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The slave trade and the origins of matrilineal kinship

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Matrilineal kinship systems—where descent is traced through mothers only—are present all over the world but are most concentrated in sub-Saharan Africa. We explore the relationship between exposure to Africa's external slave trades, during which millions of people were shipped from the continent during a 400-year period, and the evolution of matrilineal kinship. Scholars have hypothesized that matrilineal kinship, which is well-suited to incorporating new members, maintaining lineage continuity and insulating children from the removal of parents (particularly fathers), was an adaptive response to the slave trades. Motivated by this, we test for a connection between the slave trades and matrilineal kinship by combining historical data on an ethnic group's exposure to the slave trades and the presence of matrilineal kinship following the end of the trades. We find that the slave trades are positively associated with the subsequent presence of matrilineal kinship. The result is robust to a variety of measures of exposure to the slave trades, the inclusion of additional covariates, sensitivity analyses that remove outliers, and an instrumental variables estimator that uses a group's historical distance from the coast as an instrument. We also find evidence of a complementarity between polygyny and matrilineal kinship, which were both social responses to the disruption of the trades.

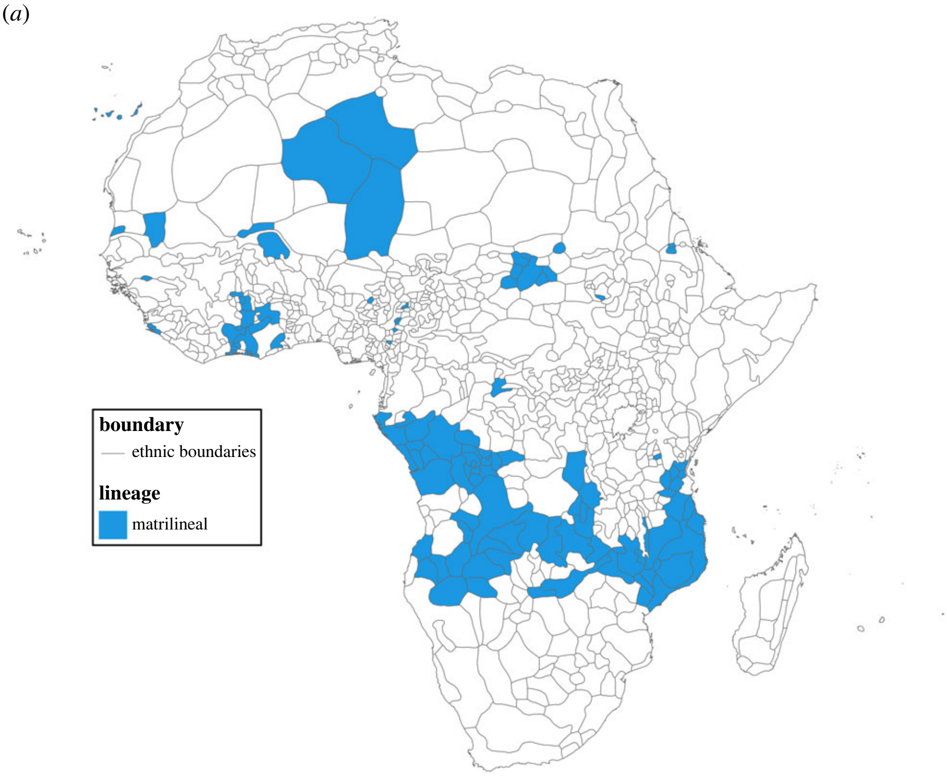
This article is part of the theme issue 'Social norm change: drivers and consequences'.

1. Introduction

Kinship systems are an important social structure in many societies. One of the key distinctions in kinship structure is whether lineage and descent are traced through women or men. Most common throughout the world are patrilineal systems, in which lineage and descent are traced through men. However, particularly in sub-Saharan Africa, there exist matrilineal systems, which use women for the determination of group membership. Matrilineal kinship has been shown to have important positive effects on female empowerment and the health, education and overall wellbeing of children [1]. While there is increasing interest in the effects of kinship structure on a wide variety of outcomes [1–3], there is little evidence on the origins of variation in kinship structure [4,5].

Matrilineal kinship is present throughout the world, but by far the highest density of matrilineal kinship systems is in central Africa, in the 'matrilineal belt' and in West Africa (see figure 1*a* for the distribution of matrilineal kinship in Africa and electronic supplementary material, figure A1 for the global distribution). There are many hypotheses on the origins of matrilineal kinship [10–14]. Generally, these hypotheses focus on ecological factors that would make tracing lineage through women relatively more beneficial [5,15–18]. We examine an alternative hypothesis that is relevant for the populations of the African continent, which is that the slave trades facilitated the adoption of matrilineal kinship.

(*a*)



(*b*)

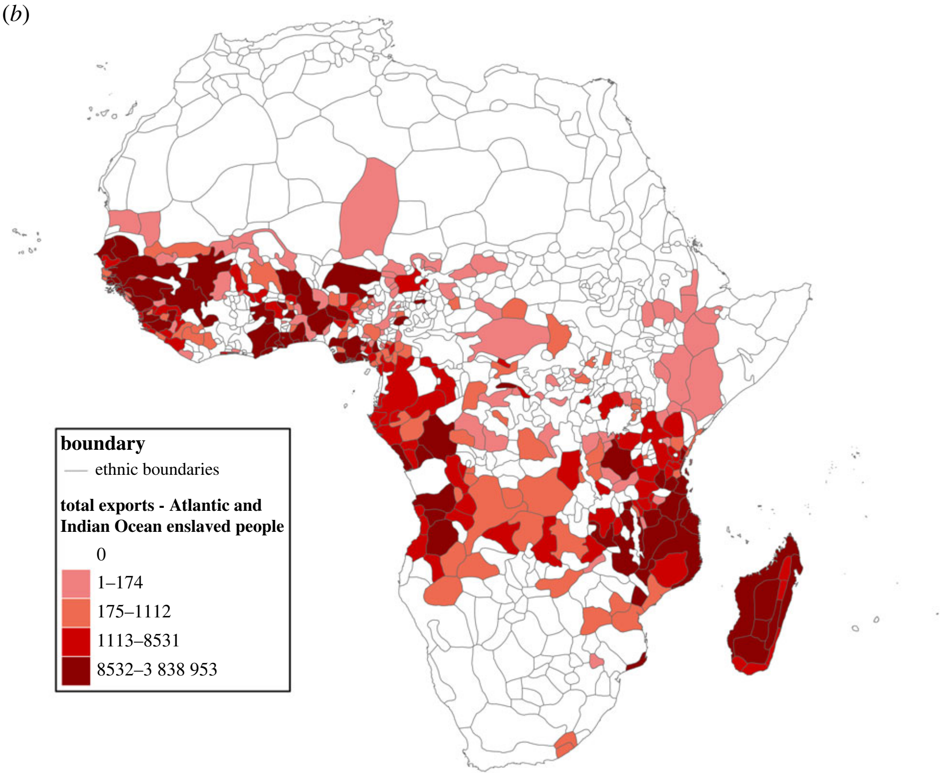


Figure 1. Matrilineal kinship and the slave trades. The maps present Murdock ethnic group boundaries [6], the practice of matrilineal kinship (*a*) [7], and each ethnic group's exposure to the Atlantic and Indian Ocean slave trades (*b*). Source: [8,9], and own calculations. (Online version in colour.)

For a period of nearly 500 years, from 1400 to 1900, the slave trades forcibly removed millions of people from Africa. There were four distinct slave trades: the trans-Atlantic trade, the Indian Ocean trade, the Red Sea trade and the Saharan trade. The Indian Ocean, Red Sea and Saharan trades are the oldest, dating back to 800 AD according to some estimates. In those trades, enslaved people were shipped to the Middle East, with some even reaching India. For the Indian Ocean slave trade, in the later centuries (i.e. after 1700), enslaved people were also shipped to the plantation islands of Mauritius and Reunion. The trans-Atlantic slave trade was the largest in magnitude, resulting in approximately 12 million enslaved people being taken from Africa. It is estimated that approximately 6 million enslaved people were taken during the other three trades [8]. For a map of ethnic group level exposure to the Atlantic and Indian Ocean slave trades, see figure 1*b*.[1]

The slave trades constituted a massive disruption to the social order of much of the African continent [9,13,19]. A large literature documents the effects of the slave trade on outcomes such as income, ethnic stratification, polygyny, trust, warfare and female labour force participation [8,20–23]. Anthropologists and historians suggest that exposure to the slave trade led to changes in patterns of kinship and marriage and changed the underlying social structures, including the prevalence of matrilineal kinship [24,25]. There are several reasons why matrilineal kinship may be relatively beneficial in the context of the slave trades, including that matrilineal kinship is flexible at incorporating new members [13,14,26–29]; creates networks of men across villages which are useful in the context of trade [14,30]; and is able to better insulate children from the consequences of the removal of a father and protect the integrity of the lineage in the face of the demographic imbalance induced by the disproportionate capture of men to work in overseas plantations in the Americas and the Indian Ocean [19,25].

We formally test the hypothesis of a connection between the slave trades and matrilineal kinship by combining historical data on exposure to the slave trades and the presence of matrilineal kinship on the African continent. We use information on the estimated number of individuals taken during the slave trades from each ethnic group. The data are from Nunn & Wantchekon [9] for the trans-Atlantic and Indian Ocean slave trades and the authors' calculations for the trans-Saharan and Red Sea slave trades using the source data from Nunn [8] that was used to construct country-level estimates. We combine this with data from the Ethnographic Atlas, which documents variation in cultural practices, including the practice of matrilineal kinship [7].

We find that exposure to the slave trades from 1400 to 1900 is associated with matrilineal kinship as observed in the late nineteenth and early twentieth centuries. This is particularly the case for the Atlantic and Indian Ocean slave trades, the trades that were the most disruptive, the largest in magnitude, and where capture was most concentrated among men. The finding is robust to a variety of measures of exposure to the slave trades, an instrumental variables (IV) estimator that uses a group's historical distance from the coast as an instrument, and sensitivity analyses that remove outliers.

Second, given past work that has studied whether the slave trades affected the prevalence of polygyny (e.g. [20]), another potential response to the slave trades that some have argued reduces the adverse social effects of the removal of men from the community, we explore the robustness of the results to alternative specifications that account for polygyny. We show that the correlation between exposure to the slave trades and matrilineal kinship is robust, and even stronger, when we account for the presence of polygyny.

Given the importance of polygyny as a potential response, we also estimate multinomial logit regressions, where the outcome categories are: matrilineal kinship only, polygyny only, both practices or neither practice. We find that exposure to the slave trades predicts the presence of a social response, either matrilineal kinship only, polygyny only or both. According to the estimates, the largest effect was on the development of both polygyny and matrilineal kinship, suggesting that the two innovations may have been complements of each other.

Our analysis contributes to several literatures. We contribute to the literature on the origins of matrilineal kinship. The existence of matrilineal societies has been explained as the result of an evolutionary process that created social structures suited to their ecological environments. Several factors have been identified as contributing to the adoption of matrilineal kinship, including women's participation in agriculture [15], low paternal certainty [16], daughter-biased investment [18], communal breeding [31,32], tsetse fly prevalence [17] or the absence of pastoralism, intensive agriculture, colonialism and societal complexity [33]. Recent research also finds a relationship between matrilineal kinship and reef density in the Solomon Islands [5]. Other work examines factors that can drive the transition away from matrilineal kinship, such as changes in subsistence patterns, intensive agriculture or integration into markets [33]. Our findings highlight how the African slave trades may have also contributed to the adoption and spread of matrilineal kinship, highlighting a socio-political origin of kinship structure.

Our findings also contribute to the quantitative literature on the effects of the slave trades, starting with Manning [19], Nunn [8], and Nunn & Wantchekon [9] (followed by [22,23,34,35]). Most closely related is work by Dalton & Leung [20], who provide evidence that polygyny may have been a social adaptation to the skewed sex ratios during the slave trades. When there were few men relative to women, this led to the greater practice of polygyny. We provide evidence that other social structures also changed in response to the slave trades; namely, that matrilineal kinship was also a response. We also provide evidence of an interaction between matrilineal kinship and polygyny, showing that they both appear to have been responses to the slave trades that act as substitutes for each other.

Finally, we contribute to the literature on the determinants and dynamics of culture and norms. See for example Harrington & Gelfand [36], Grosjean [37], Talhelm *et al.* [38], Lowes *et al.* [39], BenYishay *et al.* [5] and Schulz *et al.* [40], as well as references in the summary articles by Muthukrishna & Slingerland [41] and Gelfand *et al.* [42].

2. Background: the slave trades and matrilineal kinship

While the relationship between matrilineal kinship and the slave trade has yet to be explored quantitatively, the potential for a relationship has been noted by many scholars. For example, Paul Lovejoy [24], a historian of the slave trade, writes, 'No one has argued as much, but it may be that matrilineality and the export trade were interrelated. They certainly reinforced each other' [24, p. 388]. Along similar lines, anthropologist Jan Vansina [13] argues that matrilineality is not a vestige of 'antiquity', but rather that it was invented (perhaps more than once) and spread across central Africa. He argues that this was facilitated by the spread of the Atlantic trade, which created an integrated economic area in equatorial Africa [13, p. 152]. MacGaffey [25] hypothesizes that matrilineal descent was a modification of more-ancient pre-existing bilateral structures and that it emerged and spread with the intensification of the slave trades, resulting in the matrilineal belt. He writes, 'the shift [to matrilineal systems] probably took place in large part as a result of the slave trade and the demographic changes it induced; […] the Atlantic trade encouraged the formation of groups descended in the female line' [25, p. 215].

A number of hypotheses have been put forward for why the slave trades may have resulted in a greater prevalence of matrilineal kinship. We discuss these now.

(a) Incorporation of unaffiliated men

Unlike patrilineal systems, matrilineal systems could more easily incorporate unaffiliated men into the matrilineal group. Doing so is more difficult in patrilineal societies where male membership is established through birth [13]. In a context where many men are being forcibly removed, it may have been beneficial to make it relatively easier to replace them. Douglas [14] also highlights the general flexibility of matrilineal systems at incorporating new members: 'If there is any advantage in a descent system which overrides exclusive, local loyalties, matriliny has it. Furthermore, matrilineality, by its ambiguities, gives scope to the enterprising individual to override ascribed roles' [14, p. 128]. The process of enslaving people and absorbing them into lineages seems to have been quite common. By the mid-seventeenth century, as people were captured and enslaved, some would be absorbed into the societies by whom they had been captured, and previously free members of that society would replace them in the trade [27,43]. A specific example of this is provided by Wilks [28], who describes the development of the matriclan among the Akan in Ghana in West Africa as arising due to the ability of the matriclan to assimilate strangers—particularly 'unfree labor' [28, p. 81].

(b) Cooperation across villages

With the extensive trading networks associated with the slave trade, there arose a need for institutions that spanned across villages [30]. Unilineal descent systems allowed for linkages across villages and also limited the number of claimants in succession and inheritance issues. Vansina [13] argues that matrilineality was invented to meet these various needs. Matrilineal kinship is well placed as an organizing structure relative to patrilineal systems because it links groups of men across space, as related men move to other villages upon marriage [13]. This would be the case with both *avunculocal* residence (which is the most common in sub-Saharan Africa), where young men move to their mother's brother's village or with *matrilocal* residence, where men move to their wife's family's home. In work documenting the long distance trade routes in Central Africa, Vansina [30] highlights the trade linkages from the Kongo Kingdom eastward across Africa, connecting many matrilineal groups in Central Africa in the trade of ivory and enslaved people.

Along these same lines, Mary Douglas [14] argues that matrilineal kinship facilitates economic cooperation. She writes, 'Inter-group alliance is generally strong and group-exclusiveness is weak in matrilineal systems… Where intermarriage takes the form of an exchange of males, the cross-cutting ties which make for a criss-cross of reciprocal obligations are carried by the dominant sex. This implies more emphasis on intergroup alliance than in a system where the cross-cutting ties are carried by the weaker sex' [14, p. 126]. Thus, matrilineal kinship may have provided better support for cooperation across villages, including military cooperation, which was particularly important during the slave trades. Matrilineal kinship systems are also thought to be adaptive for external warfare [44].

(c) Resilience to the removal of men

The slave trades, particularly those supplying enslaved people to plantation economics—i.e. the trans-Atlantic and to a lesser extent the Indian Ocean trades—produced a large demographic imbalance, as primarily male individuals were sought for export. Thus, a system that traced lineage through women, rather than men, would have been more resilient. In particular, the effects of the removal of men from the lineage would have had very different effects on the lineage system and particularly on the children. To illustrate this, we provide a stylized example shown in figure 2*a*,*b*. Both show three generations, where a couple has three sons and three daughters and two sons and two daughters each have two children, a son and a daughter. Thus, in both lineages there are four grandchildren who are part of the lineage: iii, iv, vii, and viii in the patrilineal group and i, ii, v, vi in the matrilineal group.

The key difference between the two lineage systems is in the identity of the male figures who support the children. In the patrilineal group, children iii and iv are primarily supported by their father, denoted by 5, and children vii and viii are supported by father 9. In the matrilineal group, children i and ii are supported, not only by one male figure, but to a significant extent by all of their uncles: male figures 5, 8 and 9. Children v and vi are similarly supported by the same set of uncles: 5, 8 and 9.

We next consider the consequences of a male of the second generation being captured. Consider the case where male 5 is captured during the slave trade. In the patrilineal society, this leaves children iii and iv without a male provider in their life. In the matrilineal society, children i and ii lose one of the three male figures in their life, but they still have two of the three. Similarly, children v and vi lost one of the three male figures but they are left with two.

The example illustrates that matrilineal lineages provide a greater natural diversification of risk in a setting where men are being taken. Interestingly, the benefit of the diversification that matrilineal kinship affords is even greater the more important men are in the society. To the extent that the slave trade leads to a rise of conflict, the importance of men, and patriarchal relationships, this provides an even stronger advantage of matrilineal kinship.

We have summarized what we view as some of the most prominent hypotheses linking the slave trade to matrilineal kinship. This is not exhaustive and one can think of others. For example, if the disruption caused by the slave trades led to lower paternity certainty [16] or more communal breeding [31,32], the slave trades could have promoted matrilineal kinship through these channels as well. In the end, our analysis only tests for a reduced-form relationship between the slave trades and matrilineal kinship. We are unable to distinguish between the many competing hypotheses for the relationship. However, we view our analysis as an important first step towards a deeper understanding of the social consequences of the slave trades.

3. Empirical strategy

To examine the relationship between exposure to the slave trades and the presence of matrilineal kinship we combine

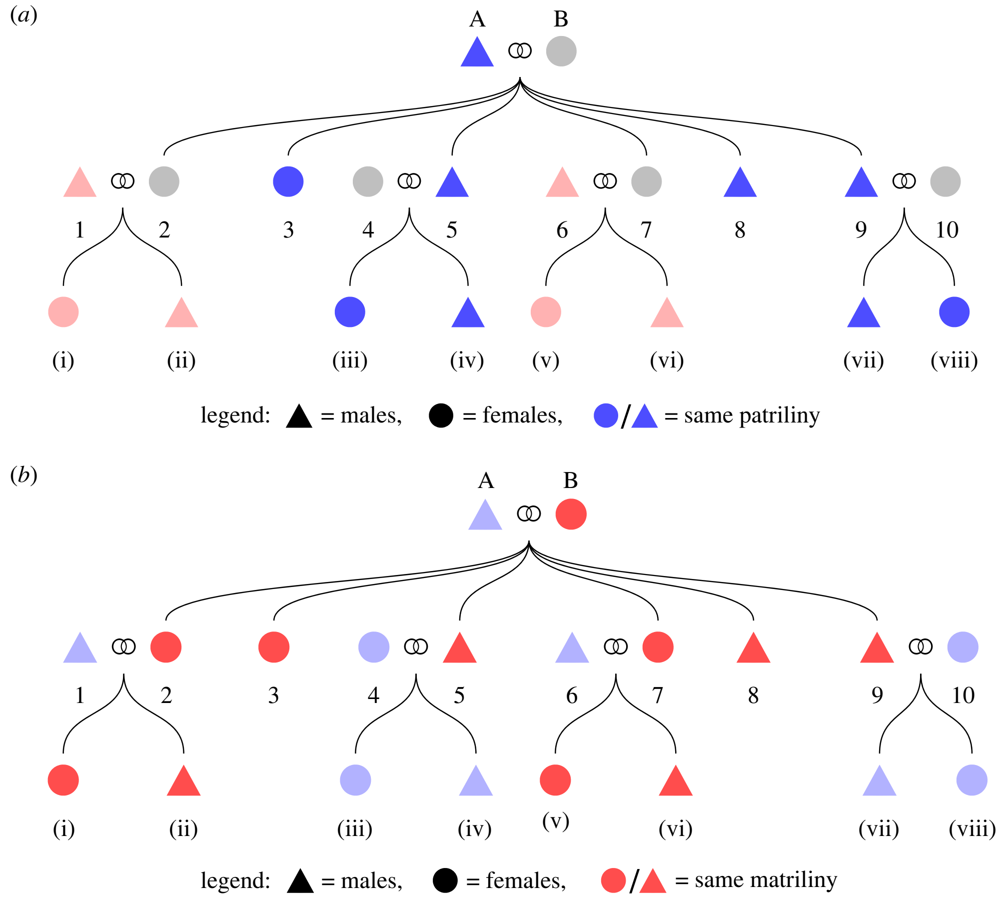


Figure 2. Kinship diagrams. (*a*) Patrilineal kinship, (*b*) matrilineal kinship. (Online version in colour.)

several sources of data. First, we use data with ethnicity level estimates of exposure to the trans-Atlantic and Indian Ocean slave trades from Nunn & Wantchekon [9]. These were constructed by combining shipping records, which provide close to a complete quantification of the forced removal of enslaved people from the continent, and samples of enslaved people for whom we know their ethnic identity. The sample for the trans-Atlantic slave trade comprises 80 656 enslaved individuals with 229 ethnic designations, while the Indian Ocean sample comprises 21 048 individuals from 80 different ethnic groups [8]. Nunn & Wantchekon [9] use these data to construct ethnicity-level estimates of the number of individuals that were taken during both slave trades between 1400 and 1900.

We focus on the trans-Atlantic and Indian Ocean slave trades because they are the trades for which the most precise ethnicity-level estimates are available. Beyond this, these trades enslaved from more groups in sub-Saharan Africa and more men than the other trades. They are also the trades that were being studied by the authors who hypothesized an effect on matrilineal kinship. In auxiliary analyses, we check the robustness of our estimates to considering all slave trades. We use ethnicity-level estimates of exposure to the two other slave trades (the Red Sea and Saharan) as covariates in our specifications. They are constructed from the ethnicity-level data and the shipping counts that comprised the sources for Nunn's [8] country-level estimates of the number of enslaved individuals shipped from each region that today is a country during the two slave trades. The Saharan estimates are based on a sample of 5385 enslaved individuals from 23 different ethnic groups and the Red Sea estimates are from 67 enslaved individuals from 32 ethnic groups. For more information, see Nunn [8,45].

Second, we combine data on cultural characteristics of ethnic groups from the Ethnographic Atlas (EA) with the Murdock ethnic group boundary map [6]. There is not a one-to-one matching between the EA and the Murdock map. Therefore, to match between the EA and the Murdock map, we create a concordance using data on cultural proximity from Murdock [7]. The source provides an index, which lists each ethnic group and assigns them an index code. Ethnic groups with the same index code share cultural features. Additionally, ethnic groups are assigned broader cultural group codes. This allows us to match ethnic groups described in the Murdock map with either (i) an exact match from the EA (based on name or a cultural index code) or (ii) if there is no exact name or index code match, we can assign a match within the cultural group; (iii) if there are no exact matches or cultural group matches, we assign the EA centroid that is most physically proximate to the Murdock polygon. See Lowes [1] for more information on this matching procedure.

Our empirical analysis also uses additional geographical data, including data on the suitability for the tsetse fly [46], ruggedness [47], malaria suitability [48] and suitability for agriculture and pastoralism [49]. These controls help address other factors that may affect the relative benefits of the adoption of matrilineal kinship, such as the presence of heritable property [17], the presence of pastoralism [18] and intensive agriculture [33].

Figure 1*a* visualizes the presence of matrilineal kinship as of the late nineteenth and early twentieth century. Figure 1*b* presents a map of the Atlantic and Indian Ocean Slave trades. Comparing the two maps, there appears to be a potentially positive relationship between the intensity of the slave trades and matrilineal kinship. However, there are many parts of the continent that experienced the slave trades, such as parts of the rift valley or much of west Africa. It is possible that the lack of a perfect relationship is explained by other ecological factors associated with matrilineal kinship and the intensity of the slave trades (e.g. pastoralism, intensive agriculture, etc.).

Given this, we next turn to a multivariate analysis of the relationship between the intensity of the slave trades and matrilineal kinship. We do this by estimating the following equation using an ordinary least squares (OLS) estimator:

$$\text{Matrilineal}_e = \alpha + \gamma\,\text{SlaveTrade}_e + \mathbf{X}_e\Gamma + \varepsilon_e, \tag{3.1}$$

where Matrilineal_e, the dependent variable of interest, is an indicator variable equal to one if the group is reported to have matrilineal kinship in the EA (variable v43). The independent variable of interest, denoted SlaveTrade_e, is an ethnic group e's measure of exposure to the slave trades, which we measure in multiple ways. $\mathbf{X}_e$ is a vector of covariates for ethnic group e: the year the ethnic group is observed in the EA (variable v102), an indicator for whether the group has an exact match in the EA, malaria suitability [48], absolute latitude of the Murdock polygon centroid, longitude of the Murdock polygon centroid, ruggedness [47], tsetse fly suitability [46] and suitability of land for agriculture and for pastoralism [49]. Because our baseline slave trade exposure measures are totals and do not account for the size of an ethnic group, we also include the natural log of land area and the natural log of land area squared of an ethnic group's territory measured using the polygons from the Murdock map. As noted, we also include controls for exposure to the Red Sea and Saharan slave trades.

While the unit of analysis is the Murdock ethnic group, information on the practice of matrilineal kinship varies at the EA group level. Beyond this, EA groups themselves may not be independent (i.e. Galton's problem). To account for potential non-independence, our baseline estimates use standard errors that allow for spatial autocorrelation using the estimator developed by Colella *et al.* [50].

We measure exposure to the slave trade in several ways. First, we use the total number of individuals taken during the slave trades. Because a larger ethnic group is mechanically going to have a higher value, in all regressions, we include controls for the size of each ethnic group, measured using a polynomial in the natural log of land area. Because the enslavement measure is highly skewed, with many ethnic groups experiencing zero enslavement and a few ethnic groups with many enslaved people, we also use two transformations that address this issue: the natural log of one plus the measure and the inverse hyperbolic sine transformation (IHS). Previous studies of the effects of the slave trade have implemented alternative strategies. Teso [23] normalizes the enslaved people measure by land area and winsorizes the variable at the 95th percentile to reduce the skewness, Nunn & Wantchekon [9] use the natural log of one plus enslaved people divided by land area, and Corno *et al.* [35] use the IHS transformation of enslaved people divided by land area. We also report estimates using each of these three strategies. Lastly, we construct an indicator variable for whether any enslaved person was taken from an area during the slave trades. This measure, although it captures the extensive margin (and not intensive) of the trade, has the benefit of removing skewness and reducing measurement error.

4. Results

Table 1 presents the estimates of equation (3.1). In all columns, we include baseline controls. In the even numbered columns, we add additional geographical controls and controls for exposure to the trans-Saharan and Red Sea trades. Columns 1 and 2 show that for all measures of exposure to the slave trade we find a positive effect of exposure to the slave trade on the presence of matrilineal kinship, although in some specifications the estimates are underpowered and statistically insignificant. This is not surprising given that the sample includes North Africa, which was primarily impacted by the trans-Saharan and Red Sea slave trades. While we account for these in column 2, due to limitations in the availability of underlying primary sources, the constructed exposure figures are very noisy [8,9]. Because North African ethnic groups suffer from this potential bias, we also report estimates that exclude North African ethnic groups from the sample. Reassuringly, the estimates, shown in columns 3 and 4, are very similar for this subsample.[2]

Studies have found evidence that present day rates of polygyny are correlated with exposure to the slave trades [20]. In an environment where large proportions of the male population were taken, polygyny may have been an adaptive response. Estimating our regressions without accounting for this potential factor may lead to biased estimates. Motivated by this, we estimate the relationship between the slave trades and matrilineal kinship, while accounting for polygyny as a potential response to the slave trades. The first exercise that we undertake is to omit from the sample ethnic groups located in West Africa, the region with the greatest prevalence of polygyny today [20,52].

The estimates, which are reported in columns 5 and 6, remain positive and significant and actually become larger in magnitude. This is consistent with a downward bias in the estimated effect of interest if we fail to account for polygyny. We explore the interplay between the slave trades, polygyny and matrilineal kinship further below.

We also report several sensitivity checks of the findings of table 1. The first is the use of an IV estimator where the instrument is the average distance of an ethnic group's traditional territory to the coast. Prior work has shown that this is a strong instrument given the historical context and that the exclusion restriction likely holds [9]. The IV estimates have the benefit of being more interpretable as causal. As reported in electronic supplementary material, appendix tables A1 and A2, we continue to estimate positive coefficients for all regressions and the estimated magnitudes tend to be larger, although the standard errors also increase. In most specifications, we cannot reject the exogeneity of the OLS estimates, which suggests that any endogeneity and selection present do not swamp the causal effects being estimated. We also examine the sensitivity of our estimates to using a measure of exposure to the slave trades that includes all four slave trades, rather than the Atlantic and Indian Ocean trades only. As reported in electronic supplementary material, appendix table A3, the estimates are very similar.

The second exercise we undertake is to account for polygyny. We use our samples that include West Africa

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Table 1. The Atlantic and Indian slave trades and matrilineal kinship. Each cell is a regression; Conley standard errors with a 200 km bandwidth in parentheses. *Matrilineal* is an indicator variable equal to one if the ethnic group or its match is reported to practice matrilineal kinship in the Ethnographic Atlas [7]. *Enslaved people* (*in 10 000s*) is the total number of enslaved people divided by 10 000. *Enslaved people/area* is number of enslaved people divided by the Murdock polygon's land area. *IHS enslaved people* is the inverse hyperbolic sine of number of enslaved people. *IHS enslaved people/area* is the inverse hyperbolic sine of number of enslaved people normalized by land area of a Murdock polygon. *Ln(1+enslaved people/area)* is the natural log of 1 + number of enslaved people normalized by land area. *Any enslaved person* is an indicator variable equal to 1 if any person was enslaved from that ethnic group. *Baseline controls* are: year of observation in the EA (v102) and whether the group is an exact match between the EA and Murdock. *Geographic controls* include: malaria suitability [48], absolute latitude of Murdock polygon centroid, longitude of Murdock polygon centroid, ruggedness [47], tsetse fly suitability index [46] and agricultural and pastoral suitability [49]. For measures of the slave trade that are not normalized by area, additional controls include ln of land area and ln of land area squared. *Other trades controls* are: number of people exported through the Red Sea and Saharan trades with the same functional form as the displayed independent variables.

	OLS; dep. var.: matrilineal kinship					
	Atlantic and Indian slave trades					
	full sample		without N. Africa		without W. Africa	
	(1)	(2)	(3)	(4)	(5)	(6)
enslaved people (in 10 000s)	0.002***	0.002***	0.002***	0.002***	0.003***	0.002***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.001)	(0.001)
ln(1+enslaved people)	0.015***	0.013**	0.015***	0.012**	0.032***	0.027***
	(0.005)	(0.006)	(0.005)	(0.006)	(0.007)	(0.007)
IHS enslaved people	0.014***	0.011**	0.014***	0.011**	0.029***	0.025***
	(0.005)	(0.005)	(0.005)	(0.005)	(0.007)	(0.007)
enslaved people/area[a]	0.094**	0.087**	0.091**	0.086**	0.258***	0.221***
	(0.040)	(0.039)	(0.041)	(0.039)	(0.067)	(0.063)
ln(1+enslaved people/area)[c]	0.051	0.046	0.048	0.046	0.237***	0.198***
	(0.036)	(0.034)	(0.036)	(0.033)	(0.075)	(0.068)
IHS enslaved people/area[b]	0.043	0.039	0.041	0.039	0.190***	0.159***
	(0.029)	(0.027)	(0.029)	(0.026)	(0.059)	(0.054)
any enslaved person	0.083**	0.056	0.081**	0.056	0.176***	0.138***
	(0.038)	(0.043)	(0.040)	(0.044)	(0.053)	(0.050)
baseline controls	Y	Y	Y	Y	Y	Y
geographical controls	N	Y	N	Y	N	Y
other trade controls	N	Y	N	Y	N	Y
observations	823	822	720	719	577	576
mean dep. var.	0.142	0.142	0.148	0.148	0.154	0.154
s.d. dep. var.	0.349	0.349	0.356	0.356	0.361	0.361

[a]Measure from Teso [23].
[b]Measure from Corno *et al.* [35].
[c]Measure from Nunn & Wantchekon [9].
$*p < 0.10$, $**p < 0.05$, $***p < 0.01$.

but add a control for polygyny to our main specification from equation (3.1). We code polygyny based on whether the EA reports that a group practiced polygyny (variable v9). From this, we create an indicator variable that equals one if the society has a form of polygyny beyond 'occasional polygyny' (category 2). Thus, the constructed measure can be thought of as capturing the presence of widespread polygyny. The estimates are presented in table 2 for the full sample (columns 1 and 2) and the subsample that omits North Africa (columns 3 and 4). The findings from the estimates are consistent with those from table 1. Even when we account for this other possible adaptation to the slave trades, the slave trades remain a robust predictor of matrilineal kinship.

The last exercise that we undertake is to estimate multinomial logit models, where the outcome is matrilineal kinship, polygyny, both practices or neither practice. Given the difficulty in estimating spatial models in this context, we instead estimate standard errors clustered at the level of ethnic clusters (111 in total), which are defined in the Ethnographic Atlas. The estimates are presented in table 3. We find that the slave trade measures are consistently associated with

Table 2. The Atlantic and Indian slave trades and matrilineal kinship: control for polygyny. Each cell is a regression; Conley standard errors with a 200 km bandwidth in parentheses. *Matrilineal* is an indicator variable equal to one if the ethnic group or its match is reported to practice matrilineal kinship in the Ethnographic Atlas [7]. Each regression controls for *Polygyny*, an indicator variable equal to one if the ethnic group or its match is reported to practice polygyny in the EA (variable v9) [7]. *Enslaved people* (*in 10 000s*) is the total number of enslaved people divided by 10 000. *Enslaved people/area* is number of enslaved people divided by the Murdock polygon's land area. *IHS enslaved people* is the inverse hyperbolic sine of number of enslaved people. *IHS enslaved people/area* is the inverse hyperbolic sine of number of enslaved people normalized by land area of a Murdock polygon. *Ln(1 + enslaved people/area)* is the natural log of 1 + number of enslaved people normalized by land area. *Any enslaved person* is an indicator variable equal to 1 if any person was enslaved from that ethnic group. *Baseline controls* are: year of observation in the EA (v102) and whether the group is an exact match between the EA and Murdock. *Geographical controls* include: malaria suitability [48], absolute latitude of Murdock polygon centroid, longitude of Murdock polygon centroid, ruggedness [47], tsetse fly suitability index [46] and agricultural and pastoral suitability [49]. For measures of the slave trade that are not normalized by area, additional controls include ln of land area and ln of land area squared. *Other trades controls* are: number of people exported through the Red Sea and Saharan trades with the same functional form as the displayed independent variables.

	OLS; dep. var.: matrilineal kinship			
	Atlantic and Indian slave trades			
	full sample		without N. Africa	
	(1)	(2)	(3)	(4)
enslaved people (in 10 000s)	0.002***	0.002***	0.002***	0.002***
	(0.000)	(0.000)	(0.000)	(0.000)
ln(1 + enslaved people)	0.015***	0.013**	0.015***	0.012**
	(0.005)	(0.006)	(0.005)	(0.006)
IHS enslaved people	0.014***	0.011**	0.014***	0.011**
	(0.005)	(0.005)	(0.005)	(0.005)
enslaved people/area[a]	0.094**	0.087**	0.091**	0.086**
	(0.040)	(0.039)	(0.041)	(0.039)
ln(1 + enslaved people/area)[c]	0.051	0.046	0.048	0.046
	(0.036)	(0.034)	(0.036)	(0.033)
IHS enslaved people/area[b]	0.043	0.039	0.041	0.039
	(0.029)	(0.027)	(0.029)	(0.026)
any enslaved person	0.083**	0.056	0.081**	0.056
	(0.038)	(0.043)	(0.040)	(0.044)
baseline controls	Y	Y	Y	Y
polygyny control	Y	Y	Y	Y
geographical controls	N	Y	N	Y
other trades controls	N	Y	N	Y
observations	823	822	720	719
mean dep. var.	0.142	0.142	0.148	0.148
s.d. dep. var.	0.349	0.349	0.356	0.356

[a]Measure from Teso [23].
[b]Measure from Corno *et al.* [35].
[c]Measure from Nunn & Wantchekon [9].
*$p < 0.10$, **$p < 0.05$, ***$p < 0.01$.

a significant reduction in the likelihood of having neither of the two practices. This is consistent with matrilineal kinship and polygyny both being responses to the slave trade. Although the power and significance varies, in all specifications, we find the slave trade is associated with a greater likelihood of having polygyny, matrilineal kinship, or both. The positive estimates for the category of both practices suggests that the two may have been complementary responses. The positive coefficient indicates that, in response to the slave trades, the emergence of one practice was more likely if the other practice was also adopted.[3]

In column (7) of table 3, we report the results from an F-test that tests whether the sum of the effects of the slave trade exposure measure for matrilineal kinship and both practices is statistically different from zero. This tests whether the slave trades are associated with matrilineal

Table 3. The Atlantic and Indian slave trade and matrilineal kinship, polygyny, both or neither. Each row reports the estimates of a multinomial logit regression and displays the average marginal effects of the independent variable listed in the left-most column on whether the ethnic group practices matrilineal kinship, polygyny, neither or both (exclusive and exhaustive categories); standard errors clustered at the Ethnographic Atlas (EA) cultural group level in parentheses (variable v114 in the EA). *Matrilineal* is the case where the ethnic group or its match is reported to practice matrilineal kinship in the EA [7]. *Polygyny* is the case where the ethnic group or its match is reported to practice polygyny in the EA (variable v9) [7]. *Matrilineal and polygyny* is the case where the ethnic group or its match is reported to practice both. *Neither* is the case where neither matrilineal kinship or polygyny is reported as being practiced. *Enslaved people (in 10 000s)* is the total number of enslaved people divided by 10 000. *Enslaved people/area* is number of enslaved people divided by the Murdock polygon's land area. *IHS enslaved people* is the inverse hyperbolic sine of number of enslaved people. *IHS enslaved people/area* is the inverse hyperbolic sine of number of enslaved people normalized by land area of a Murdock polygon. *Ln(1 + enslaved people/area)* is the natural log of 1 + number of enslaved people normalized by land area. *Any enslaved person* is an indicator variable equal to 1 if any person was enslaved from that ethnic group. *Baseline controls* are: year of observation in the EA (v102) and whether the group is an exact match between the EA and Murdock. *Geographical controls* include: malaria suitability [48], absolute latitude of Murdock polygon centroid, longitude of Murdock polygon centroid, ruggedness [47], tsetse fly suitability index [46], and agricultural and pastoral suitability [49]. For measures of the slave trade that are not normalized by area, additional controls include ln of land area and ln of land area squared. *Other trades controls* are: number of people exported through the Red Sea and Saharan trades with the same functional form as the displayed independent variables.

	multinomial logit; dep. var.: matrilineal kinship, polygyny, both or neither						
	Atlantic and Indian slave trades: full sample						
	categories of outcome variable						
	neither	matrilineal	polygyny	matrilineal and polygyny	*obs.*	*num. clusters*	*p-value* (2) + (4) = 0
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Panel A: baseline controls							
enslaved people (in 10 000s)	−0.148	0.008	0.123	0.017	823	111	0.222
	(0.117)	(0.006)	(0.097)	(0.015)			
ln(1 + enslaved people)	−0.030***	0.002	0.017*	0.012***	823	111	0.017
	(0.009)	(0.002)	(0.009)	(0.004)			
IHS enslaved people	−0.028***	0.002	0.015*	0.011***	823	111	0.019
	(0.008)	(0.002)	(0.009)	(0.004)			
enslaved people/area[a]	−0.176	0.027*	0.094	0.056*	823	111	0.029
	(0.110)	(0.015)	(0.100)	(0.030)			
ln(1 + enslaved people/area)[c]	−0.219	0.022*	0.158	0.039	823	111	0.126
	(0.161)	(0.013)	(0.136)	(0.031)			
IHS enslaved people/area[b]	−0.160	0.017*	0.112	0.030	823	111	0.114
	(0.115)	(0.010)	(0.098)	(0.024)			
any enslaved person	−0.168***	0.002	0.085	0.081**	823	111	0.092
	(0.044)	(0.017)	(0.059)	(0.041)			

(*Continued.*)

Table 3. (*Continued.*)

	multinomial logit; dep. var.: matrilineal kinship, polygyny, both or neither						
	Atlantic and Indian slave trades: full sample						
	categories of outcome variable						
	neither	matrilineal	polygyny	matrilineal and polygyny	*obs.*	*num. clusters*	*p-value* (2) + (4) = 0
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Panel B: geographical and other trade controls							
enslaved people (in 10 000s)	−0.032	0.003*	0.026	0.003	822	111	0.119
	(0.020)	(0.002)	(0.017)	(0.003)			
ln(1 + enslaved people)	−0.008	0.003	−0.002	0.008**	822	111	0.032
	(0.005)	(0.002)	(0.007)	(0.003)			
IHS enslaved people	−0.007*	0.002	−0.002	0.007**	822	111	0.038
	(0.004)	(0.002)	(0.006)	(0.003)			
enslaved people/area[a]	−0.023	0.028*	−0.043	0.038**	822	111	0.020
	(0.059)	(0.015)	(0.058)	(0.019)			
ln(1 + enslaved people/area)[c]	−0.038	0.020*	−0.001	0.018	822	111	0.137
	(0.059)	(0.011)	(0.055)	(0.020)			
IHS enslaved people/area[b]	−0.027	0.017*	−0.005	0.016	822	111	0.118
	(0.045)	(0.009)	(0.043)	(0.016)			
any enslaved person	−0.050*	0.002	0.000	0.048	822	111	0.241
	(0.029)	(0.017)	(0.048)	(0.036)			

[a]Measure from Teso [23].

[b]Measure from Corno *et al.* [35].

[c]Measure from Nunn & Wantchekon [9].

*$p < 0.10$, **$p < 0.05$, ***$p < 0.01$.

kinship (and whether or not it occurred alongside polygyny). We see that for many specifications, the p-value of the test is significantly different from zero, suggesting that we can reject the null hypothesis that the slave trades did not affect the occurrence of either outcome (matrilineal kinship with or without polygyny).

5. Conclusion

In this paper, we explored the hypothesis put forward by anthropologists and historians of the slave trades that the adoption of matrilineal kinship may have been driven by exposure to the slave trades. The slave trades may have encouraged the adoption of matrilineal kinship, which was better able to incorporate new members, promote cooperation across villages, and provide resilience against the removal of men from society. Motivated by these hypotheses and descriptive accounts, we tested for a connection between the slave trades and matrilineal kinship by combining historical data on exposure to the slave trades and the subsequent presence of matrilineal kinship. We found evidence that the slave trade is associated with a greater prevalence of matrilineal kinship. The finding is robust to multiple methods of measuring exposure to the slave trades, the use of an IV estimator, controlling for a wide variety of covariates and accounting for outliers. Our findings are consistent with matrilineal kinship being a response to the slave trades.

We also found an interaction between polygyny and matrilineal kinship. Using a multinomial logit estimator, we found that exposure to the slave trades is predictive of a social response, either matrilineal kinship, polygyny or both. We also found evidence that the two responses were complementary to each other. Adopting one was more likely if the other way was also adopted.

The slave trades constituted a massive disruption to the social order. Millions of individuals were enslaved. This paper has presented evidence of yet another side effect of the slave trades: changes to the underlying social structure of society. This is particularly important given the recent evidence that social structure is important for a range of factors that are key for contemporary economic development.

Data accessibility. The data and replication files can be accessed from ICPR depository: https://doi.org/10.3886/E195623V1 [53].

Supplementary material is available online [54].

Conflict of interest declaration. We declare we have no competing interests.

Declaration of AI use. We have not used AI-assisted technologies in creating this article.

Authors' contributions. S.L.: conceptualization, data curation, formal analysis, funding acquisition, investigation, methodology, project administration, resources, software, supervision, validation, visualization, writing—original draft, writing—review and editing; N.N.: conceptualization, data curation, formal analysis, funding acquisition, investigation, methodology, project administration, resources, software, supervision, validation, visualization, writing—original draft, writing—review and editing.

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Endnotes

[1]For a map of ethnic group level exposure to all of the slave trades, see electronic supplementary material, figure A2.

[2]Groups are identified as part of North Africa if their centroid is located within a contemporary North African country as defined by United Nations Statistics Division [51]. Electronic supplementary material, Appendix figure A3 reports a map that denotes region. Three groups that cover a large territory (Regeibat, Teda and Bideyat) are not North African according to our procedure (which is based on the location of their centroid) but with large proportions of their territory in North Africa. The estimates are very similar if we define these groups as in North Africa.

[3]The finding of an interplay between the slave trades, polygyny, and matrilineal kinship is important given recent studies that question whether the slave trades actually had an effect on polygyny (e.g. [52]). Our findings suggest that it is important to take into account both effects when estimating the effect of the slave trade on either practice.

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