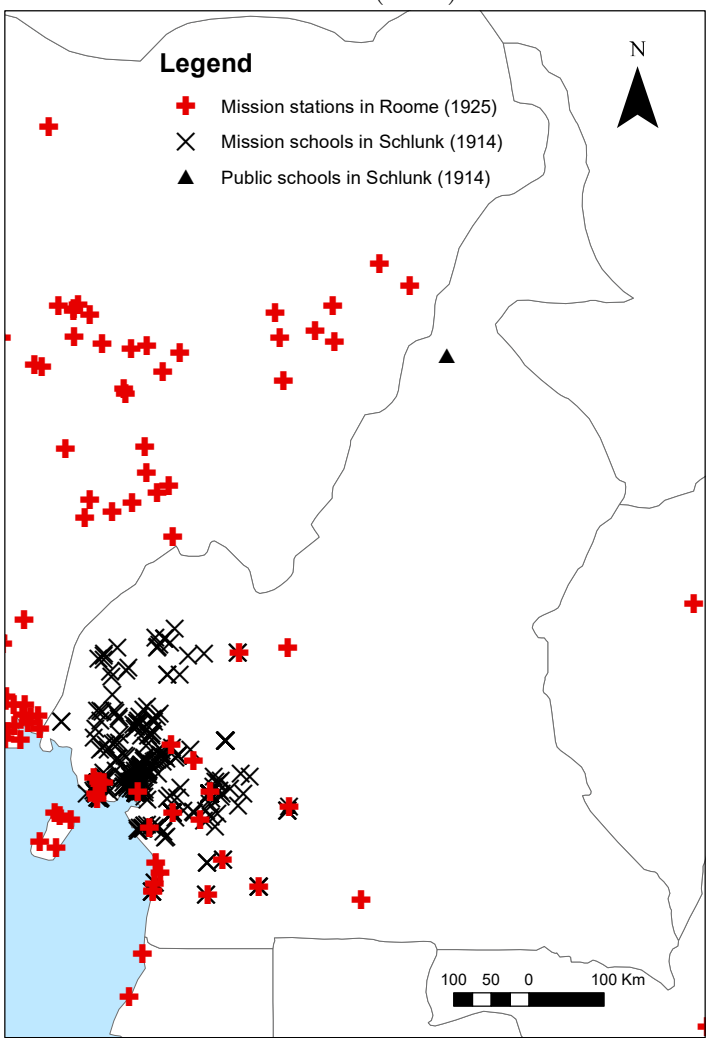
Main rivers. Data on the location of rivers come from `www.naturalearthdata. com/downloads/10m-physical-vectors/`.

Towns in 1922. Data on the location of towns in 1922/1923 come from France, Ministère des Colonies (1922) and Great Britain, Colonial office (1923).

Roome mission stations. The mission station map of Roome (1925) was digitized by Nunn (2010) and is available at `https://scholar.harvard.edu/nunn/pages/data-0`.

German mission/public schools in 1913. Data on German mission schools and public schools in 1913 comes from Schlunk (1914) and was digitized by Dupraz (2019). See figure A.1 below.

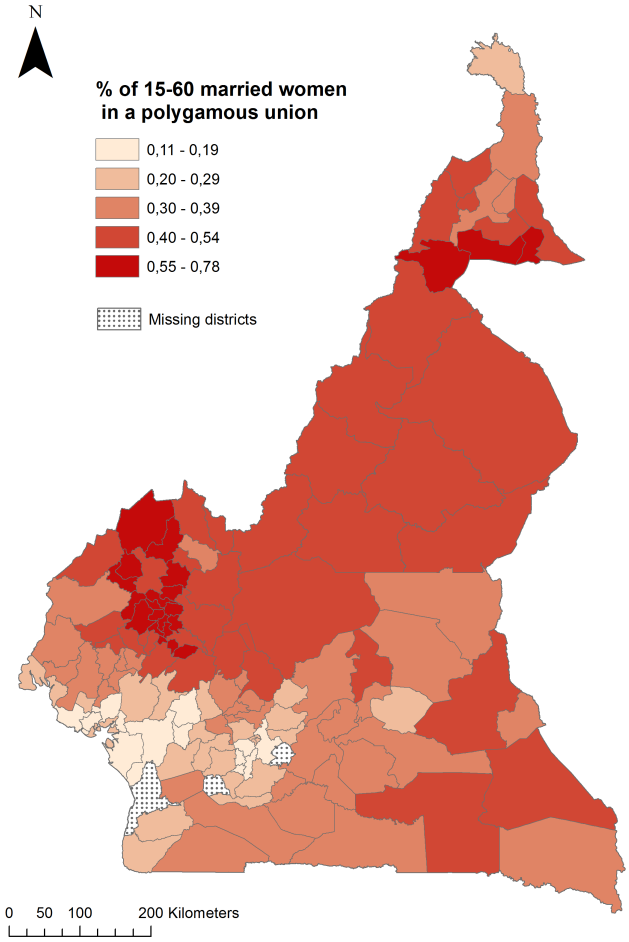
Figure A.1: Mission stations in Roome (1925) and schools in Schlunk (1914)



Source: Roome (1925) and Schlunk (1914).

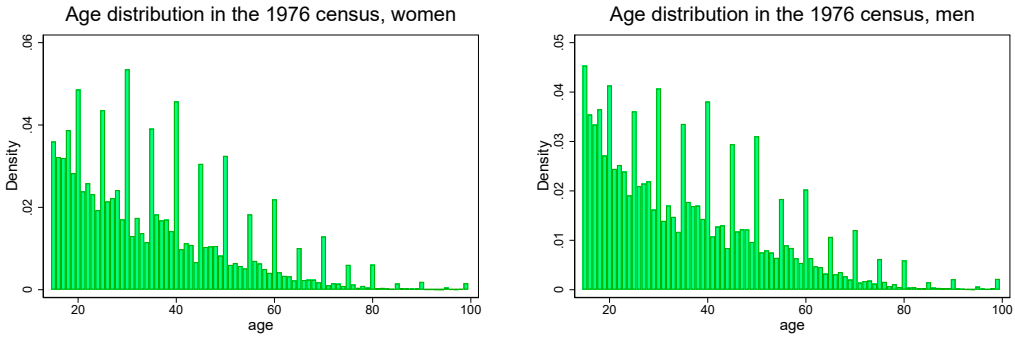
B. Additional descriptive statistics

Figure B.1: Share of married women aged 15–60 in a polygamous union in 1976



Authors' map from 1976 Cameroonian population census data.

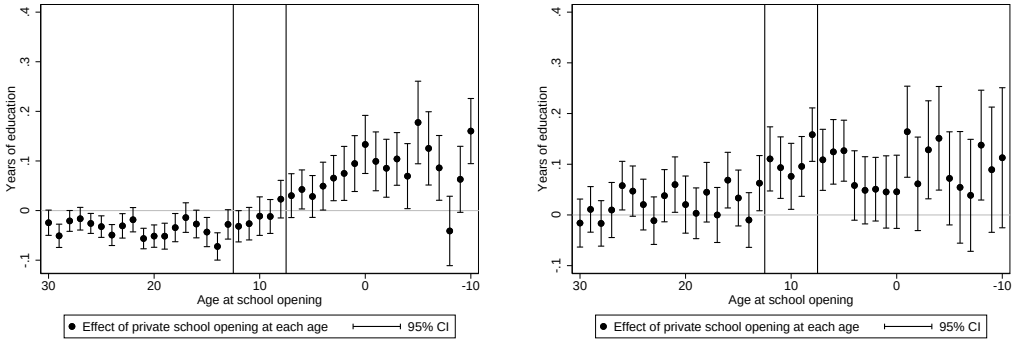
Figure B.2: Age heaping in the 1976 census



C. Additional results

Figure C.1: Event study graphs: effect of private school openings on education

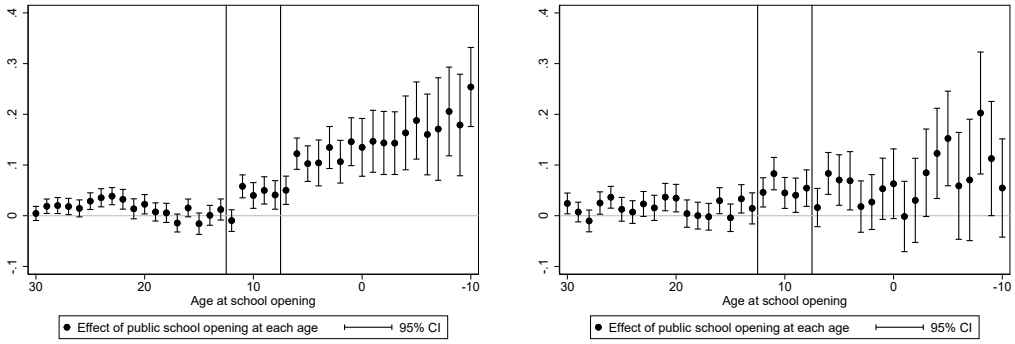
(a) Women (b) Men



Note: Both figures display the $\beta_{private}$ coefficients of equation (1), estimated separately for men and women. Standard errors are clustered at the village level.

Figure C.2: Event study graphs: effect of public school openings on education, including schools that opened after 1960

(a) Women (b) Men



Note:Both figures display the β_{public} coefficients of equation (1), estimated separately for men and women. Contrary to figure 5, we also consider the schools that opened after 1960.

Figure C.3: Selection of the age maximizing the first stage F-test

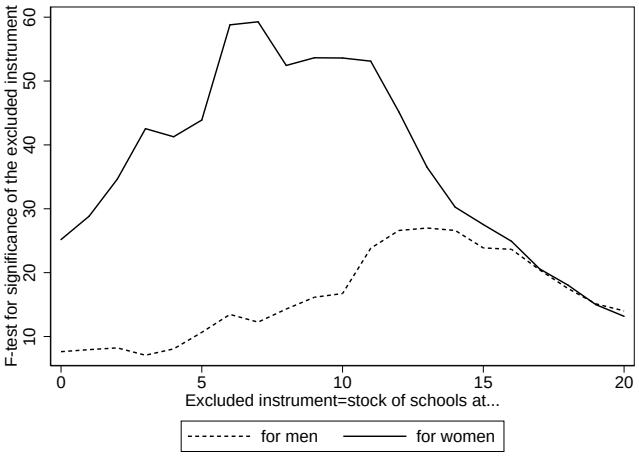


Table C.1: Results of 2sls estimation with 2 instruments: labor market and extensive margin of marriage

	(1)	(2)	(3)	(4)	(5)
	Panel A: women				
	In labor force	Wage earner	Ever married	Widow	Divorced
	OLS (with cohort and village fixed effects)				
Years of schooling	-0.001	0.020***	-0.023***	-0.007***	0.003***
	(0.001)	(0.002)	(0.001)	(0.000)	(0.000)
	2SLS (instruments=# public schools at 7 and # public school openings 8-13)				
Years of schooling	-0.020	0.034***	-0.010	-0.046**	-0.025*
	(0.032)	(0.008)	(0.014)	(0.023)	(0.015)
K-P F-stat	31.10	48.61	31.36	31.36	31.36
Observations	696,119	386,450	698,736	698,736	698,736
# clusters	9,213	7,307	9,214	9,214	9,214
	Panel B: men				
	In labor force	Wage earner	Ever married	Widow	Divorced
	OLS (with cohort and village fixed effects)				
Years of schooling	0.003***	0.037***	0.009***	-0.002***	-0.002***
	(0.000)	(0.001)	(0.001)	(0.000)	(0.000)
	2SLS (instruments=# public schools at 7 and # public school openings 8-13)				
Years of schooling	0.022	0.120***	0.028	0.014**	-0.003
	(0.015)	(0.040)	(0.038)	(0.007)	(0.011)
K-P F-stat	14.45	15.42	15.34	15.34	15.34
Observations	604,931	558,430	604,670	604,670	604,670
# clusters	9,203	9,166	9,201	9,201	9,201

Sample: all non-migrant men/women aged 25-60 in 1976. Standard errors clustered at the village level in parentheses. $^{*}p < 0.1$, $^{**}p < 0.05$, $^{***}p < 0.01$.

Table C.2: Results of 2sls estimation with 2 instruments: sample of married individuals

	(1)	(2)	(3)	(4)	(5)	(6)
			Panel A: women			
	Husband's education	Husband wage earner	Husband polygamous	Husband's # of wives	Wife rank	Husband's age
			OLS (with cohort and village fixed effects)			
Years of schooling	0.603***	0.033***	-0.011***	-0.018***	-0.029***	-0.539***
	(0.009)	(0.001)	(0.001)	(0.003)	(0.003)	(0.017)
			2SLS (instruments=# public schools at 7 and # public school openings 8-13)			
Years of schooling	0.569***	0.078***	0.054*	0.217**	-0.020	-1.999***
	(0.115)	(0.016)	(0.030)	(0.086)	(0.077)	(0.603)
K-P F-stat	40.05	43.72	39.99	39.99	40.68	40.47
Observations	491,152	451,030	490,045	490,045	498,101	491,806
# clusters	9,040	8,985	9,039	9,039	9,074	9,042
			Panel B: men			
	Wife(s)'s education		Polygamous	Number of wives		Wife(s)'s age
			OLS (with cohort and village fixed effects)			
Years of schooling	0.286***		0.003***	0.008***		-0.336***
	(0.004)		(0.001)	(0.001)		(0.013)
			2SLS (instruments=# public schools at 7 and # public school openings 8-13)			
Years of schooling	1.340***		0.103***	0.178**		0.044
	(0.250)		(0.039)	(0.072)		(0.541)
K-P F-stat	13.18		13.13	13.04		12.97
Observations	438,328		472,341	470,247		439,070
# clusters	9,041		9,093	9,091		9,043

Sample: all non-migrant men/women aged 25-60 in 1976. Standard errors clustered at the village level in parentheses. $^{*}p < 0.1$, $^{**}p < 0.05$, $^{***}p < 0.01$.

Table C.3: 2sls results: district-level instrument

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
				Panel A: women			
	Migrant	Wage earner	Ever married	Husband's education	Husband polygamous	Husband's # of wives	Husband's age
				2SLS on the full sample			
Years of schooling	0.069*	0.035**	-0.022**	0.460***	0.031	0.165**	-1.154**
	(0.037)	(0.014)	(0.011)	(0.110)	(0.029)	(0.081)	(0.476)
K-P F-stat	17.25	24.31	17.21	16.29	16.37	16.37	16.34
Observations	961,810	502,693	958,629	669,448	668,088	668,088	670,435
# clusters	112	112	112	112	112	112	112
				2SLS on the sample of non-migrants			
Years of schooling		0.037***	-0.036***	0.412***	0.043*	0.211***	-1.243**
		(0.011)	(0.012)	(0.121)	(0.024)	(0.074)	(0.599)
K-P F-stat		28.50	30.74	25.46	25.58	25.58	25.60
Observations		387,108	698,993	491,459	490,357	490,357	492,115
# clusters		112	112	112	112	112	112
				Panel B: men			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
	Migrant	Wage earner	Ever married	Wife(s)'s education	Polygamous	Number of wives	Wife(s)'s age
				2SLS on the full sample			
Years of schooling	0.317*	0.091	0.082	2.330	0.123	0.259	-1.932
	(0.165)	(0.064)	(0.113)	(1.570)	(0.167)	(0.327)	(2.580)
K-P F-stat	3.62	4.36	3.61	1.75	1.43	1.40	1.76
Observations	854,308	774,653	848,307	589,253	645,505	642,724	590,339
# clusters	112	112	112	112	112	112	112
				2SLS on the sample of non-migrants			
Years of schooling		0.077	0.068	1.867***	0.125	0.280	-2.083
		(0.057)	(0.075)	(0.711)	(0.083)	(0.172)	(1.563)
K-P F-stat		6.84	6.59	5.41	5.08	4.95	5.39
Observations		558,744	604,976	438,684	472,689	470,597	439,427
# clusters		112	112	112	112	112	112

Sample: all men/women aged 25-60 in 1976. Standard errors clustered at the village level in parentheses. $^{*}p < 0.1$, $^{**}p < 0.05$, $^{***}p < 0.01$.

Table C.4: Matrix A (husband polygamous)

Matrix A w/o taking into account matching on education

	Husband polygamous	Husband education	Husband education control function	Other husband characteristics
Wife education	0.35**			✓
	(0.16)			
Wife education control function	-0.00			✓
	(0.01)			
Other wife characteristics	✓			✓

Matrix A w/o taking into account matching on education

	Husband polygamous	Husband education	Husband education control function	Other husband characteristics
Wife education	0.28*	0.96***	0.04	✓
	(0.16)	(0.30)	(0.05)	
Wife education control function	0.01	-0.03	0.06***	✓
	(0.01)	(0.07)	(0.00)	
Other wife characteristics	✓	✓	✓	✓

Observations: 853,620. Each observation is a pair of couples within the same village (women 25-60 and their husband). Standard errors clustered at the village level in parentheses. $^{*}p < 0.1$, $^{**}p < 0.05$, $^{***}p < 0.01$. Other husband and wife characteristics are: number of private schools in the village at age 7 (for women) an 13 (for men), a quartic (4th degree) polynomial in age, and a quartic polynomial in age interacted with a vector of time-invariant village variables.

D. Mathematical appendix

D.1. Proof of Theorem 1

This proof requires a few notations. For any transferable utility function following (5) and (6), let us define:

$$\begin{cases} u(x,y,n) = u_0(x,y,n) - \tau(x,y,n) \\ v(x,y,n) = v_0(x,y,n) + \tau(x,y,n) \end{cases} \tag{13}$$

where $\tau(x,y,n)$ is the (positive or negative) utility transfer given by the man to his wife of type y. $\pi_m(x,y,n) = f(x)\pi(y,n|x)$ is the number of men of type x who want to marry a woman of type y with n co-spouses; similarly, $\pi_w(x,y,n) = g(y)\pi(x,n|y)$ is the number of women of type y who want to marry a man of type x with n co-spouses. There is an equilibrium when $\pi_m(x,y,n) - \pi_w(x,y,n) = 0$. $\pi_m(x,y,n)$ and $\pi_w(x,y,n)$ are continuous functions of $\tau(x,y,n)$. Besides, for every (x,n,y):

$$\begin{cases} \lim_{\tau(x,y,n)\to+\infty} \pi_m(x,y,n) - \pi_w(x,y,n) = 0 - g(y) \\ \lim_{\tau(x,y,n)\to-\infty} \pi_m(x,y,n) - \pi_w(x,y,n) = f(x) - 0 \end{cases} \tag{14}$$

Thus, the generalization of the intermediate values theorem to the multidimensional case, the Poincaré-Miranda theorem, proves there is a solution to the problem $\pi_m - \pi_w = 0$. (Technically, the Poincaré-Miranda theorem applies only to bounded sets. However, changing the variable to $\tau' = tanh^{-1}(\tau)$ trivially solves this issue.)

D.2. Proof of Lemma 1

From equation (7), we can write the probability for a man to be married with a woman of type y and n_Y other wives:

$$\begin{aligned} \pi(y,n_Y|x) &= \frac{\sum_{Y'\in\mathcal{Y}, y\in Y', n'_Y=n_Y} \exp\left(U(x,Y')\right)}{\sum_{Y'\in\mathcal{Y}} \exp\left(U(x,Y')\right)} \\ &= \frac{\exp(u(x,y,n_Y)) \sum_{Y'\in\mathcal{Y}, y\notin Y', n'_Y=n_Y} \exp\left(\sum_{y'\in Y'} u(x,y',n'_Y)\right)}{\sum_{Y'\in\mathcal{Y}} \exp\left(U(x,Y')\right)} \end{aligned}$$

We assume that the chances to marry a spouse of type y are small for any number of spouses $n_Y + 1$. This implies the set of spouses type is large enough. A consequence of this is, for any n_Y:

$$\frac{\sum_{Y' \in \mathcal{Y}, y \in Y', n'_Y = n_Y} \exp\left(\sum_{y' \in Y'} u(x, y', n'_Y)\right)}{\sum_{Y' \in \mathcal{Y}, n'_Y = n_Y} \exp\left(\sum_{y' \in Y'} u(x, y', n'_Y)\right)} \approx 0$$
$$\frac{\sum_{Y' \in \mathcal{Y}, y \notin Y', n'_Y = n_Y} \exp\left(\sum_{y' \in Y'} u(x, y', n'_Y)\right)}{\sum_{Y' \in \mathcal{Y}, n'_Y = n_Y} \exp\left(\sum_{y' \in Y'} u(x, y', n'_Y)\right)} \approx 1$$

So that

$$\pi(y, n_Y|x) = \frac{\exp\left(u(x, y, n_Y)\right) \sum_{Y' \in \mathcal{Y}, n'_Y = n_Y} \exp\left(\sum_{y' \in Y'} u(x, y', n'_Y)\right)}{\sum_{Y' \in \mathcal{Y}} \exp\left(U(x, Y')\right)}$$

And we can write the number of matches $\pi(x, y, n_Y)$ in two ways, as a function of males' utility and as a function of females' utility: $\pi(x, y, n_Y) = f(x)\pi(y, n_Y|x) = g(y)\pi(x, n_Y|y)$, where $f(x)$ is the density of x and $g(y)$ is the density of y.

$$\pi(x, y, n_Y) = \exp\left(u(x, y, n_Y) - a(x, n_Y)\right) \tag{15}$$
$$= \exp\left(\tilde{v}(x, y, n_Y) - b(y)\right) \tag{16}$$

where $a(x, n_Y) = \log\left(\sum_{Y' \in \mathcal{Y}} \exp\left(U(x, Y')\right)\right) - \log\left(\sum_{Y' \in \mathcal{Y}, n'_Y = n_Y} \exp\left(\sum_{y' \in Y'} u(x, y', n'_Y)\right)\right) - \log f(x)$ and $b(y) = \log \sum_{(x, n_Y) \in \mathcal{X} \times \mathbb{N}} \exp\left(\tilde{v}(x, y, n_Y)\right) - \log g(y)$.

Taking the square root of the product of (15) and (16), we obtain the the matching function:

$$\pi(x, y, n_Y) = \exp\left(\frac{\Phi(x, y, n_Y) - b(y) - a(x, n_Y)}{2}\right)$$

D.3. Proof of Theorem 2

This proof follows two steps: the first step explains why equation (10) is necessary to have an equilibrium. It requires only a recall of a few elements from the main text. The second part explains why equation (10) defines exactly one distribution

for every distribution $g(y)$ and $f(x, n_Y)$.

(10) is necessary for any equilibrium. Indeed, equations (15) and (16) are clearly necessary as they follow from the multinomial logit following the model, and they imply (10).

There is a single distribution following (10) This step proves that, for every distribution $g(y)$ and $f(x, n_Y)$, there are several vectors a and b that define a distribution following (10); but each of these vectors defines the same distribution $\pi(x, y, n_Y)$.

Firstly, let us introduce the notation $\phi = \exp \frac{\Phi}{2}$, and let a be the vector of all the $a(x, n_Y)$, and b be the vector of all the $b(y)$.

It is possible to write the density $g(y)$ as a function of a and b:

$$g(y) = \sum_{x,n} \phi(x, y, n) \exp((-a(x, n) - b(y))/2) \tag{17}$$

$$B_y(a) := \exp(-b(y)/2) = \frac{g(y)}{\sum_{x,n} \phi(x, y, n) \exp(-a(x, n)/2)} \tag{18}$$

$$\frac{\partial B_y(a)}{\partial a(x, n)} = \frac{B_y(a)\pi_a(x, y, n)}{2g(y)} \tag{19}$$

where $\pi_a(x, y, n) := \phi(x, y, n) \exp(-a(x, n)/2)B_y(a)$ is the number of matches of type x, n, y implied by a and the accountability of women in (17). Similarly, $\pi_a(x, n) = \sum_y \pi_a(x, y, n)$ is the number of males of type x, n implied by a.

We search for the vectors $a \in \mathbb{R}^k$ such that $\pi_a(x, n) = f(x, n)$ for every (x, n), and we show that all the solutions lead to the same density.[44]

Firstly, there is always a vector a that solves $\pi_a(x, n) = f(x, n)$ for every (x, n). Indeed, $\pi_a(x, n)$ is a continuous function of a and for every (x, n):

$$\begin{cases} \lim_{a(x,n)\to+\infty} \pi_a(x, n) = 0 \\ \lim_{a(x,n)\to-\infty} \pi_a(x, n) = \sum_y g(y) = 1 \end{cases} \tag{20}$$

Thus, the generalization of the intermediate values theorem to the multidimensional case, the Poincaré-Miranda theorem, proves there is a solution to the prob-

[44] k is the number of points on the support of x, n

lem. (Technically, the Poincaré-Miranda theorem applies only to bounded sets. However, changing the variable to $a' = tanh^{-1}(a)$ trivially solves this issue.)

Secondly, let us study the gradient of $\pi_a(x,n)$. The partial derivatives of π_a are:

$$\frac{\partial \pi_a(x,n)}{\partial a(x,n)} = \frac{1}{2}\sum_y \left(-1 + \frac{\pi_a(x,y,n)}{g(y)}\right)\pi_a(x,y,n) \tag{21}$$

when $x' \neq x$ or $y' \neq y$:

$$\frac{\partial \pi_a(x,n)}{\partial a(x',n')} = \frac{1}{2}\sum_y \frac{\pi_a(x',y,n')}{g(y)}\pi_a(x,y,n) \tag{22}$$

Let $u = (u(x,n))$ be a vector that defines a direction in the space of the vector a. Then:

$$\text{grad}\pi_a(x,n)\cdot u = -\frac{1}{2}\sum_y \pi_a(x,y,n)\left[u(x,n) - \sum_{x',n'} u(x',n')\frac{\pi_a(x',y,n')}{g(y)}\right] \tag{23}$$

Here, $\sum_{x',n'} u(x',n')\frac{\pi_a(x',y,n')}{g(y)}$ is the weighted average of the $u(x',n')$, where the weights follow the distribution of the x',n' conditional on y implied by a. Two cases emerge:

- For every x,n, $u(x,n) = \alpha \in \mathbb{R}$. $\text{grad}f_{x,n}(a)\cdot u = 0$: the densities are unchanged for a variation of a in this direction. The reason is the following: if $a(x,n)$ increase by α for every x,n and $b(y)$ decrease by α for every y, equation (10) is unchanged.

- $u(x,n)$ depends on x,n. u has a dimension x_m, n_m (or several dimensions) such that $u(x_m,n_m)$ is maximal. In this dimension, the sign of (23) is constant. $u(x_m,n_m) > u(x,n)$ for some x,n, and $\text{grad}f_{x_m,n_m}(a)\cdot u < 0$. For any line of the space following the direction defined by u, there is exactly one point such that $f_{x_m,n_m}(a) = \pi(x_m,n_m)$. So there is at most one point such that $f_{x,n}(a) = \pi(x,n)$ for every (x,n).

So for every line of the space, there is at most single density following equation (10), $g(y)$ and $f(x,n)$. There cannot be several densities over $\mathbb{R}^k$ ($\mathbb{R}^k$ is a star domain).

D.4. Proof of Theorem 3

We start by writing $P(m, w)$ the probability that man m of type $\mathbf{x}_m$ is matched with woman w of type y_w. Given the independence between the sympathy shocks, each match of type $(\mathbf{x}, y)$ is equiprobable, which means that $P(m, w)$ is simply:

$$\mathrm{P}(m, w) = \frac{\pi(\mathbf{x}_m, y_w)}{N_{\mathbf{x}_m} N_{y_w}} = \exp\left(\Phi(\mathbf{x}_m, y_w) - a_m - b_w\right) \tag{24}$$

where $N_{\mathbf{x}_m}$ and N_{y_w} are respectively the density of men of type $\mathbf{x}_m$ and the density of women of type y_w. We add some flexibility in the model here, in the sense that a_m and b_w are sets of individual fixed effects, that need not be fully determined by $\mathbf{x}$ and y.

Given that woman w is married, the probability for her husband (denoted $h(w)$) to be man m is:

$$\mathrm{P}(h(w) = m) = \frac{\mathrm{P}(m, w)}{\sum_{m'} \mathrm{P}(m', w)} = \frac{\exp\left(\Phi(\mathbf{x}_m, y_w) - a_m\right)}{\sum_{m'} \exp\left(\Phi(\mathbf{x}_{m'}, y_w) - a_{m'}\right)}$$

And her probability to marry man m given that she's married in a set of men S is:

$$\mathrm{P}(h(w) = m | h(w) \in S) = \frac{\exp\left(\Phi(\mathbf{x}_m, y_w) - a_m\right)}{\sum_{m' \in S} \exp\left(\Phi(\mathbf{x}_{m'}, y_w) - a_{m'}\right)} \tag{25}$$

Let us now consider a pair of couples, two women $w = 1$ and $w = 2$ whose respective husbands $h(1) = h_1$ and $h(2) = h_2$ are (respectively or not) $m = 1$ and $m = 2$. We are interested in the probability that the couples are $(1, 1)$ and $(2, 2)$ rather than the opposite. This probability writes:

$$\mathrm{P}(h_1 = 1 | \{h_1, h_2\} = \{1, 2\}) = \frac{\mathrm{P}(h_1 = 1, h_2 = 2)}{\mathrm{P}(h_1 = 1, h_2 = 2) + \mathrm{P}(h_1 = 2, h_2 = 1)} \tag{26}$$

To simplify notations, let's denote $\Phi_{11} = \Phi(\mathbf{x}_1, y_1), \Phi_{12} = \Phi(\mathbf{x}_1, y_2)$. From equation

(25) and Bayes' rule, we have:

$$\mathrm{P}(h_1 = 1, h_2 = 2) = \frac{\exp\left(\Phi_{11} - a_1\right)}{\sum_{m'} \exp\left(\Phi(\mathbf{x}_{m'}, y_1) - a_{m'}\right)} \frac{\exp\left(\Phi_{22} - a_2\right)}{\sum_{m' \neq 1} \exp\left(\Phi(\mathbf{x}_{m'}, y_2) - a_{m'}\right)}$$

Similarly, we can write $\mathrm{P}(h_1 = 2, h_2 = 1)$. If we assume that $\frac{\sum_{m' \neq 1} \exp(\Phi(\mathbf{x}_{m'}, y_2) - a_{m'})}{\sum_{m' \neq 2} \exp(\Phi(\mathbf{x}_{m'}, y_2) - a_{m'})}$ is sufficiently close to 1 (which means that the fact that one particular man is already married hardly affects the overall probability for a woman to get married), then the probability (26) simplifies and we have:

$$\begin{aligned} \mathrm{P}(h_1 = 1 | \{h_1, h_2\} = \{1, 2\}) &= \frac{\exp\left(\Phi_{11} + \Phi_{22}\right)}{\exp\left(\Phi_{11} + \Phi_{22}\right) + \exp\left(\Phi_{12} + \Phi_{21}\right)} \\ &= \frac{\exp\left(\Phi_{11} + \Phi_{22} - \Phi_{12} - \Phi_{21}\right)}{1 + \exp\left(\Phi_{11} + \Phi_{22} - \Phi_{12} - \Phi_{21}\right)} \end{aligned}$$