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Religion and Polygamy: Evidence from the Livingstonia Mission in Malawi

Yuya KUDO*

September 2014

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In contrast to the prevailing preconception, Christian females engage in polygyny in most of sub-Saharan Africa. Based on individual-level data provided by the Demographic and Health Survey (2000, 2004, 2010) in Malawi, this study explores whether Christian identity reduces the likelihood that females enter into polygyny. To address the endogeneity associated with this identity, the analysis adopts an instrumental variable (IV) approach by exploiting the unique setting of a Christian mission dating back to the late 19th century. Exposure to the mission, measured by geographical distance to the influential mission station, Livingstonia, enabled the indigenous population to gradually convert to Christianity. This is particularly true for the local population not belonging to the Yao, an ethnic group that was largely proselytized into Islam because of their historical connection with the Arabs. Using the distance-ethnicity (non-Yao) interaction as an IV for women's Christian identity, with numerous historical, geographic, and climate controls, this study discovers that compared to those practicing other religions (Islam and other) or no religion, Christian females are indeed less likely to form polygynous unions. This study also provides some evidence suggesting that the Christianity effects are more evident in a society at a more primitive stage of development.

Keywords: Christianity, Culture, Gender, Mission, Polygyny, Religion

JEL classification: J12, N37, Z12, Z13

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1 Introduction

In the developing world, marriage is an event of significant consequence for economic growth, as the formation of a joint production and consumption unit affects a household's investment in capital resources (Fafchamps and Quisumbing (2008)) and often supplements welfare services insufficiently provided by formal institutional mechanisms (e.g., health insurance) (Weiss (1997)).

While both rigorous empirical and theoretical research remains scarce, several novel contributions have just recently been made to the knowledge and understanding of economic impacts of polygyny (e.g., Tertilt (2005, 2006); Schoellman and Tertilt (2006); Bove and Valeggia (2009); Edlund and Lagerlöf (2012)). For example, Tertilt (2005) quantitatively demonstrated that legally prohibiting polygyny resulted in a considerable increase in savings and a decrease in fertility in sub-Saharan Africa, which had a high incidence of polygyny.[1] Edlund and Lagerlöf (2012) also theoretically argued that monogamy boosted human capital investment by encouraging young males to spend more time educating their children in their married life rather than pursuing leisure as they did during bachelorhood. Despite its evident significance, however, there is a marked paucity of empirical studies that have explored issues affecting women's engagement in polygyny (e.g., Jacoby (1995); Fenske (2013a); Dalton and Leung (2014)). Generally, factors of economic reasoning and cultural elements, or the interplay between the two, may justify the prevalence of polygyny. By focusing on cultural influences, which appear to be less sufficiently explored than economic motives, this study attempts to fill the knowledge gap in the context of sub-Saharan Africa and improve the understanding of factors contributing to Africa's economic performance, which has been one of the central subjects in the development community.

Apparently for cultural factors, it is common knowledge that unlike Islam, Christianity prohibits polygamy.[2][3] However, such a dichotomous view may be misleading. Based on data drawn from the Demographic and Health Survey of 31 sub-Saharan African countries, Table 1 presents the proportion of females in a polygynous union relative to the total number of married females aged 15 to 49 years by religious identity. It is evident from the table that polygyny is more common among non-Christian females than among Christians. However, a certain proportion of Christian females are also engaged in polygynous marriages. While it is relatively difficult to obtain precise

[1] Based on Tertilt (2005), enforcing monogamy reduces the return on raising daughters by generating negative bride prices at equilibrium. In a monogamous society, as having children becomes less profitable, investment in physical assets becomes more important for security in old age. Similar effects are obtained by transferring the right to choose a husband from fathers to daughters (Tertilt (2006)).

[2] This study interchangeably uses polygamy and polygyny, since polyandry is rarely observed in societies.

[3] As explained in more detail in footnote 13, the author conducted a short questionnaire-based survey in three districts (Machinga, Mulanje, and Zomba) in southern Malawi in 2013. Whether the respondents were Christians or Muslims, they usually perceived that Christianity prohibited polygyny unlike Islam.

estimates, moreover, the absolute number of Christian females entering into polygyny is likely to be much larger than that of Muslim females in this region. This is because the Christian population in sub-Saharan Africa is almost twice as that of Muslims (Pew Forum on Religion & Public Life (2010), p. ii), and the majority of the population is affiliated with either religion. This picture questions the causal interpretation of the relationship between Christianity and the likelihood of polygamy. The uncertainty about the causal inference may also arise from syncretism, which often abounds in Africa, whereby people tend to venerate both, their ancestors and religious authorities. Marginally related to this point, Lewis (1955) also noted that people are prone to ignoring religious precepts that conflict with their economic interest, and that religious doctrines are continuously adjusted to new social conditions (pp. 103-104; p. 106).[4] Given these pieces of consideration, this study formally tests whether Christianity reduces the incidence of polygyny.

To estimate Christianity effects on the practice of polygynous marriage, this study uses repeated cross-sectional data drawn from the Malawi Demographic and Health Surveys (MDHS) 2000, 2004, and 2010. The data contains a variety of information pertaining to marriage, fertility, family planning, reproductive health, child health, and HIV/AIDS at the individual level, and therefore it is a highly valuable resource for an empirical study. The country selected suits the purpose of the current study for the following three reasons. First, Malawi is one of the highly polygynous countries in (particularly eastern) sub-Saharan Africa, with more than 10% of married men having multiple wives. Second, the MDHS data set contains a reasonable range of females practicing Christianity, Islam, other, or no religions, which is useful in an empirical analysis. As reported in Table 2, in the data set, approximately 85.9% of the females in the sample practiced some form of Christianity, whereas about 13.0% and 1.0% of them practiced Islam and other/no religions, respectively.[5] Third, this country's experience with the Christian mission (Livingstonia Mission) provides a unique setting that facilitates identification of the causal Christianity effects.

The descriptive analysis presented in this study reveal that Christian females are indeed less likely to be in polygynous unions. However, this observation may not be interpreted as evidence supporting the causal influence of Christianity for a few reasons. For example, the present prevalence of Christianity in this country originates from European contacts, such as the Christian

[4]For instance, given potential adherents' strategic choice of religion, it is possible that each denomination may modify the codes to entice them in a competitive religious market. In addition, priests may also differently (re-)interpret religious doctrines from their conviction, frustration, or ambition.

[5]In Table 2, the proportion is unweighted. To calculate the true proportion of the entire population from the sample data, appropriate sample weights are required. However, the weighting may not significantly affect the overall picture. For example, based on the recent estimate in 2010, provided by Pew Forum on Religion & Public Life (`http://features.pewforum.org/global-christianity/total-population-percentage.php`), approximately 82.7% of the total population in Malawi was Christian, which is very close to the unweighted proportion observed in the MDHS data.

missions of the 19th and 20th centuries, followed by colonial administration. If such European influence has a long-term independent influence on the incidence of polygamy, then the simple cross-sectional comparison results in a biased estimate of interest.

To address a few potential endogeneity issues, this study adopts two strategies. First, this study attempts to control for pre-determined local conditions that might have affected both the advancement of missionary penetration and colonial operation. Hence, a great number of geographic and climate conditions surrounding the surveyed communities (e.g., climatology, landscape typology, soil and terrain, and crop season parameters) are exploited as controls in the estimations. In addition, the regressors include historical information on travel routes of European explorers, railway lines in the 20th century, and the volume of slave export in the 19th century. All these pieces of information, which cannot not be discerned from the MDHS, will be taken from other data sets of the third Integrated Household Survey (IHS) 2010-2011 and Nunn and Wantchekon (2011).

The second approach addresses the endogeneity problems by adopting an instrumental variable (IV) strategy. This study notes that Christianity was less appealing to the Yao, an ethnic group that was largely proselytized into Islam, because of their ivory and slave trade with the Arabs, which existed before the arrival of the Christian mission. Thereafter, the interaction of an MDHS community's distance to the mission's influential station, Livingstonia, with an indicator variable for non-Yao ethnic groups will be used as an instrument for an individual's Christian identity. By performing three independent falsification tests, the exclusion restriction of the instrument is also carefully discussed.

This study contributes to many strands of the extant literature. First, this study can be seen as one of the few empirical studies exploring the determinants of polygamy in the developing world. For instance, Jacoby (1995) examined Côte d'voire to argue that women's high marginal contribution to agricultural production lowered the cost that males incurred to have an additional wife (i.e., the shadow price of wives), and therefore prompted the incidence of polygyny. Dalton and Leung (2014) provided empirical evidence suggesting that in western Africa, polygyny emerged as an institution that has persisted to the present as a result of the transatlantic slave trades that generated a great shortage of males in marriage markets during that time. In the context of sub-Saharan Africa, Fenske (2013a) also tested a variety of influential hypotheses that may explain polygyny, such as inequality in male resources (Becker (1981)), colonial schooling, economic growth, rainfall, political shocks, and a desire to acquire many (possibly male) offsprings (Grossbard-Shechtman (1986); Milazzo (2014)), and the aspects investigated by Jacoby (1995) and Dalton

and Leung (2014).[6][7] The current study underscores the contribution of one factor perceived to be cultural, i.e., religion, to this practice.

Second, within the field of economics, empirical studies exploring the impacts of religion on economic outcomes are scarce (see Iannaccone (1998) and Aldashev and Platteau (2014) for a brief review on the literature), and the causal relationship is not always explicit. As indicated in the previous literature (de Jong (2011); Aldashev and Platteau (2014)), this ambiguity is, in part, attributed to difficulty in establishing a solid empirical strategy to identify the causal effects. In addition, previous studies were typically based on cross-country comparisons or analyses at a sub-national level (e.g., Guiso et al. (2003); Barro and McCleary (2005); Noland (2005); McCleary and Barro (2006)) and consequently, micro-evidence from within (particularly low-income) countries is extremely scarce (e.g., Clingingsmith et al. (2009); Chen (2010)). In contrast to those studies, by using large-scale micro-level data collected in Malawi, this study attempts to identify the causal effects of religious identity in a rigorous manner. The use of an individual as a unit of observations may allow this study to discuss the role of religious values internal to individuals as a mechanism behind the identified impacts. The in-depth within-country nature of the analysis also helps disentangle the complexity between religion and the socio-economic environment, which is usually difficult in macro-level studies.

Third, there has been a recent effort by economists to better understand the role played by culture, norms, and beliefs in an individual's decision making and the intergenerational transmission of such cultural values (For example, see Fernández (2011) and Alesina and Giuliano (2013) for a brief review on the literature). By adding a new piece of empirical evidence from a religious perspective, the current study will also contribute to this rapidly growing body of research.

Finally, a growing body of research has demonstrated the long-term impacts of historic events and the associated social institutions on development (e.g., Acemoglu et al. (2001); Acemoglu et al. (2002); Nunn (2008)). In the context of the current study, for example, with a thorough

[6] For example, several sources of male inequality, such as income and the number of sisters (Bergstrom (1994)) as well as differences in technological efficiency of human capital creation between young and old generations (Edlund and Lagerlöf (2012)), are also analyzed in the previous theoretical studies.

[7] Regarding the inequality of male endowments, Becker (1981) theoretically demonstrated that even when the numbers of males and females are equal, polygyny emerges because "superior" males endowed with resources having high complementarity with women's marginal contribution to the marital output (e.g., land-rich males) can expel from the marriage market "inferior" males endowed with resources having low complementarity with women's marginal productivity (e.g., resource-poor peasants). This situation may be relatively true for less-developed societies. As the economy grows, however, the marital output depends more on children's human capital rather than their quantity, increasing the value of women's ability to produce offspring of good quality over their fecundity in a marriage market. The child quality is raised when mothers have plentiful human capital in high complementarity with that of their husbands. In modern economies, it is difficult for a husband to afford multiple wives of high quality due to an increase in their shadow prices. Consequently, the growth of the economy makes the marital institution less polygynous, until skill-based assortative monogamous mating emerges as an equilibrium (Gould et al. (2008)). This mechanism is also compatible with the theoretical framework provided by Becker (1981), suggesting that inequality in female resources generates polyandry, or at least reduces polygyny.

focus on the endogeneity, Gallego and Woodberry (2010) and Nunn (2014), by using regional- and individual-level data sets, respectively, estimated the lasting impacts of the Protestant and Catholic missions on the promotion of education in colonial Africa. In addition to the reduced-form effects of the Livingstonia Mission on the formation of women's polygynous relationships, the IV approach used in the current study also reveals the influence of religious conversion prompted by the mission. However, due to an insufficient number of good instruments, this study does not disentangle the Christianity effects, although the previous studies often highlighted the differing influences of the Protestant and Catholic missions on present-day economic development levels (e.g., Weber (1958); Becker and Woessmann (2009); Arruñada (2010)).[8]

This study is organized into six sections. Section 2 discusses an empirical strategy, followed by a data overview in Section 3. Historical background relevant to the identification strategy is provided in more detail in the Appendix A. The main findings of this paper are presented in Section 4. Section 5 presents an interpretation of the findings. The heterogeneity of Christianity effects is also explored in Section 5, with concluding remarks presented in Section 6.

2 Empirical Strategy

2.1 Specification

As explained in Section 3, the primary data used in this study is from three rounds (2000, 2004, 2010) of the Malawi Demographic and Health Survey (MDHS) that aimed to collect representative data on population, health, and nutrition of females of reproductive age (15-49).

For a female i living in a community j that were married when the surveys were conducted, this study estimates

$$y_{ij} = \alpha_1 + \alpha_2 c_{ij} + \alpha_3 e_{ij} + \alpha_4 \mathbf{x_{ij}} + \epsilon_{ij}, \tag{1}$$

whereby y_{ij} is an indicator, equal to one if the marriage-type was polygyny and zero otherwise;

[8]For example, using province-level data covering 17 sub-Saharan African countries, Gallego and Woodberry (2010) found that Protestant missionary activities had greater long-term impacts on educational attainment than the Catholic missions, which contributed less to increasing the present-day level of schooling. They also extended the analysis to argue that the Protestant missionary effects were mainly observed in Catholic areas, whereby Catholic missionaries occupied a sort of "monopolistic position" in the religious market due to the protection provided by former colonial governments. Therefore, to gain converts, the Protestant missionaries had to exercise efficiency to overcome their institutional disadvantage. In addition, using 2005 Afrobarometer data covering 17 sub-Saharan African countries, Nunn (2014) also found a long-term positive influence of both Catholic and Protestant missions on present education levels and also found that the Protestant missions reduced the gender gap, whereas the Catholic missions increased it.

c_{ij} takes the value of one if she was Christian and zero otherwise; a dummy variable for non-Yao ethnic groups are measured by e_{ij}, which will be discussed in detail in subsection 2.3; the vector $\mathbf{x_{ij}}$ contains other determinants of polygamy specific to her, her original household, and her natal community, in addition to birth-cohort-fixed effects (classified into five groups: born in the 1950s, 60s, 70s, 80s, and 90s) and survey-round-fixed effects; and ϵ_{ij} represents a stochastic error. In this study, married females include both those currently in a marital union and those living with a partner. Approximately 92% of all "married" females apply to the former case. It is preferred that the $\mathbf{x_{ij}}$ is evaluated at the point when she entered into a marriage market. Hence, to capture the levels of wealth at a household's disposal at that point, in addition to her birth order and other standard controls such as age and (arguably pre-determined) education, the $\mathbf{x_{ij}}$ included the number of both younger and older siblings that had passed away as well as the number of siblings living when she was 15 years old, based on recall information provided by the survey responses.[9] The number of deceased siblings is included in the $\mathbf{x_{ij}}$, presuming that the mortality information may positively correlate with her original household's poverty status. Conditional on the mortality information, the number of existing siblings may reflect a household's financial capacity to raise children. Moreover, Malawi has one of the highest HIV prevalence rates in the world, which may also affect the marital practice as shown by Ueyama and Yamauchi (2009), for example.[10] To control for the influence of HIV, this study also included in $\mathbf{x_{ij}}$ a community's distance to the origin of the HIV virus in the Democratic Republic of the Congo (latitude, -6.31; longitude, 23.59), as indicated by Oster (2012).[11][12]

Notably, modeling women's entry into a polygynous union given the available data poses one limitation. While the specification (1) apparently attempts to relate women's *own* religion to

[9] In the marriage equation, the level of education is assumed to be pre-determined, although it may still be possible that both the marital and schooling decisions are simultaneously made. Nevertheless, excluding educational attainment from regressors did not alter the implications obtained from the analysis including it.

[10] They showed that an increase in mortality among prime-age adult population lowered women's marriageable age in Malawi, and they interpreted this finding as women's attempts to avoid HIV infection associated with pre-marital sexual intercourse.

[11] The 2004 and 2010 MDHS collected blood for HIV testing from sample respondents who volunteered for the test. Thus, as Oster (2012) demonstrated, the analysis could also have collapsed the HIV data to the cluster level. However, this method results in excluding the entire observations of the 2000 MDHS from the analysis. It might also have been possible to estimate past HIV prevalence by using the current information (e.g., Oster (2010)). However, the implementation of such a task requires additional pieces of information that may not be available. As a result, this study decided to use the distance rather than the actual prevalence, which would also help avoid controlling for the endogeneity associated with the latter as well as simplify the analysis.

[12] Using the DHS data drawn from 14 African countries including Malawi, Oster (2012) showed that a community's distance to the origin of the HIV virus had a significantly negative association with the rate of HIV prevalence in a community. To examine this negative association in the current context, this study related a community's HIV prevalence, measured by the proportion of HIV positive respondents (both male and female) among those who tested for HIV in each community, to the community's distance to the origin point, with a control for an urban dummy, latitude/longitude, geography and climate, as well as district- and survey-round-fixed effects. The analysis using the community-level observations validated the negative relationship between the distance to the virus origin and HIV prevalence at a coefficient of -0.607 with 5% significance, suggesting that in Malawi, HIV prevalence was less in areas far from the virus' origin in the Democratic Republic of the Congo.

polygamy, in reality, it may result in exploring the influence of *parents*' religious identity on their daughters' marriage. This case is likely if parents and their daughters share the same religious faith when the daughters reach the marriageable age determined by society as well as the daughters have less autonomy in spouse selection. As the data do not contain information for who makes the final decision on a marriage, the estimated Christianity effects should be interpreted as referring to the average impacts of Christian identity observed among relevant decision makers on a bride's side (e.g., whether the bride, her parents, or other relevant parties).

The estimated α_2 does not necessarily imply causal Christianity effects on polygynous relationship (if any) for the following reasons. First, as previously noted, the mass conversion of this country's population to Christianity can be attributed to missionary penetration followed by British colonial administration. If such European influence has directly altered the marital behavior of the present generation, this will bias the Christianity effect.

Second, while inter-faith marriage may typically be less preferred in some African countries (Pew Forum on Religion & Public Life (2010), p. 40), this may not necessarily be true in Malawi. To complement the analysis based on the MDHS data, the author conducted a short questionnaire-based survey in southern region of Malawi in 2013.[13] Based on this survey, for example, more than 75% of the respondents answered that inter-religious marriages are common and all mentioned that in such cases, women typically follow their husbands' religion after marriage.[14] In addition, in the MDHS data, approximately 80% of the surveyed couples shared the same religious faith.[15] The same religious identity shared by the great proportion of couples observed in the MDHS data may also suggest the conversion of married females to their husband's religion.

Because the MDHS data contain information only on an individual's *current* religion, the measured Christianity used in this study has noise that may lead to relative difficulty in analyzing

[13] To examine people's perception of marital and inheritance practices as well as the relationship between these practices and religious beliefs, the author conducted a short questionnaire-based survey in three districts (Machinga, Mulanje, and Zomba) in southern Malawi in 2013. After obtaining the village list from the respective district council, in this survey, the author randomly selected at least one village from each district, resulting in five villages surveyed in all the three districts. In each village, two to five residents were interviewed, and the duration of each of those interviews was approximately 30-60 minutes. To ensure confidentiality and to increase data reliability, the interviews were conducted in an environment where the respondent was alone with the author and the research assistant (for translation to and from Chewa). Since the interviewed respondents were not randomly selected due to limited resources (i.e., convenience sampling), it is difficult for the current study to generalize the findings from the field interviews. The survey eventually reached eight male and 12 female adult respondents. Among the respondents were members of four ethnic groups (the Lomwe, Ngoni, Nyanja, and Yao); 11 respondents were Muslim and nine were Christian.

[14] In addition to the religious dimension, in the short-questionnaire based survey, the author also asked the respondents if inter-ethnic marriages were common. Approximately 90% of the respondents agreed on its commonness, and approximately 33% of marriage cases observed in the couple-level data of the MDHS were inter-ethnic.

[15] A partner's religion and ethnicity were not indicated by questionnaire responses from the surveyed females. However, the MDHS, while emphasizing data collection from females, also surveyed males between the ages of 15 and 54 in one-third (one-fourth in 2000) of the selected households, resulting in information on 7,287 couples in the data set used in the current research. This feature allows this study to analyze the data from the perspective of couples.

the influence of Christian identity during the formation of a marital relationship.[16] In addition, considering that Islamic law does not prohibit polygyny, Christian females may allow their Christian husbands, willing to have multiple wives, to convert to Islam. As females usually follow their husband's religion, in this case, these married Christian females may also convert to Islam (reverse causality).[17]

2.2 Controlling for Pre-determined Conditions

To address the endogeneity issues, first, this study attempted to control for pre-determined local conditions that characterized the entry and explosion of the missionary venture as well as colonial administration.

2.2.1 Geographic and Climate Controls

The settlement pattern of the missionaries was influenced by a number of factors. As indicated by Johnson (1967) and elsewhere (e.g., Nunn (2010); Nunn (2014)), the key elements generally included health-related items such as the availability of clean water and malaria-preventing geographic and climatic conditions (e.g., low temperature, high altitude); economic considerations such as access to trade routes from/to Europe (which might have been affected by railway networks in colonial periods) and the availability of fertile land needed for the creation of a cash crop economy; and the mission's benevolent nature to eradicate slave trades. All these points are indicated in the Livingstonia Mission as described in Appendix A.1.

To attenuate the possibility that these factors confound causal inference of the religious effects, an attempt was made to control for the large number of geographic and climate conditions that must have been encountered by the missionaries. However, apparently no suitable pre-missionary data exist for an empirical analysis. Thus, given the assumption that those conditions have not noticeably changed over the last century, the current study alternatively decided to use such information collected in the recent past. In the subsequent analysis, this information was provided by another survey of the third Integrated Household Survey (IHS) 2010-2011, since this information was not included in the MDHS data.

With technical assistance offered by the World Bank Living Standards Measurement Study-Integrated Surveys on Agriculture (LSMS-ISA) team, the National Statistical Office (NSO) in

[16] In addition to inter-religious marriages, the author's field survey also identified respondents that converted to another religion to avoid a large amount of donation paid to their previously affiliated religious authority.

[17] In this case, the relationship between Christianity and polygamy identified in the ordinary least square (OLS) estimations may be biased downwards.

Malawi implemented the IHS in the period from March 2010 to March 2011. With stratification based on geography, respondents belonging to 12,271 households in 768 enumeration areas (communities) were randomly contacted through the IHS, which provided information on various aspects of welfare and socio-economic status of the population.[18][19] The IHS data also contained abundant information on geography and climate surrounding the surveyed communities, such as climatology, landscape typology, soil and terrain, and crop season parameters (see Appendix B for details).

Both the MDHS and IHS projects published the GPS-based coordinates of the surveyed communities after displacing the coordinates by applying a random offset within a specified range to the positions (see Appendix C.1 for details). This was to maintain the confidentiality of the surveyed respondents, while still partially satisfying the public demand for the positional information. The GPS latitude and longitude position allowed this study to calculate the great-circle distance (GCD) between the MDHS and IHS communities, i.e., the shortest distance between any two points on the surface of a sphere measured along a path on the surface of the sphere (as opposed to going through the sphere's interior). Figure A.1 marked the sample communities in both the MDHS and IHS (for ease of visual identification, only the 2010 MDHS communities were compared to the IHS ones in the figure). Because both the MDHS and IHS communities were spread spatially across the country, it was convenient to identify the IHS community located closest to a community surveyed in the MDHS (see Appendix C.2 for the details of the identification process). In fact, approximately 95% (99%) of the MDHS communities corresponded with the nearest IHS community situated less than 10 (15) kilometers away from them. Consequently, for the geographic and climate information of the MDHS communities, the analysis used the data from the nearest corresponding IHS communities. In Appendix C.3, goodness of the fit of the IHS community characteristics to that of the MDHS data was informally checked by performing a few exercises. Those exercises simplified the subsequent analysis by using community-level information sourced from the IHS.

In addition to the geography and climate for each sample community, the IHS also provided information on a community's descent rule (i.e., matrilineal, patrilineal or dual descent), the most common religion practiced in a community (i.e., Christianity, Islam, or African traditional faiths. See Figure A.2 for the distribution), the number of churches and mosques in a community, the

[18] This study uses "enumeration areas" and "communities" interchangeably.

[19] For the details on sampling design, see "*Third Integrated Household Survey* (*IHS*3) 2010-2011 *Basic Information Document*, *March* 2012" at `http://siteresources.worldbank.org/INTLSMS/Resources/3358986-1233781970982/5800988-1271185595871/IHS3.BID.FINAL.pdf`.

number of primary and secondary schools operated by religious organizations in a community, and whether the nearest doctor in a community is found at the respective religious facility. The analysis also included the controls needed for the discussion to follow.

2.2.2 Historical Controls

The detailed information on geography and climate in a community is primarily intended to control for the missionaries' considerations of health-related factors and land productivity in selecting their settlement. While this information (e.g., elevation, slope, terrain roughness) may also be associated with the administration of trade routes from/to the coast and the intensity of slave trades, it may still be effective to consider these additional factors. Thus, to reinforce the primary instruments of the geography and climate, an empirical analysis also exploited additional covariates measuring European influence during colonial periods as well as the severity of slavery during the 19th century.

All these pieces of information were taken from data used by Nunn and Wantchekon (2011) that contained (i) an indicator that takes one if a European explorer traveled through land historically inhabited by an ethnic group, (ii) a dummy variable equal to one if any part of railway lines in the first decade of the 20th century drawn from Century Company (1911) passed through land historically occupied by an ethnic group, and (iii) the total number of slaves taken from an ethnic group that was normalized by the area of land inhabited by the ethnic group during the 19th century (log of one plus the normalized slave export measure). Unlike the aforementioned geographic and climatic controls measured at the community level, these items were evaluated at the ethnicity level. Thus, the information was appended to the MDHS data using the names of ethnic groups provided by the two independent data sets. Consequently, only the few ethnic groups in the MDHS not identified in the study by Nunn and Wantchekon (2011) data were excluded from the subsequent regression analysis.[20] These omitted groups represent approximately 5% of all the females in the sample.

Two limitations to using both the aforementioned community characteristics and ethnicity-level historical controls should be recognized. First, the information on the current residential location may not be sufficient to control for issues arising in cases involving women married to spouses living far away from their natal homes. Such cases may typically apply to females coming from ethnic groups that traces their descent through fathers, i.e., patrilineal ethnic groups.[21] This is

[20] The following ethnic groups were identified in both the MDHS and Nunn and Wantchekon (2011) data sets: the Chewa, Lomwe, Ngoni, Lambya, Manga'nja, Nkhonde, Sena, Tonga, Tumbuka, and Yao.

[21] While a patrilineal descent system is quite common in many sub-Saharan African countries, matriliny is also commonly observed in Malawi. For example, the Chewa, Lomwe, and Yao are typically referred to as matrilineal ethnic groups.

because in such an ethnic group, when a rural woman marries, she usually leaves her kin to reside with her husband living outside her original village (i.e., patrilocal marriage). However, using a community's descent rule sourced from the IHS as a regressor may partly control for this influence, as the descent rule is likely to correlate with the residential rule associated with marriage. The other issue is that the historical information is specific to the location *historically* inhabited by each ethnic group, not to the ethnic group's present area of residence. For ethnic groups that migrated into their present residential spaces far from their original settlements, it would also have been preferable to control for the pre-colonial and/or colonial controls associated with their present settlement.

2.3 Instrumental Variable Approach

These community- and ethnicity-level controls may mitigate the concern of omitted-variable bias attributable to European influence, but not the other concerns. Consequently, the current research also exploits an instrumental variable approach.

To identify a reasonable instrument correlated with Christian identity but uncorrelated with other omitted factors determining polygamy, this study notes that the present popularity of Christianity can be attributed to the Christian mission dating back to the late 19th century. More precisely, it is presumed that the prevalence of Christian beliefs is determined by two factors: (i) the date on which Christian ideas were introduced to a community and (ii) the speed at which the doctrine spread through the society, which in turn was governed by the frequency of social interactions among members as well as the rate of transmission of the religious values.[22] As the frequency of the transmission of religious faith could not be discerned from available data, to find an adequate instrument, this study focuses on the date Christianity was introduced; in particular, the date on which the missionaries had a contact with members in a community. The earlier they preached the Gospel in a community, the earlier the community's members converted to Christianity, and consequently the more likely their descendants are to be Christian.

The information on the date of the first missionary contact is neither contained in the data used in this study nor probably available elsewhere, however.[23] Nevertheless, it appears that the introduction date is closely related to a community's distance to the mission's station, since those living in the close proximity to the station might have had earlier opportunities to encounter the

[22] Discussions made in this paragraph refer to Oster (2012), who exploited a community's distance to the origin of the virus in the Democratic Republic of the Congo as an instrumental variable for the rate of HIV prevalence in the community to estimate the causal effects of the prevalence on an individual's sexual behavior.

[23] A parish register might have been used to identify the introduction date if this study had surveyed churches established around the MDHS communities.

missionaries.

While the historical background is provided in more detail in Appendix A.1, one of the most important missions that introduced Christianity into Malawi is the Livingstonia Mission of the Free Church of Scotland, which was founded in 1875. Although the picture should not be over-simplified, it is presumed that Christianity exploded from the northern areas in this country, where the Mission's influential station, Livingstonia (also known as Khondowe), was erected (See Figure 1 for the position). Consequently, this study uses a community's distance to Livingstonia (latitude, -10.36; longitude, 34.06) as an instrumental variable for an individual's current Christian identity. The distance was based on the GPS-based coordinates provided by the MDHS and the analysis calculated the great-circle distance d_j between the MDHS communities and Livingstonia. In practice, the distance interacts with an indicator variable for non-Yao ethnic groups, as described in Appendix A.2, as the Yao largely converted to Islam in the late 19th century because of their ancestors' strong alliances with the Arabs present prior to the arrival of the mission.

In sum, the assumption eventually made to exploit the instrument is that since the non-Yao residing far away from Livingstonia in the late 19th or early 20th century were expected to have been less exposed to the missionary contacts as well as parents have passed their religious beliefs over to their children (Nunn (2010)); therefore, a community's distance to Livingstonia multiplied by the non-Yao dummy is likely to explain the probability of the current generation being Christian. This statement can be checked by estimating the following first-stage equation as well as testing that $\beta_2 = 0$ and $\beta_3 < 0$:

$$c_{ij} = \beta_1 + \beta_2 d_j + \beta_3 d_j e_{ij} + \beta_4 e_{ij} + \beta_5 \mathbf{x_{ij}} + u_{ij}. \tag{2}$$

Apparently, the argument for instrument relevance can be made by implicitly assuming that the spatial mobility of the population has been completely limited at the ethnicity level. However, it might have been possible that the mission's involvement in political disputes among indigenous leaders, which were sometimes observed in the early periods of the missionary penetration, altered the spatial distribution of ethnic groups to a certain degree.[24] Thus, the assumption made here actually allows for the spatial mobility of the ethnic groups that might have existed, but might not have been strong enough to invalidate the instrument relevance. Another issue to be recognized is that once the propagation of Christianity reached a steady state, the date of the first missionary

[24]For example, see the relationship of the mission with the lakeside Tonga and the northern Ngoni in the early periods of the Livingstonia Mission (McCracken (1977), pp. 73-99).

contact, and thus the distance to Livingstonia, may no longer be able to explain the present-day distribution of Christianity. Thus, the distance could be used as a valid instrument only when the study used data drawn from periods during which the mission's arrival date was still relevant. The first-stage estimation results reported below provide strong support for the arguments of instrument relevance, which makes these concerns less critical.

Using the interaction term between the community-level distance and an individual's ethnicity (a dummy for the non-Yao) as an instrumental variable has two merits for the analysis. First, it allows the analysis to test whether the pre-determined community-level variables explained in subsection 2.2 sufficiently controlled for all time-invariant community-level characteristics affecting the likelihood of polygamy, because one could instead estimate equations (1) and (2) by replacing those community characteristics with community-level fixed effects.[25] Second, it is possible to perform a falsification test of used by Nunn and Wantchekon (2011) that will be conducted to check if the instrument can be excluded from the second-stage estimations.

The exclusion restriction is always a matter of concern for researchers using the instrumental variable approach. In the current context, a community's distance to Livingstonia may also be correlated with its distances to other locations important for the missionaries as well as to the British Government maintaining the colonial state, for example. If such distances had an independent influence on present-day polygamy, the excludability of the instrument would not be supported. In addition, one may also doubt that the ethnicity e_{ij} characterizes the marital practices only through its influence on women's religious identity (even if the ethnicity information interacts with the distance to Livingstonia and the level effect is already controlled for). Thus, to check the exclusion restriction of the instrument, this study conducts three falsification tests (including a Nunn-Wantchekon-type test), which is explained in subsection 4.4 after presenting the main estimation results.

Finally, while this study regards Livingstonia as an important Christian center, the author neither implies that the site was the *only* place of importance in the north nor intends to disregard the importance of other missions active in the central and southern regions (e.g., Nkhoma Synod of the CCAP, Blantyre Mission, or the Zambezi Industrial Mission). To control for the influence of other missions, this study also includes among the regressors a number of early mission stations situated within 25 kilometers radius from each MDHS community. The measure is created based on the positional information of the early mission stations shown in Figure 1, which is taken from

[25] In this case, the distance itself (d_j) will also be removed from the regressors in estimating the equations (1) and (2) to avoid perfect multicollinearity.

Nunn (2010).[26]

3 Data

This study primarily uses repeated cross-sectional data drawn from the MDHS (2000, 2004, and 2010) implemented by the NSO from July to November 2000, October 2004 to January 2005, and from June to November 2010, respectively. The MDHS is a nationally-representative household survey providing information in the areas of population, health, and nutrition such as marriage, fertility, family planning, reproductive health, child health, and HIV/AIDS. Because of these areas of interest, women of reproductive age are the main target of this survey. In the 2010 MDHS, 23,020 females aged 15 to 49 years old residing in 24,825 households located in 849 enumeration areas (communities) were interviewed in total, with 11,698 and 13,220 resident females of 13,664 and 14,213 households situated in 521 and 559 communities in the 2000 and 2004 MDHS, respectively.[27] The MDHS households are stratified random samples based on a study domain and urban/rural considerations.[28] Although the MDHS has been conducted multiple times, there has been no panel element in terms of either the clusters or households. As explained in subsection 2.2, this study also uses community-level variables sourced from the third IHS 2010-2011 and ethnicity-level historical controls taken from Nunn and Wantchekon (2011), to complement the limited information discerned from the MDHS.

Table 2 reports the distribution of religious identity among the respondent females. As mentioned in subsection 2.3, the Yao are predominantly Muslim. On the other hand, approximately a mere 4% of the non-Yao population is Muslim. Given the observation that there is not much data variation in religion within the non-Yao ethnic groups, one may argue that it is difficult to identify impacts of interest by adopting the IV approach. However, this is not necessarily the case because the analysis also uses Christianity-Islam variation within the Yao. It is evident from Table 2 that approximately 25% of the Yao are Christian.[29]

[26] However, it should be noted that excluding this control from the analysis yields almost the same results as those obtained from the analysis including it.

[27] In the survey, all females between the ages of 15 and 49 in the selected households and all males between 15 and 54 in one-third (one -fourth in 2000) of the selected households were eligible for the interviews.

[28] Similar sampling exercises were implemented in all the surveys. For example, the 2010 MDHS sample households were selected in two stages. By separating the 27 study domains (districts) into urban and rural areas, the nation was first stratified into 54 sampling strata consisting of the 9,144 enumeration areas established in the 2008 Malawi Population and Housing Census (PHC). The selection of 849 clusters from those enumeration areas was made in the first stage, with 158 urban and 691 rural ones. In the second stage, it was designed to select 20 households in an urban cluster and 35 households in a rural cluster, which generated the target sample size of 27,345 households at the national level. See "*Malawi DHS Final Report*" (2000, 2004, 2010) for details of the sampling framework.

[29] Moreover, also note that the absolute number of the non-Yao Christians is still large, as the sample size used in the current research is reasonably large.

Table 3 provides summary statistics of selected variables of self-identifying Christian females who were in marital relationships, with a check of the equality of the mean between these two groups. First of all, panel B (see "the most common religion") indicates that Christian females more evidently resided in communities primarily settled by Christians than their non-Christian counterparts. This observation establishes one of several checks performed in Appendix C.3 to verify goodness of the fit of community-level characteristics sourced from the IHS to individual characteristics of the MDHS females. Similarly, it also shows that Christian females lived in communities that had a larger (smaller) number of churches (mosques), than did non-Christian females.

Second, Christian and non-Christian females were found to be significantly different in an observable way in many individual- (panel A), community- (panels B and C), and ethnicity-level characteristics (panel D). For example, compared to non-Christian females, Christian females obtained more education and (with marginal significance) had fewer siblings who had passed away by the time these females reached the age of 15 years. As often indicated by relevant historical research, both the greater educational achievement and lower level of sibling mortality among Christian females may suggest that the Christian mission has made a significant contribution to economic development over the last century by creating a legal, institutional, and economic basis for a modern market economy as well as by offering both educational and health-related facilities.[30]

The significant differences in observed traits between Christian and non-Christian females indeed underscore the importance of controlling for unobserved (as well as observed) factors associated with an individual's religious faith for potential causal inference in the subsequent empirical analysis. In particular, given the presumption that polygamy is less common in advanced economies, the association of Christianity with modernity (in terms of educational attainment and health endowment) may suggest that the estimated Christianity effect involves downward bias, unless the unobserved characteristics correlated with religious faith are appropriately controlled for. On the other hand, the potential noise contained in the measured Christianity explained in subsection 2.1 may also attenuate the impact. Consequently, the direction of bias may not be explicitly established from the descriptive analysis.

[30] As reported in many literature sources, one of the most important services provided by missionaries in colonial Africa was European education (e.g., Woodberry (2004); Woodberry and Shah (2004); Gallego and Woodberry (2010); Nunn (2014)). Education was primarily provided to lure Africans into the Christian domain. As also discussed in previous studies, the missionary activities have had a long-term influence on educational advancement through two channels: First, their activities altered people's perceptions of the values and beliefs attached to educational investment that might have been transmitted from parents to children. It is certainly possible that this change in perception encouraged descendants of those in contact with the mission to demand high-quality education. Second, the missionaries made a long-term investment in the educational infrastructure. The establishment of educational facilities must have contributed to satisfying the demand for better education from the public, raising the equilibrium level of education.

While not a sufficient condition, successful implementation of the instrumental variable procedure requires a strongly negative association between a community's distance to Livingstonia and the prevalence of Christianity in non-Yao ethnic groups. Although the summary statistics do not provide a formal assessment of the negative relationship, the observation that Christian females lived largely in communities closer to Livingstonia than their non-Christian counterparts, and that Christians came primarily from non-Yao groups may support the validity of the instrument's relevance. In addition, the near-absence of the Yao among Christian females is also consistent with the historic account that the Yao were less amenable to Christianity than other ethnic groups because of their strong socio-economic ties with Arab Muslims, which existed before the advent of the Christian mission and, possibly because of their matrilineal descent custom, which is explained below. Related to this, the Yao have historically inhabited the southeast areas of a thin strip of land of the country, while Christian females were more likely to be located in the northwest of this country than non-Christians (See also Figure A.3).

Following these observations, the descriptive statistics also provide several other findings potentially compatible with historical records on the advancement of the mission. For example, the smaller number of matrilineal communities among Christian females relative to non-Christians may be explained by Christianity's mythical view of the origin of gender relationships. As this view might have violated the beliefs of matrilineal ethnic groups such as the Chewa and Yao, which held that the original human being was female and the blood line flows from a mother to a daughter and/or a son, local inhabitants in those communities may not have felt inclined toward complete submission to the mission (Davison (1997), p. 101). In addition, as explained in Appendix A.1, in its pioneering years, the Livingstonia Mission moved and established a settlement in the Northern Province partly to evade the unhealthful climate conditions in the south (e.g., Cape Maclear), which harbored malaria. This resulted in the subsequent establishment of the mission's main work centers in the northern highlands. Consistent with this view, it is shown that in contrast to non-Christians, Christian females were largely distributed in northern areas characterized by low temperatures and high altitudes as well as steep ascents.

Panel *D* also shows that Christian females belonged to ethnic groups that had historically inhabited areas where fewer European explores traveled, more railway networks were built, and slavery was less intense. It may be difficult to obtain a coherent picture from these observations, partly because these pieces of information were evaluated in terms of the historical settlement of ethnic groups, rather than an individual's present residential space. Nevertheless, at least, the third of these features may indicate that slave labor was a fundamental feature of the Yao society,

which was largely proselytized into Islam.

Finally, the panel *A* shows that Christian females engaged less in polygynous relationships than did non-Christians. The goal of this study is to investigate if this is a consequence of Christianity.

4 Estimation Results

4.1 OLS Estimates

The OLS estimation results for equation (1) are reported in columns (a) to (d) in Table 4, in which all the reported standard errors are robust to heteroskedasticity as well as clustered residuals within a community. In addition to the covariates whose estimates are reported, the community-level geographic and climatic controls of each surveyed community (i.e., climatology, landscape typology, soil and terrain, crop season parameters) (see Appendix B for the details) were included in the $\mathbf{x_{ij}}$ in column (a), together with birth-cohort-, district- and survey-round-fixed effects. The estimation in column (b) additionally included ethnicity-level historical controls. Both the historical controls and the non-Yao dummy were replaced by ethnicity-fixed effects (with the Yao as a reference group) in column (c). The analysis in column (d) replaced all the community-level variables with community-fixed effects.

With strong significance, the estimated religious effects revealed a relatively stable pattern across the columns. Compared to those practicing other religions and no religion, Christianity was negatively associated with the likelihood of engaging in polygyny by 8-9 percentage points. Moreover, note that using the ethnicity-fixed effects in column (c) and the community-fixed effects in column (d) almost unaffected the estimated Christianity effect reported in column (b). This fact may indicate that the geographic, climatic, and historical controls exploited in the current study adequately controlled for all the time-invariant determinants of polygamy that those fixed effects are supposed to.

4.2 IV Estimates: Second-stage Estimation Results

Columns (e) to (n) in Tables 4 present the two-stage least-squares (2SLS) estimation results of equation (1). In the columns (e) to (g), Christian identity was instrumented with *both* the distance to Livingstonia, which interacted with a dummy variable for non-Yao ethnic groups. On the other hand, only the interaction term was exploited as the excluded instrument in all the remaining columns, while maintaining the distance in the second stage in columns (h) to (j) and not doing

so in columns (k) to (n). As in the OLS estimation results, a different set of controls included in each estimation is explained at the bottom of the table. Again, the standard errors were corrected to allow for intra-community correlation in all the 2SLS estimations but those of column (n), which involved computational difficulty for the calculation due to a considerably large number of community-fixed effects. Throughout the paper, both the F-statistics of the first-stage estimations and p-values of the over-identification test are reported at the bottom of the tables if available.

As before, all those 2SLS estimations maintained a remarkably steady pattern for the estimated religious effects across the columns, keeping the implications obtained from the OLS estimates unchanged. However, the magnitude of the impacts was markedly altered by the IV approach. Now, the results suggest that Christian females are approximately 20-30 percent less likely to engage in polygynous relationships than non-Christians. Considering the proportion of polygynous marriages among all (current) marriages, and the 16 percent that were discerned from the MDHS, these impacts are truly remarkable.

Given the presumption that the 2SLS estimations yielded more reliable point estimates, a comparison between the OLS and 2SLS estimation results suggests that the OLS estimations generated a considerably large upward bias on the negative Christianity effects on polygyny. Section 3 argued that the religious effects estimated by the OLS might involve (if any) any direction of bias. Nevertheless, the difference between the OLS and 2SLS estimates may be explained by the observed Christian identity measured with classical errors.[31]

4.3 Robustness Checks

4.3.1 Measurement Noise in the Geographic and Climatic Conditions

While the informal analysis correspondence in Appendix C.3 provides some support for the quality of the correlation between the MDHS and IHS data sets, the current study cannot exclude the existence of measurement noise in evaluating geographic and climatic conditions of the MDHS communities. Two factors may account for the potential noise, one of which stems from the adjustment of the GPS-based coordinates made in both the surveys for the public use before the dissemination. However, the *random* offset applied to the coordinate values to displace the

[31] Alternatively, the pattern of bias demonstrated in the current estimations may also provide an indication that the possible omitted regressors might have been related to the pre-missionary level of economic prosperity. This consideration results from the observation that the pioneering missionaries were willing to preach the word of Jesus Christ in the north, which was estimated to be less-densely populated in the late 19th century, as seen from Figure 3. Intuitively, in advanced areas with dense populations, it is likely that women are unlikely to select polygynous relationships. If the pre-missionary level of economic development is negatively correlated with Christianity, the correlation is also likely to generate exactly the bias observed in the current estimations.

community-level positions may render the potential causal effects of religious identity unaffected by this measurement noise; because of its random nature, the noise that may be contained in the error terms of the equation (1) is unlikely to correlate with the religious beliefs. The other concern is solely based on the likelihood that irrespective of the displacement of the GPS-based coordinates, the IHS communities positioned the closest to MDHS communities may not have similar local characteristics. While the similarity in the estimates between the analysis using these spatial attributes and that exploiting community-fixed effects may mitigate this concern, the estimation in column (a) in Table 5 also limited its focus to data on females living in the MDHS communities located under 10 kilometers from the nearest IHS communities. The obtained implications remained unchanged.

4.3.2 Multicollinearity

One potential concern for the remarkably large impacts of Christianity identified in the second-stage estimations is the high correlation between the estimated Christianity obtained from the first-stage regressions and the non-Yao dummy. While the bivariate correlation between the original c_{ij} and e_{ij} is not extremely high, with a coefficient of 0.68, the corresponding coefficient between the estimated Christianity and e_{ij} is 0.92 in the analysis in column (f) in Table 4, for example. While by design, the high correlation between the instrumented variable and the other regressors is typically observed in the second-stage estimations of 2SLS, this issue may deserve more discussion.

From a theoretical standpoint, exploiting an additional variable with a high correlation with an exogenous covariate already included among the regressors reduces the precision of point estimates (unless the additional inclusion increases explanatory power of the empirical model) without altering their consistency. However, the informal statistical guidelines also indicate that exploiting two highly and positively correlated variables in the same estimation tends to result in overestimating one parameter as well as underestimating the other (Williams (2013)).

In fact, while they do not necessarily seem to be robust, the 2SLS estimation results in Table 4 suggest that the Yao females tend to avoid polygyny, which is not indicated by the OLS estimates reported in columns (a) to (d) in the table. The interpretation of the 2SLS estimates is still possible. For example, before the arrival of the mission, the Yao enjoyed prosperity because of the fortune they had amassed through trading ivory and slaves to the Arabs. As the findings were obtained *conditional on* the Christianity effects, they may indicate the long-lasting impacts of the wealth accumulated by the Yao in the 18th and 19th centuries (although the sign may not necessarily be explicit). Alternately, the non-Yao ethnic population contains both the matrilineal

groups that have started to adopt patrilineal practices (e.g., the Chewa) and patrilineal groups, as opposed to the Yao, who strictly adhere to matrilineal custom (Mtika and Doctor (2002)). The oft-cited positive correlation between polygamy and patriliny may explain the association between the non-Yao dummy and polygamy (although a community's descent rule is already included among the regressors) (e.g, Jones (2011)). Nevertheless, the fact that the instrumental variable approach changed the ethnicity effects may still provide the indication that the remarkably great impacts of Christianity may be driven by the issue of multicollinearity.

While there seems to be no irrefutable test showing whether multicollinearity is a problem, in the presence of this issue, coefficients tend to dramatically change when different samples, specifications, and estimation techniques are exploited. Accordingly, several exercises were additionally conducted in columns (b) to (m) in Table 5.

First, the analysis in column (b) focused on females in their first marital union, in contrast to previous estimations that used data pertaining to all females who were married at the point of the survey. This exercise may allow this study to analyze more directly women's entry into their first marriage. In columns (c) and (d), based on the survey rounds, data on all married females were split into two groups (2000/2004 and 2010). The results left the implications obtained from the preceding analysis almost unaffected.

To alleviate the correlation between the estimated Christianity and e_{ij} in the second stage, this study appended the DHS data drawn from neighboring countries of Zambia (2007) and Zimbabwe (2010) to the Malawian data. These three countries, which constituted the Federation of Rhodesia and Nyasaland between 1953 and 1963, were historically under the influence of the British administration. While the geographic, climatic, and historical controls were not exploited due to the limitations of the data, using this extended data set did not change the implications obtained from the previous analysis, as seen from the estimates in column (e) in Table 5.[32] However, given the case that as fewer as less than 1% of the females in the sample are Muslim in both the Zambia and Zimbabwe DHS, this exercise might not have mitigated the concern of multicollinearity. Therefore, the analysis in column (f) additionally exploited the DHS data of Mozambique (2011).[33] While Mozambique was not under the British control, approximately 15% of the females in the sample from the Mozambique DHS were Muslim. Unlike the previous estimates, the result now reports a positive correlation between the Christianity and polygamy. Given the p-values of the Hansen

[32]The ethnicity information was not available in the DHS data of Zimbabwe. Thus, all females in the Zimbabwe DHS were assumed to be non-Yao in the estimation.

[33]The author also attempted to use the DHS data drawn from Tanzania. However, as no information on religion and ethnicity was collected in Tanzania, this study avoided using it.

test reported at the bottom of the table, however, it appears that this correlation was driven by the violation of the exclusion restriction of the instrument.

In column (g), the analysis simply exploited data pertaining to non-Yao females. While the statistical significance has disappeared, both the magnitude and sign of the coefficient on Christianity are still consistent with the previously identified estimates. Instead of the linear 2SLS, the (recursive) bivariate probit model was applied to the estimation of column (h).[34] The negative Christianity effect (marginal effect reported) was still identified with the similar magnitude. The exercise in column (i) used the ethnicity dummy only in the first-stage estimation. In other words, the estimated Christianity was obtained similarly to the previous analysis. However, the second-stage regression exploited only the estimated Christianity, while excluding the non-Yao dummy from the regressors. This most interesting exercise (in the author's view) was equivalent to assuming that the ethnicity affects the Christianity but not polygamy. This assumption was made because the OLS estimates shown in columns (a) to (d) in Table 4 indicate no significant association between the non-Yao dummy and polygamy and the first-stage estimation results reported in subsection 4.4.1 (columns (a) to (d) in Table 6) highlight the importance of the non-Yao dummy in explaining Christian identity. While the estimated Christianity effect was reduced by more than half, compared to the estimates obtained from the previous analysis, it is still significantly negative.[35] Moreover, the 2SLS estimation was performed in column (j) after removing the non-Yao dummy from both the first- and second-stage estimations. The negative Christianity effect was again identified.

In columns (k) to (m) in Table 5, this study used the rank of the respondent among the partner's wives as a dependent variable. This rank takes n if a female is the nth wife of her husband, while applying the value of one to all females in monogamous marriage. Within females in a polygynous union, this alternative dependent variable allows the current study to make a distinction between the first wife, whose marriage is likely to have started as a monogamous relationship, and wives of the other ranks, who entered into polygamy from the beginning of the marriage.[36] As the husbands

[34] More precisely, the estimated model is

$$\begin{aligned} y_{ij} &= I(\alpha_1 + \alpha_2 c_{ij} + \alpha_3 e_{ij} + \alpha_4 \mathbf{x_{ij}} + \epsilon_{ij} > 0), \\ c_{ij} &= I(\beta_1 + \beta_2 d_j + \beta_3 d_j e_{ij} + \beta_4 e_{ij} + \beta_5 \mathbf{x_{ij}} + u_{ij} > 0), \end{aligned}$$

with

$$\begin{pmatrix} \epsilon_{ij} \\ u_{ij} \end{pmatrix} \sim N\left[\begin{pmatrix} 0 \\ 0 \end{pmatrix}, \begin{pmatrix} 1 & \rho \\ \rho & 1 \end{pmatrix} \right],$$

whereby $I(\cdot)$ is an indicator function.

[35] In this exercise, the standard errors were estimated by bootstrapping with 100 replications.

[36] To be precise, however, since only the current rank of the respondent was identified from the data, it may not necessarily be identical to her original rank with her current husband. For example, it is certainly possible that she got married as a second wife, followed by the death of her husband's first wife. In this case, in the data set,

of approximately 91% of females currently in polygynous unions had two wives, the analysis in columns (l) and (m) exploited the logarithmic number of the rank as a dependent variable, in contrast to the estimation in column (k), which uses the natural number. In addition to the 2SLS estimate reported in column (l), moreover, the control function (CF) approach was also taken in column (m).[37] All these results again identified the significantly negative Christianity effects.

4.3.3 Selectivity Concern

While not explicitly discussed before, another empirical challenge may also arise from using only females who were married at the point of the DHS. For example, if Christian females show little propensity to marry and, conditional on getting married, tend to form unions with males with a larger (smaller) number of wives due to their unobserved personality traits, this would make the estimated α_2 biased upwards (downwards) in the OLS.[38] In addition, if Christian females married to males with larger (smaller) numbers of wives are less likely to get divorced or be widowed in some unobserved way, this would also overestimate (underestimate) the impacts of Christianity on entry into polygynous marriage. Indeed, it is shown from Table 3 that among females who were married at the point of the survey, a greater proportion of Christian females were in their first marriages than non-Christians. This may suggest that the former group is less likely to get divorced than the latter.

One possible way to solve the selection problem is to use a selection correction methodology by explicitly modeling the selection process. However, this strategy often yields evidence sensitive to a parametric assumption made in the process and needs effective instruments that explain the selection but not the outcomes. In the current context, however, adopting this approach would be difficult, because once a distinction is required between females that had never been married, females in marital unions, and females separated from their husbands due to divorce or a husband's death, the approach needs to consider not only selection into marriage but also selection into divorce/widowhood. Due to the complexity in modeling these selection mechanisms and the lack of good instruments that could be exploited to control for each selection process, this is not a strategy employed by the current study.

she would be recorded as the first wife at the point of the survey. However, as this is measurement noise of the dependent variable, as long as the error is classical, it would primarily affect the precision of the estimates, not the consistency.

[37] The control included in the second-stage estimation is $\frac{\phi[Z_{ij}]}{\Phi[Z_{ij}]}c_{ij} - \frac{\phi[Z_{ij}]}{1-\Phi[Z_{ij}]}(1-c_{ij})$, whereby $Z_{ij} \equiv \pi_1 d_j + \pi_2 d_j e_{ij} + \pi_3 e_{ij} + \pi_4 \mathbf{x_{ij}}$, and $\phi(\cdot)$ and $\Phi(\cdot)$ are standard normal density and distribution functions, respectively.

[38] Note that this is a standard selection problem. A similar issue arises when estimating the impact of educational attainment on earnings, for example. If the educated show a high propensity to become employed and (conditional on obtaining a job) tend to be paid well due to their (unobserved) ability, the educational effect on earnings would be biased upwards, unless the employment selection is appropriately addressed.

Alternatively, this study attempted to check if the obtained results were entirely attributed to the selection problem. The analysis in columns (n) (reduced-form equation) and (o) (structural equation) in Table 5 exploited observations of both single and married female respondents under the age of 25 years and estimated their ranking among the partner's wives. Since the information was absent for unmarried females, the rank was assumed to take the value of zero in their case. As these females are young, it appears that a distinction between those who were in wedded relationships and those who were not simply reduces into a distinction between females that had never been married and females that got married. Consequently, this sample restriction was made to enable the analysis primarily to consider the concern associated with selection into the first marriage (i.e., to focus on the formation of the first marital union), de-stressing the concerns associated with selection into separation (and/or selection into the second or further marriage).

Estimating the rank by using both the single and married females did not affect the implications obtained from the previous analysis, which provided support for the view that Christian females are less likely to enter into polygynous relationships. While this exercise undoubtedly falls short of providing evidence ruling out the selectivity concern, it may provide some evidence that the selectivity bias *alone* does not completely account for the previously identified Christianity effects. Finally, even if the selection problem biases the OLS estimation results, it may not be the case in the 2SLS estimations, provided that the distance-ethnicity interaction is uncorrelated with some unidentified attributes that not only drive the selection but also correlate with an individual's religious identity as well as the type of marriage. This study has difficulty in enumerating such personal traits that have correlation with the instrument.

4.4 Excludability of the Instrument

4.4.1 Reduced-form and First-stage Estimation Results

To examine the exclusion restriction of the instrument, this study conducted three falsification tests. The first test follows a technique employed by Nunn and Wantchekon (2011). To identify the causal relationship between the exposure of ancestors of the same ethnic group to slave trades and the current differences in trust levels in Africa, they exploited an ethnic group's distance from the coast at the time of the slave trade as an instrumental variable for the number of slaves taken. After showing the reduced-form relationship between the distance and the trust levels, to remove the concern that the distance affected the trust levels for reasons other than the influence on the slave trades, they showed that there was no relationship between distance and trust *outside* of

Africa, where there was no slave trade. In the current context, due to the lower sensitivity of the Yao toward the Livingstonia Mission, the following reduced-form equation can be estimated

$$y_{ij} = \gamma_1 + \gamma_2 d_j + \gamma_3 d_j e_{ij} + \gamma_4 e_{ij} + \gamma_5 \mathbf{x_{ij}} + \nu_{ij}, \tag{3}$$

to show that there is no systematic relationship between the distance to Livingstonia and the marriage type among the Yao, i.e., $\gamma_2 = 0$.

The OLS estimates are reported in columns (e) to (h) in Table 6; standard errors are robust to heteroskedasticity and adjusted for clustering on a community. As before, a different set of regressors is explained at the bottom of the table. As expected, the distance $itself$ indeed had no significant impacts on polygynous probability.

In addition, given the presumption that non-Yao populations residing longer distances from Livingstonia are less likely to be Christian due to their less exposure to Christian doctrine ($\beta_3 < 0$), it is expected that the γ_3 has an opposite sign value of α_2. Regarding the negative association of distance with Christianity within non-Yao ethnic groups, the analysis in columns (a) to (d) in Table 6 estimated the first-stage equation of the 2SLS, i.e., equation (2). The results showed that the distance indeed had a significantly negative correlation with the probability of being Christian only for non-Yao ethnic groups. Figure 2 also provides the graphical representation of the negative relationship. The semiparametric regression curve (Lowess) of a partial linear model based on Yatchew (1997, 1998)'s differenced-based method clearly shows that the negative relationship is observed only for non-Yao groups.[39] Moreover, the estimates in columns (e) to (h) in Table 6 also confirmed the expected relationship between the sign of the estimated α_2 and that of γ_3, suggesting that due to less familiarity with Christian tenets, non-Yao females living further away from Livingstonia were more likely to engage in polygynous marriage than their non-Yao counterparts residing in closer proximity to Livingstonia.

4.4.2 Pre-missionary Economic Prosperity

However, the fact that distance has no impacts on the likelihood that Yao females engage in polygyny does not necessarily mean that the distance is uncorrelated with other omitted factors affecting the probability of forming a polygynous union. While it is unlikely that distance actually *drives*

[39]The IV approach using overly strong instrumental variables often yields estimates almost identical to OLS estimates, both of which are biased. The instrumental variables used in the current research appear to be quite strong, but the IV estimates are significantly different from the OLS estimates. This observation may also be credited to the reliability of the IV estimates.

marital behavior, it is still important to consider more carefully whether the instrumental variable satisfies the exclusion restriction. This check may be performed by exploring the relationship between distance and polygamy in the periods *before* the missionary contacts. If the distance had no impact on the likelihood of polygyny in pre-missionary periods, the subsequently emerging differences between Christian and non-Christian females may indeed be attributed to the impacts of Christianity originating from the Livingstonia Mission. On the other hand, the presence of a significant correlation between the distance and polygamy before missionary penetration indicates a violation of the excludability of the instrument.

Unfortunately, information on polygyny in the late 19th century is not available. However, it is likely that the practice was correlated with economic prosperity, which may in turn be measured by population density (Acemoglu et al. (2002)). Thereafter, the second falsification test investigated the relationship between the pre-missionary population density and the distance.

While it is relatively difficult to obtain population data from before the arrival of the Mission, this study exploited two independent data sets. The first historical population data were sourced from the History Database of the Global Environment (HYDE) 3.1. Within the field of economics, Fenske (2013b) has recently used this database to explain pre-colonial land tenure and slavery in Africa. The HYDE provides estimates of historical population from 10000 BC to 2005 AD with a spatial resolution of 5-minute longitude/latitude in raster format (Goldewijk et al. (2010)). The current study exploited the data on population density in 1900 that was plotted in Figure 3. In the regression analysis, the 5-by-5-minute cell was used as a unit of observation and accordingly, the distance to Livingstonia was calculated as that between the centroid of each cell and Livingstonia.

Since historical population estimates are unavoidably imprecise, this study also used census data as an alternative to the HYDE. However, it appeared that the earliest census data tenable to an empirical analysis could be sourced only from the post-colonial periods, more precisely, the "Malawi Population Census 1966."[40] To compensate for the disadvantages of having to use data on the post-colonial population density, this study explored the associations of the distance to Livingstonia, particularly with the density of the population aged above 60 years. This exercise was completed with the assumption that the density of the elderly cohort could still be used as a proxy for the true density of the total population in the late 19th or early 20th century.[41] The

[40] Several documents also provided some information on population in the early 20th century, such as the "Census of the Nyasaland Protectorate 1911" and annual reports of "Colonial Reports-Annual, British Central Africa Protectorate" for the period from 1904 to 1936. The digital version of the latter documents can be obtained from `http://libsysdigi.library.illinois.edu/ilharvest/Africana/Books2011-05/469188/` thanks to a contribution made by University of Illinois at Urbana-Champaign. The population information in those periods can also be obtained from Dixey (1928). However, these documents did not provide detailed figures that could be exploited in an empirical analysis.

[41] A similar idea can be found in Oster (2012)'s study mentioned in footnote 22. In the study, to examine the

assumption may be strong because the elderly who lived until the middle 20th century might have been selected from the initial population born in those periods, and their longevity may be due to some mechanisms possibly related to the level of economic development in their areas of residence. Acknowledging this limitation, nevertheless, the second analysis was conducted based on the population density of the elderly cohort identified in the 1966 census. In this analysis, the district was used as a unit of observation and accordingly, the distance to Livingstonia was measured by that between a district's capital city or major town and Livingstonia.

After replacing the polygamy indicator with the pre-missionary population density, a version of equation (3) was first estimated in columns (a) to (e) in Table 7. The analysis in column (a) exploited population data sourced from the HYDE, whereas that in columns (b) to (e) used the 1966 census data. Instead of the non-Yao dummy used in equation (3), all the estimations in those columns attempted to exploit the proportion of the non-Yao population relative to the total population of an observational unit (i.e., 5-by-5 minute cell or district). However, the HYDE does not contain population information on ethnic groups. As a result, in column (a), the analysis exploited the non-Yao proportion of a district in 1966 that each cell in Figure 3 belongs to. In the analysis at the district level reported in columns (b) to (e), the exact non-Yao proportion in 1966 of each district was utilized.

Having a similar set of controls, but using different sources for the population density revealed similar sign values of all coefficients in columns (a) and (b). The exclusion restriction of the non-Yao-distance instrument requires no significant relationship between the distance to Livingstonia and the population density of regions primarily settled by non-Yao ethnic groups. Indeed, the estimates provided support for this view, because the interaction term between the distance and the non-Yao proportion had no significant impacts on the pre-missionary population density. In column (c), a district's gender composition and average age were additionally included. The analysis in columns (d) and (e) estimated the density of the overall population in 1966. In Table A.3, the density of both the elderly and the general population in 1966 was also estimated by using a district-age-gender cohort as a unit of observations, rather than only a few district-level observations exploited in columns (b) to (e) in Table 7. These estimates also revealed that neither the distance to Livingstonia nor its interaction term with the non-Yao proportion had any significant association with pre-missionary population density. Given the limitation that the non-Yao proportion was

exclusion restriction of an instrumental variable, she attempted to examine whether there was a relationship between a community's distance from the origin of the HIV virus and an individual's sexual behavior in the period before the epidemic. For this purpose, she investigated pre-marital sexual behavior of older individuals (aged 45 years and above) who were interviewed in the DHS, assuming that these individuals would have been engaged in such behavior before the epidemic.

discerned only from the 1966 census, the analysis in columns (f) to (j) in Table 7 ultimately avoided utilizing this information. Again, the results provided no strong support against the extremely strong causal case derived by the instrumental variable approach.[42]

4.4.3 Placebo Experiment

Thus far, the current study has mainly shown evidence suggesting that the distance to Livingstonia may be excluded from the second-stage estimations of the 2SLS. However, the primary instrument exploited in this study is the *interaction* of distance with the non-Yao indicator. For this interaction term to be a valid instrument, the significant association of the interaction term with the polygynous probability shown in the reduced-form estimates in column (e) to (h) in Table 6 must stem only from its influence on Christian identity. If the relationship is, given the excludability of the distance, attributed to a spurious correlation between the non-Yao indicator and polygynous marriage, this would invalidate the assumption of the exclusion restriction.

Regarding this concern, after replacing the distance to Livingstonia with a random variable generated from the standard normal distribution function, the equation (3) was estimated in columns (i) to (m) in Table 6. By design, this random number should have no impact on polygyny. As described above, however, if the significant association of the interaction term between the distance to Livingstonia and the non-Yao dummy with polygynous probability (reported in column (e) to (h) in Table 6) arose from some spurious correlation between the non-Yao dummy and polygyny, then, the interaction term between the random number and the non-Yao indicator is also likely to significantly affect marital practice exactly because of the spurious attributes of the non-Yao dummy. On the other hand, the absence of such significant association may alleviate the concern that the non-Yao dummy used in this study (interacting with the distance to Livingstonia) does not satisfy the exclusion restriction.

The OLS estimates for equation (3) that replaces the distance to Livingstonia with the random number are reported in columns (i) to (m) in Table 6. As anticipated, the random variable revealed no significant association with polygyny. More importantly, after controlling for the level effects of the ethnicity, the interaction term between the random number and the non-Yao indicator does not correlate with the polygynous probability.

Finally, in addition to the above three falsification tests, one more exercise was performed.

[42] It is possible that population density in the late 19th century affected the mission's decision to establish the station such as Livingstonia. The exercise in Table 7 is performed simply to check the correlation between the distance to Livingstonia and the population density (conditional on some covariates), not to report the causal impact of the distance.

While the number of early mission stations located in the vicinity of each MDHS community was included in $\mathbf{x_{ij}}$ in the previous estimations, in this final exercise, the author attempted to use this number as an alternate IV to the distance to Livingstonia to see if a different IV would provide a similar estimate (these results, however, are not reported). Unfortunately, the number did not strongly correlate with an individual's religious identity, although it negatively correlated with polygny with strong significance. However, this does *not* imply that the distance to Livingstonia is an invalid IV. While the concern of the exclusion restriction is clearly a limitation, the excludability of the instrument may be redeemed by the exercises performed in this subsection 4.4.

5 Discussions

While this study began by revealing some skepticism about the idea that Christianity prohibits women's engagement in polygyny, thus far, the analysis has provided evidence showing that on average, this common belief is indeed true. One interpretation of this finding is that individuals' internal Christian *values* (or beliefs, religiosity) make them hesitant to enter into polygyny. However, given that the previous analysis focused solely on the relationship between Christian *identity* and the polygynous probability, this interpretation may be overly simplistic. Moreover, while it was shown that Christianity reduced the likelihood of polygamy, some Christian females are still forming polygynous unions. Then, what conditions prompt Christian females to consent to polygyny? This section provides some discussion relevant to these two issues.

5.1 Beliefs or Institutions?

The Christianity effects might have included the influence of investments made in religious infrastructure and/or that of religion-based social networks established in a community. Related to this concern, note that the previous estimations controlled for a community's major religion, the number of churches and mosques in a community, the number of primary and secondary schools run by religious organizations in a community, medical services offered at a community's religious facility, and the number of early mission stations located in the proximity to a community (see also the significantly positive correlation of a community's Christianity and the number of churches and the negative correlation of the number of mosques with an individual's Christian identity reported in columns (a) to (c) in Table 6). While these controls are only evaluated at the point of the IHS (so, not during the formation of a marital union), they may still (at least, partly) allow this study

to segregate the effect of Christian values from that of institutional factors relevant to religion.

Moreover, if polygynous marriages cannot be blessed in church, such a religious rule, rather than Christian faith, might have also prevented Christian females from engaging in polygyny. In the previous analysis, a distinction was not made between formal (those in a marital union) and informal (those living with a partner) marriage cases. If this mechanism explains the estimated Christianity effects, Christian females in a polygynous union may primarily be found in the latter marriage type. However, irrespective of whether a marriage case is monogamous or polygamous, in the data, approximately 90% of married Christian females were in a formal union.

To further this argument, two additional exercises were performed. By including an indicator for informal marriage among the regressors, first, equation (1) was estimated by 2SLS in column (a) in Table A.4. While informal marriage had a significantly positive correlation with polygamy, the estimated Christianity effects were almost unaffected. Second, using the estimated Christianity obtained from the previously conducted first-stage estimation of 2SLS, a multinomial logit model was also applied to the second-stage estimation, whereby monogamy (base outcome), formal polygamy, and informal polygamy were dependent variables. The results reported in columns (b) and (c) in Table A.4 did not provide support for the view that the Christianity effects were more evident in informal marriage than in formal ones.

Finally, given the importance of European education provided by missionaries in colonial Africa, the estimated Christianity effects might have included the educational influence. However, the previous analysis has already controlled for the level of an individual's schooling (and excluding education from regressors almost unaffected the estimated Christianity effects). In addition, while the results are not reported to save space, a community's other characteristics relevant to educational facilities (sourced from the IHS) - the number of teachers and pupils at the nearest government primary and secondary schools and the number of private primary and secondary schools - are also included in regressors. The obtained implications remained unchanged. While it is difficult to completely exclude the influence of institutional factors, at the very least, the analysis conducted in this study fails to reject the importance of Christian values as a facilitators of the identified Christianity effects.

5.2 Heterogeneity

To examine the factors that prompt Christian females to engage in polygyny, this study explored the heterogeneity of the Christianity effects. In this exercise, Christian identity interacted with

several pre-determined and/or (likely) exogenous variables included in $\mathbf{x_{ij}}$. In addition to d_j and $d_j e_{ij}$ used to instrument the c_{ij}, the 2SLS estimations performed here additionally exploited $d_j e_{ij}$ interacted with the $\mathbf{x_{ij}}$ as instruments for the interaction terms between the Christian identity c_{ij} and $\mathbf{x_{ij}}$.[43] The estimation results are reported in Table 8. For brevity in both reporting and interpreting the results, the table does not include the standard errors of the estimates, and the analysis used indicators for those who were older in age and educated (upper 50% quantile). It is expected that using the discrete measures of age and education rather than continuous measures still allows for the non-linear impacts on polygyny observed in Table 4 and Table 5.

Notably, the likelihood that Christian females engage in polygyny *increases* over time (conditional on influence of age), whereas the general time-trend shows the declining tendency (see birth-cohort fixed effects and the interaction terms with Christianity in columns (r) and (s)). Based on the result in column (r) in Table 8, for example, there is no significant difference in the likelihood of entering into polygyny between Christian and non-Christian females born in the 1990s. Even within each birth cohort (i.e., conditional on the fixed effects), young Christian females are also *more* likely to form polygynous unions than older Christians, even though the age-polygyny relationship is reversed for non-Christian females (columns (a) and (s)). In addition, while polygyny is typically less common in the first marriage, a *greater* proportion of Christian females engage in polygyny than their non-Christian counterparts in their first marriages (columns (g) and (s)). Moreover, Christian females living in urban areas are *more* likely to enter into polygynous relationships than urban non-Christian females, despite polygyny being generally *less* observed in urban residential areas (columns (j) and (s)).

Considering the Christian tenets that prohibit polygamy, these findings may be consistent with the secularization hypothesis in Weber (1958)'s classic work that the influence of religion declines as an economy becomes modern and urbanized.[44] More generally, the findings may also suggest that cultural factors play a more important role in characterizing people's behavior in a society, which is at a more primitive stage of development.

Another interpretation for the findings is that to take advantage of welfare services provided by the Christian mission, strict adherence to the Christian doctrines, including avoidance of polygamy, might have formerly been required, and such requirements no longer hold today. All these results should be interpreted as providing only suggestive evidence due to the potential endogeneity of

[43] While the first-stage F-statistics are not reported here, it was confirmed that all the instruments had strong explanatory power.

[44] This indication may also be consistent with the estimation results reported in columns (c) and (d) in Table 5. While the estimates may not be significantly different, the identified Christianity effects were lower in the analysis using the 2010 MDHS than in that using the old two rounds of 2000 and 2004.

$\mathbf{x_{ij}}$. Nevertheless, it seems that in Malawi, Christianity gradually loses its influence in restricting women's engagement in polygyny, relatively signifying other factors.

6 Conclusion

In contrast to the prevailing preconception, Christian females have been observed in polygynous unions in many sub-Saharan African countries. Based on individual-level data provided by the Demographic and Health Survey (2000, 2004, 2010) in Malawi, this study explored whether Christianity reduced the incidence of polygyny.

To address potential endogeneity associated with Christian identity, two strategies were simultaneously adopted. First, an attempt was made to control for geographic, climate, and historical conditions that might have affected both the Christian missions and European administration. Such controls were taken from the IHS (2010-2011), which provided an abundance of geographic and climatic information related to the surveyed communities, as well as from Nunn and Wantchekon (2011) that contained the details of travel routes of European explorers, railway lines in the 20th century, and the volume of slave exports in the 19th century.

The second strategy exploited an instrumental variable approach. Given the fact that the Yao largely converted to Islam because of their alliance with the Arabs based on ivory and slave trades that had existed prior to the arrival of the Christian mission, it was assumed that the non-Yao who lived close to the influential mission station, Livingstonia, in the late 19th and early 20th centuries and their descendants were more clearly familiar with Christian ideas than their counterparts living away from Livingstonia. Using a community's distance to Livingstonia interacted by an indicator variable for the non-Yao ethnic groups as an IV for the Christianity identity of the present generation, together with the previously explained numerous controls, this study found that compared to those practicing other religions (Islam and other) or no religion, Christian females were indeed less likely to engage in polygynous relationships. In addition, if not all, it appears that the Christianity effects are explained by Christian values internalized by individuals. By examining the heterogeneity of the Christianity effects, the current research also provided evidence suggesting that religion plays a more important role in explaining the difference in the incidence of polygyny in less-developed economies.

Tertilt (2005) considered a balanced growth path for an economy that accepts polygyny and calibrated the model to the average state of polygynous countries in sub-Saharan Africa (including Malawi), with at least 10% of the male population in polygynous unions. She numerically showed

that legally enforcing monogamy decreased fertility by 40% and raised savings and output per capita by 70% and 170%, respectively. Unfortunately, the potential multicollinearity concern makes the current research somewhat hesitant to provide the precise magnitude of the Christianity effects. Nevertheless, based on the OLS estimates that may be seen as the lower bound of the religious effects obtained from the current research, being Christian reduces the likelihood of females entering into polygyny by 8-9%, which is almost half of the proportion of polygynous marriage relative to the total number of marital unions formed by prime-age (15-49) females in Malawi. In Africa, most people adhere to either Christianity or Islam, with the population roughly balanced between them, with the southern regions being more evidently Christian (Pew Forum on Religion & Public Life (2010), p. ii). While the polygyny-reducing impacts identified in the current study may not be directly comparable across countries, it appears that Christianity introduced by the mission has had non-negligible influence on Africa's economic development.[45][46]

[45] In addition to its influence on polygyny that in turn has an impact on welfare, it may also be possible that Christianity has affected Africa's development through other channels, although identifying the alternative mechanisms is beyond the scope of the current research.

[46] Moreover, during the last decade, much political effort has been expended to place religious forces and institutions on the development agenda (Haar and Ellis (2006)). For instance, UNDP (2004) lists religion (in parallel to ethnicity) as a source of cultural diversity and sees this cultural liberty as a vital part of human development. In addition, Commission for Africa (2005) (p. 31; pp. 127-129) highlights the potential of religion, which provides both materials and spiritual services, to play a positive role in the development process on this continent. The UK Department for International Development (DFID) also financed a series of multi-million-pound comparative research projects that the Religions and Development Research Programme Consortium undertook between 2005 and 2010 (See `http://r4d.dfid.gov.uk/Project/3896/` and `http://www.religionsanddevelopment.org/index.php?section=10#mod_58` for the details). This trend seemingly builds on the political society's firm belief that by understanding the socio-economic roles played by religion, one may remove political aspects from the dimension and design effective policy tools that exploit and/or change the economic impacts of religion on the society. The findings reported in this study may also contribute to this policy discourse.

A Appendix: Historical Background

The Livingstonia Mission of the Free Church of Scotland was founded in 1875 and has long been recognized as one of the most important missions introducing Christianity into Malawi in the late 19th century. Largely sourced from Pike (1968), McCracken (1977), and Msiska (1995), this section attempts to outline the history of the mission with a particular emphasis on their settlement pattern as well as the Yao's conversion to Islam. Further historic accounts can be found in more detail in those literature sources and elsewhere (e.g., Pike (1965); Kalinga (1985) Thompson (1995); Bone (2000); McCracken (2012)).

A.1 Livingstonia Mission

David Livingstone (1813-1873), one of the most outstanding explorers to make a transcontinental journey across Africa during the middle years of the 19th century, laid the groundwork for the mission, which was named "Livingstonia" in his honor. Sponsored by the British government, the Scottish missionary headed the "Zambezi Expedition" between 1858 and 1863, which aimed to catalogue the natural resources of the Zambezi River area as well as to identify trade routes needed for transporting raw materials from the African interior to coastal trading points that could eventually be sold on a British market. The opening of the African continent to a world economy and the promotion of local commercial activities were believed to have contributed to uprooting the African slave trade by creating "legitimate" trade of products (e.g., cotton, ivory), so that Africans did not have to sell their own people to obtain the guns, gun-powder and cloth that they desired. The expedition was also greatly motivated by Livingstone's zeal for ending the slave trade and bringing Christianity and civilization to the Africans. He also urged the cultivation of cotton (and other crops) in the unexplored territory to make the missionary activities self-supporting as well as to bypass the slave-owning American states from which most of Britain's raw cotton came.

In this expedition, he reached the conclusions that the only practicable means of linking the interior with the coast was to take a deep-water route from the Shire River to Lake Malawi by steamer, and that the Shire Highlands, a plateau in southern Malawi, was a suitable area for white settlement as well as for the creation of a cash-crop economy.[47][48] However, his statements

[47] Livingstone rejected the overland route from the south because of the presence of tsetse fly in the Zambezi valley and his expectation that the enormous amount of capital required to build railways would not be raised outside the boundaries of a European colony. Initially, he had believed that the best route to reach the interior lay along the Rovuma (Ruvuma) River. Upon investigation, however, it became clear that this route did not meet his expectations, and in May 1861, Livingstone's party returned to Zambezi to follow the Shire route.

[48] To Livingstone, it seemed that the region had laid the foundations of a successful cash-crop economy, as cotton of good quality was already cultivated in many villages in the region.

shortly encountered harsh criticism from James Stewart (1831-1905). To realize an agricultural and Christian settlement, as a devout adherent of Livingstone's model of an "industrial mission," Stewart traveled to the Shire Highlands in 1861. However, in contrast to the indication provided by Livingstone, Stewart, in his journey, eventually found that no expected commercial benefits were to be obtained from settlement in the region and discovered that the Zambezi-Shire route was shallow and difficult to navigate by steamship.[49] Concurrently, the Universities' Mission to Central Africa (UMCA), whose establishment was inspired by Livingstone's speeches at Cambridge and Oxford in 1857, built the station at Magomero between modern Zomba and Blantyre in 1861 and made a decision to move the work center to Zanzibar in 1862.[50] A few months later, the British government determined to withdraw the Zambedzi expedition, which had lasted six years, and many at the time commented that it was a failure with none of its purposes fulfilled.[51]

After ten-years of ignorance by the Free Church and other societies about Livingstone's proposals, Stewart, now the head of Lovedale Institution in South Africa, drew up a memorandum on "Livingstonia, Central Africa" after his return to Scotland in 1874.[52] To some extent, ironically, he presented to the General Assembly of the Free Church the essence of Livingstone's suggestions, that the southern end of Lake Malawi could be reached from the coast by waterway via the mouth of the Zambezi to the Shire, and that Lovedale could be an operational base for a new mission.[53] In response to his presentation, the Free Church authorities decided to found the Livingstonia Mission, which was initially largely financed and administered by a small group of philanthropic industrialists, most of whom were operationally based in Glasgow (e.g., James Stevenson).[54][55] At the time, Livingstone's "Commerce and Christianity" theory was to be put into action by

[49] In contrast to Livingstone's view described in footnote 48, when Stewart arrived at the highlands, he found that no cotton was produced in the region, and that such slow and primitive methods of spinning were exploitive. Nevertheless, even after the recall of the expedition ordered by the British government, Livingstone still insisted on the importance and practicability of introducing small colonies into the region, deploring that cotton production was not in full swing at the moment of Stewart's visit.

[50] UMCA (1857-1965) was a missionary society established by members of the Anglican Church within the universities of Cambridge, Dublin, Durham and Oxford.

[51] Up to the 1860's, Livingstone's concept of the industrial mission was closely allied with one important school of the government opinion. For example, Livingstone's scheme received a considerable amount of financial support from the government under the patronage of Henry John Temple, 3rd Viscount Palmerston (1784-1865), who served as the Prime Minister. However, Stewart's criticism, together with other failures of the "East Africa expedition" and the "Niger expedition" as well as Palmerston's death, rapidly changed the government's official views about Livingstone's theory.

[52] Lovedale was a mission station and educational institute established in Cape Province, South Africa.

[53] At that time, Stewart was eager to develop a new inland mission station that might work as a satellite for Lovedale.

[54] Until the early 20th century, the mission had to rely for much financial support on the Glasgow businessmen who discerned the economic potential of the Lake Malawi, rather than on Free Church official funds.

[55] James Stevenson, a chemical manufacturer, viewed the mission as one of among several instruments of change to integrate East Central Africa into the world economy. He believed that the mission would not succeed in building an agricultural settlement unless legitimate trade was introduced into the region by reducing transportation costs of the products, along with adequate commercial enterprises to exploit the arbitrage opportunities thus established. Accordingly, he contributed to founding a trading company, The Livingstonia Central Africa Company, in 1878, which was a predecessor of the African Lakes Company (ALC).

well-qualified people for the first time in its history.[56]

In 1875, the Livingstonia Mission established its central station at Cape Maclear (see Figure 1), a hilly promontory at the south end of Lake Malawi that served as a good port for the mission steamer. Based on a residential mission policy that demanded Africans be housed and trained in mission sites isolated from "temptations" of their own society, the mission attracted a couple of groups to the site (e.g., freed slaves returning to their homeland, a local chief's son sent to acquire a Western education, refugees defiant of the authority of local rulers). However, the settlement expansion revealed several issues, such as a shortage of sanitation facilities and the mission's insufficient ability to feed the settlers and regulate their behaviors in many spheres of social life (e.g., violence, theft, Sunday meetings, beer drinking, polygamy).[57] Moreover, it was soon evident that the mission station was nearly useless, because with a great distance away from the nearest villages; it was situated on the edge of barren and tsetse-infested plains unfriendly to animal life and lacking the fertile land needed for cotton production. These unfavorable environments made the pioneering party decide to move the central station to Bandawe, halfway up the west coast of Lake Malawi, in 1881.[58] Consequently, the years spent by the missionaries at Cape Maclear were seen as a period of adjustment in which they accustomed themselves to the realities of the African situation.

The relocation to Bandawe was a milestone in the history of the Livingstonia Mission for several reasons. First, it showed the mission's intention to shift the whole axis of its activities to the Northern Province. Such a change in direction partly stemmed from a proposal made by James Stevenson, at that time one of directors of the African Lakes Company (ALC) (a trading body formed by the aforementioned Glasgow industrialists), to build a road between Lake Malawi and Lake Tanganyika to enable the ALC to distribute commercial products to a wide inland area as well as to work in close co-operation with the missionaries.[59] Second, the mission abandoned the previously employed residential policy and alternatively decided to act on the village level with only a small residential element. The exploratory and evangelistic visits to neighboring villages made under the new strategy helped the missionaries considerably extend their Christian and educational influence outside the settlement. Third, in the early stage of the Livingstonia Mission, in the absence of any local authority, the missionaries often exercised civil powers to

[56] At the outset, the leadership of the mission was vested in the hands of E. D. Young, a navy officer who had been seconded to Livingstone's Zambezi expedition, as Stewart could not join the Livingstonia Mission due to his commitments at Lovedale. After Young's immediate leave from the Malawi region in 1877, Robert Law (1851-1934), a Scottish missionary, headed the mission for more than 50 years.

[57] The early settlers were given food supplies until they could grow their own crops.

[58] The missionaries' departure immediately weakened their influence on the promontory.

[59] Stevenson also demanded that both the Livingstonia and the London Missionary Society establish stations near the south and north end of the road, respectively.

impose discipline on the settlers as well as to counter a rash of crimes (e.g., thefts) occurring in the vicinity of the settlement. Similarly, the mission was frequently required by indigenous headmen to involve itself in native disputes as an authoritative third party. At Bandawe, however, the missionaries attempted to reject any involvement in local politics.[6061]

Despite the landmark nature of the move to Bandawe, however, both the missionaries and the Foreign Missions Committee of the Free Church at home regarded the location as a provisional outstation until another better site was found.[62] Several issues accounted for the lack of enthusiasm among them. First, the low-lying site on the lake shore seemed malaria-prone due to its proximity to swamps and marshes. In addition, its susceptibility to attacks and lack of protection from waves made the site inadequate for a mission steamship harbor. While the missionary activities at Bandawe experienced unparalleled achievement in East or Central Africa in this period, in 1894, the mission eventually decided to relocate the central station to Khondowe, further north, which later developed into a small town now known as Livingstonia. The new site lay on the highlands between Lake Malawi and Nyika Plateau and was not prone to malarial mosquitoes.

Under the directorship of a Scottish missionary, Robert Laws (1851-1934), at Livingstonia (Khondowe), the mission contributed much to providing educational facilities and services at both the primary and post-primary levels. In particular, the Overtoun Institution was founded at the new site, a training center for post-primary education, which supplied a great amount of skilled labor (e.g., clerks, typists, telegraphists, mechanics) not only to the European-controlled economy of the Northern Province, but also to other parts of South and Central Africa (e.g., Tanganyika, Northern Rhodesia).[6364] The educational expansion was followed by the widespread adoption of evangelical Christianity, and a significant improvement in evangelical strategies (e.g., using mission-educated natives as evangelists) enabled Christianity to spread as a genuinely popular movement

[60]This policy change may partly be attributed to the Blantyre Mission that the Church of Scotland set up in 1876. At the central station, Blantyre, the missionaries often imposed harsh punishments (e.g., flogging, lashing) on the settlers in the name of civil jurisdiction, which received wide publicity in the British press. To avoid the intervention of the British government and risk of being exposed to the torch of publicity, the Livingstonia Mission decided to abstain from involving itself in civil administration and discard much of its colonial apparatus. On the other hand, the Blantyre Mission still retained powers of jurisdiction.

[61]In 1911, the Livingstonia and Blantyre Synods agreed to join together to form the Church of Central Africa, Presbyterian (CCAP).

[62]The representatives of the Foreign Missions Committee and the Glasgow Livingstonia Committee formed a joint sub-committee of the Livingstonia Mission. While this sub-committee was nominally subordinate to the Foreign Missions Committee, in reality, it dealt with everything related to the Livingstonia's affairs. The activities were primarily managed by the aforementioned Glasgow businessmen, and James Stevenson was one of the committee members who had the power of vetoing issues.

[63]In the absence of significant commercial opportunities in the Northern Province, the Livingstonia elites often migrated to seek wage jobs provided in other areas. This played a crucial role in creating the migrant labor system, which was a central feature of Malawi's colonial economy.

[64]In the field of education, the institution occupied the preeminent position until similar institutes were founded elsewhere, such as the Henry Henderson Institute at Blantyre in 1909 and the Kafue Training Institute in Northern Rhodesia in 1918.

from the mid-1890s. From the long-term venture set about 20 years earlier at Cape Maclear, the mission finally established a solid base for its activities at Livingstonia. While the picture should not be over-simplified, a great movement towards Christianity began in northern Malawi.

A.2 The Spread of Islam among the Yao

The Yao are a major ethnic group primarily settling at the southern end of Lake Malawi. They originally inhabited northern Mozambique, and after an attack launched by the Makua people around 1830, they migrated from their traditional home to present-day Malawi and Tanzania, which shaped their current population distribution (See Figure A.3 for the recent spatial distribution of linguistic groups). The Yao are predominantly Muslim and indeed, Table 2, using the pooled data set of 2000, 2004, and 2010 MDHS, reports that 76% of the interviewed Yao females professed Islamic faith.

Historically, the Yao were under considerable Islamic Influence because of their alliance with the Arabs involved in the caravan trade through which the east coast was linked to markets in the African interior. For example, it was observed that by the middle years of the 18th century, the Yao caravan came to Kilwa, a great Arab port, to trade with the Arabs (Pike (1968), pp. 58-59). The Yao-Arab relationship was that of a senior and a junior business partner, whereby the Arabs learnt of the interior of Africa from the Yao, who in turn traded beads, cloth, guns, and gun-powder for ivory, tobacco, and slaves.

While the Yao had maintained the relationship with the Arab traders at latest since the early 18th century, it was not until the 1870s-1890s that the rapid expansion of Islam among the Yao became apparent (Pike (1968), p. 69; Msiska (1995), p. 52). It was believed that several factors contributed to the mass conversion of the Yao. First, powerful Yao chiefs (e.g., Makanjira, Mponda) adopted Islam to strengthen their economic ties with their Arab trading partners, and using their commercial prowess, to command their subjects' loyalty. The chiefs' conversion was typically followed by that of their subjects. Second, after the arrival of the Christian mission, Islam provided a more acceptable solution to the Yao's cultural requirements than Christianity did for several reasons. First, the Islamic faith did not interfere with Yao traditional customs and social institutions such as polygamy and partial circumcision. Second, in the Yao society, slave labor was a fundamental feature and the chiefs needed slaves not only for selling on an export market but also for domestic physical labor (e.g., farming, building, making baskets, sewing garments). Thus, it was not surprising that Christianity, in attempting to stop the slave trade, lost the battle to

entice the Yao into its religious domain. Another reason for the conversion may be attributed to the Yao's ongoing clashes with the Ngoni people, another powerful group that had migrated from the Natal region of present-day South Africa. Threatened by Ngoni raids on their territories, by adopting Islam, the Yao chiefs attempted to form a tactical alliance with the Arab traders who supplied them with flintlocks and Enfield rifles.[65]

B Appendix: Geographic and Climate Controls

This section describes community-level geographic and climatic controls (as well as the original sources), which are all publicly available in the IHS data set. The variables description refers to "Geovariables.Description.pdf" (`http://microdata.worldbank.org/index.php/catalog/1003`).

B.1 Climatology

The original data on climatology is sourced from "WorldClim - Global Climate Data," University of California, Berkeley.[66]

Mean temperature (Bio_1): average temperature (multiplied by 10 °C) based on monthly climatology between 1960 and 1990.

Mean diurnal range (Bio_2): average diurnal range - mean of monthly maximum minus minimum temperature (multiplied by 10 °C) - based on monthly climatology between 1960 and 1990.

Isothermality (Bio_3): isothermality defined as $\left(\frac{Bio_2}{Bio_5 - Bio_6} \times 100\right)$.

Temperature seasonality (Bio_4): standard deviation of temperature (multiplied by 100) based on monthly climatology between 1960 and 1990.

Maximum temperature of the warmest month (Bio_5): maximum temperature (multiplied by 10 °C) of the warmest month, based on monthly climatology between 1960 and 1990.

Minimum temperature of the coldest month (Bio_6): minimum temperature (multiplied by 10 °C) of the coldest month, based on monthly climatology between 1960 and 1990.

[65] In the literature, many other reasons are also proposed for the spread of Islam in Malawi. For instance, Islam was simply considered fashionable among the Yao in the late 19th century (Pike (1968), p. 69). In addition, people were sometimes eager to become Muslims because they perceived conversion to be a means of earning income (Msiska (1995), p. 61). This is because once they became Muslim teachers, they could typically collect fairly substantial fees from their disciples. Those disciples also had to serve their teachers until they left as full-fledged Muslims. Moreover, the colonial administration also indirectly contributed to the spread of Islam because government officials sometimes preferred Muslims and helped them build mosques, and for the period from 1888 to 1889, the Nyasaland Government banned Christian missionaries from working in Muslim areas, for example (Msiska (1995), pp. 63-64).

[66] Temperature range (Bio_7) defined as $Bio_5 - Bio_6$ was not used in the estimations to avoid perfect multicollinearity between regressors.

Mean temperature of the wettest quarter (Bio_8): average temperature of the wettest quarter (multiplied by 10 °C), based on monthly climatology between 1960 and 1990.

Mean temperature of the driest quarter (Bio_9): average temperature of the driest quarter (multiplied by 10 °C), based on monthly climatology between 1960 and 1990.

Mean temperature of the warmest quarter (Bio_{10}): average temperature of the warmest quarter (multiplied by 10 °C), based on monthly climatology between 1960 and 1990.

Mean temperature of the coldest quarter (Bio_{11}): average temperature of the coldest quarter (multiplied by 10 °C) based on monthly climatology between 1960 and 1990.

Mean precipitation (Bio_{12}): average annual precipitation (mm) based on monthly climatology between 1960 and 1990.

Mean precipitation of the wettest month (Bio_{13}): average precipitation (mm) of the wettest month based on monthly climatology between 1960 and 1990.

Mean precipitation of the driest month (Bio_{14}): average precipitation (mm) of the driest month based on monthly climatology between 1960 and 1990.

Precipitation seasonality (Bio_{15}): coefficient of variation of annual precipitation (mm) based on monthly climatology between 1960 and 1990.

Mean precipitation of the wettest quarter (Bio_{16}): average precipitation (mm) of the wettest quarter, based on monthly climatology between 1960 and 1990.

B.2 Landscape Typology

Agricultural land: percentage under agriculture within approximately 1 km buffer in 2009 based on "GlobCover Version 2.3," sourced from the European Space Agency (ESA) and Université Catholique de Louvain.

Agro-ecological zones: categorical variables for agro-ecological zones in 2009, sourced from HarvestChoice and International Food Policy Research Institute (IFPRI), i.e., (a) tropic-warm/semiarid (reference group); (b) tropic-warm/subhumid; (c) tropic-cool/semiarid; and (d) tropic-cool/subhumid.

B.3 Soil and Terrain

Elevation: elevation (m) based on the Shuttle Radar Topography Mission (SRTM) 90m data sourced from the National Aeronautics and Space Administration (NASA).

Slope: slope (percent) based on the SRTM 90m data sourced from the U.S Geological Survey (USGS).

Topographic wetness index: potential wetness index based on the modified SRTM 90m data sourced from the Africa Soil Information Service (AfSIS). This index is calculated as $\ln\left(\frac{A}{\tan b}\right)$, where A is flow accumulation or effective drainage areas and b is slope gradient.

Terrain roughness: categorical variables for terrain roughness based on the SRTM 90m data sourced from the Living Standards Measurement Study-Integrated Surveys on Agriculture (LSMS-ISA), i.e., (a) plains (reference group); (b) mid-altitude plains; (c) high-altitude plains; (d) low-lands; (e) rugged lowlands; (f) platform (very low plateaus); (g) low plateaus; (h) mid-altitude plateaus; (i) hills; (j) low mountains; and (k) mid-altitude mountains.

Nutrient availability: categorical variables for nutrient availability based on "Harmonized World Soil Database" sourced from the Food and Agriculture Organization of the United Nations (FAO), i.e., (a) no, slight, or moderate constraint (reference group); (b) severe or very severe constraint; (c) mainly non-soil; and (d) water.

Nutrient retention capacity: categorical variables for nutrient retention capacity based on the "Harmonized World Soil Database" sourced from the Food and Agriculture Organization of the United Nations (FAO), i.e., (a) no, slight or moderate constraint (reference group); (b) severe or very severe constraint; and (c) water.

Rooting conditions: categorical variables for rooting conditions based on the "Harmonized World Soil Database" sourced from the Food and Agriculture Organization of the United Nations (FAO), i.e., (a) no, slight or moderate constraint (reference group); (b) severe or very severe constraint; (c) mainly non-soil; and (d) water.

Oxygen availability to roots: categorical variables for oxygen availability to roots based on the "Harmonized World Soil Database" sourced from the Food and Agriculture Organization of the United Nations (FAO), i.e., (a) no, slight or moderate constraint (reference group); (b) severe or very severe constraint; and (c) water.

Excess salts: categorical variables for excess salts based on the "Harmonized World Soil Database" sourced from the Food and Agriculture Organization of the United Nations (FAO), i.e., (a) no, slight or moderate constraint (reference group); (b) severe or very severe constraint; and (c) water.

Toxicity: categorical variables for toxicity based on the "Harmonized World Soil Database" sourced from the Food and Agriculture Organization of the United Nations (FAO), i.e., (a) no, slight or moderate constraint (reference group); (b) severe or very severe constraint; and (c) water.

Field-management constraint: categorical variables for field-management constraint based on the "Harmonized World Soil Database" sourced from the Food and Agriculture Organization of the United Nations (FAO), i.e., (a) no, slight or moderate constraint (reference group); (b) severe

or very severe constraint; (c) mainly non-soil; and (d) water.

B.4 Crop Season Parameters

Greenness changes: mean total change in greenness (averaged by district), the integral of the daily Enhanced Vegetation Index (EVI) values within a primary growing season between 2001 and 2010, sourced from "Land Cover Dynamics - MODIS," Boston University.

Mean onset timing of greenness increase: mean onset timing of greenness increase (averaged by district) within 12 months from July to June between 2001 and 2010, sourced from "Land Cover Dynamics - MODIS," Boston University. The timing is measured by days from 1 to 356, where the 1st July is normalized to one.

Mean onset timing of greenness decrease: mean onset timing of greenness decrease (averaged by district) within 12 months from July to June between 2001 and 2010, sourced from "Land Cover Dynamics - MODIS," Boston University. The timing is measured by days ranging from 1 to 356, where the 1st July is normalized to one.

C Appendix: Merging the IHS Community-level Information with the MDHS Data

C.1 Community-level Positions

The MDHS collected coordinates of the groupings of households known as clusters (communities). To maintain the confidentiality of the surveyed respondents, the GPS latitude/longitude position was publicized after displacing the coordinates by applying a random offset within a specified range to the position. After this adjustment was made, urban clusters contained 0-2 kilometers of positional error. On the other hand, rural clusters contained 0-5 kilometers of error with a further 1% of them displaced 0-10 kilometers. Nevertheless, this displacement still made the surveyed clusters fall within an original surveyed area of the country's second administrative level (district). For the details, see `http://www.measuredhs.com/What-We-Do/GPS-Data-Collection.cfm`.

In the IHS, GPS-based household location was collected. To enforce respondent confidentiality, this information was disseminated as a community-level value after manipulating those household-level GPS coordinates. This manipulation included computing the average of household-level coordinates in a community (enumeration area) at first and then following the MDHS methodology,

applying a random offset to the average coordinate value. For urban areas, a range of 0-2 kilometers was applied as the random offset, in contrast to a range of 0-5 kilometers offset used in rural areas. An additional 0-10 kilometers offset was also exploited for 1% of the rural clusters effectively to raise the publicly known range of positional displacement (for all rural points) to the level of 10 kilometers with minimal noise. Similar to the case in the MDHS, this displacement was made, keeping a community's representative location in its original district. For the details, see "*Third Integrated Household Survey* (*IHS*3) 2010-2011 *Basic Information Document*, *March* 2012" (`http://siteresources.worldbank.org/INTLSMS/Resources/3358986-1233781970982/5800988-1271185595871/IHS3.BID.FINAL.pdf`).

C.2 Finding the Nearest IHS Community

By using the community-level GPS coordinates provided by both the MDHS and IHS, this study selected, from 768 communities surveyed in the IHS, the geographically nearest one to each community surveyed in the MDHS, which contained more than 1900 communities over all three surveys from 2000, 2004, and 2010.

When calculating the distance between the MDHS and IHS communities, this study used the great-circle distance (GCD), the shortest distance between any two points on the surface of a sphere measured along a path on the surface of the sphere (as opposed to going through the sphere's interior). More specifically, in this paper, the GCD between two points i and j was computed as:

$$\text{Radius (6378.7 km)} \times \arccos\left[\sin\left(\frac{\text{latitude}_i}{57.2958}\right) \times \sin\left(\frac{\text{latitude}_j}{57.2958}\right) + \cos\left(\frac{\text{latitude}_i}{57.2958}\right) \times \cos\left(\frac{\text{latitude}_j}{57.2958}\right) \times \cos\left(\frac{\text{longitude}_j}{57.2958} - \frac{\text{longitude}_i}{57.2958}\right)\right]. \quad \text{(C.1)}$$

Because both the MDHS and IHS communities were spatially spread over the country (see Figure A.1, whereby the sample communities in both the surveys are dotted. For ease of visual identification, only the 2010 MDHS communities were compared to the IHS ones in the figure), it was not difficult to identify an IHS community in the closest proximity (with relatively short distance) to all the MDHS communities. As a matter of fact, approximately 95% (99%) of the MDHS communities corresponded with the nearest IHS community situated less than 10 (15) kilometers away, with the MDHS community having a maximum distance of approximately 67 kilometers to the nearest IHS community.

C.3 Goodness of Fit of the IHS Data to the MDHS Data

To observe the goodness of fit of the characteristics of the nearest IHS communities to the MDHS data, three informal checks were performed. In column (a) in Table A.1, first, this study regressed an indicator, equal to one if the MDHS sample females were Christian and zero otherwise, on a dummy variable, which takes one if Christianity was the most common religion practiced in the nearest IHS communities. If the community-level characteristics of the IHS data fit well to the MDHS data, a significantly positive relationship is likely to arise, which is indeed observed. Similar exercises associated with Islam and other or no religion were also conducted in columns (b) and (c) in the table, providing further support for the fitness.

With an emphasis placed on ethnicity, the second exercise exploited a similar idea to the first check. For example, in column (d) in Table A.1, a dummy taking the value of one if the MDHS sample females were identified as from the Chewa ethnic group was related to an indicator variable, equal to one if the most common language spoken at home in the nearest IHS communities was Chewa and zero otherwise. Again, given the good fit of the IHS community characteristics to the MHDS data, it is quite likely that these two variables have a significantly positive association, which was indeed confirmed in the result presented in that column. The analysis in the remaining columns in the table reports the estimation results implemented for the other ethnic groups. As a whole, it appears that the results provided good support for the goodness of fit between the two data sets.

Finally, in columns (f) to (j) in Table A.2, an indicator, which takes one if the MDHS sample females in wedded relationship were not born in their current residential location and zero otherwise, was regressed on a dummy variable, equal to one if the nearest IHS communities traced their descent through their mothers and zero otherwise. This exercise was made to check if married females were less likely to be migrants to the present residential location if the nearest IHS communities traditionally adopted a matrilineal descent system. This is because the default norm of the marriage-related relocation associated with the matriliny is matrilocal, i.e., females stay in their natal villages, to which their husbands relocate, in contrast to patrilocality (females leaving their natal homes and marrying into their husband's villages) associated with a patrilineal descent system. As the norm may not be strictly enforced in urban areas, the analysis examined the interaction of the dummy for the nearest IHS communities characterized by the matrilineal descent rule with the distance (km) to the nearest town having population over 20000. In the analysis, the distance took a categorical form in which communities were separated into six groups in column

(f), five in (g), four in (h), three in (i), and two in (j). In all these columns, the reference group consists of communities situated the farthest from the nearest population center.

As expected, the results show that compared to their counterparts in patrilineal communities, married females residing in matrilineal communities were less likely to be migrants to their current residential location. In addition, within matrilineal communities, married females were more likely to stay in their natal homes if their current residences were situated at greater distances from the nearest population center. The analysis in columns (k) to (o) limits its attention to data pertaining to females living in the MDHS communities located less than 10 kilometers from the nearest IHS communities. The estimation results also revealed a similar pattern to those obtained from the analysis using the full sample. Consequently, the relationship between the migrant probability and matriliny may further support the goodness of fit of the community-level characteristics of the nearest IHS communities to the individual characteristics of the MDHS females.

Using only the IHS data (i.e., female observations of the IHS) and a similar set of controls and specifications to those exploited in columns (f) to (o) in Table A.2, moreover, the migrant probability was again related to a matrilineal descent rule in columns (a) to (e) in that table. The estimation results about the relationship between the migrant probability and matriliny revealed a remarkably similar pattern to those obtained from the analysis in columns (f) to (o) that used the MDHS data corresponded with the IHS. This finding may also prompt this study to use the MDHS data appended with characteristics of the nearest IHS communities in an empirical analysis.

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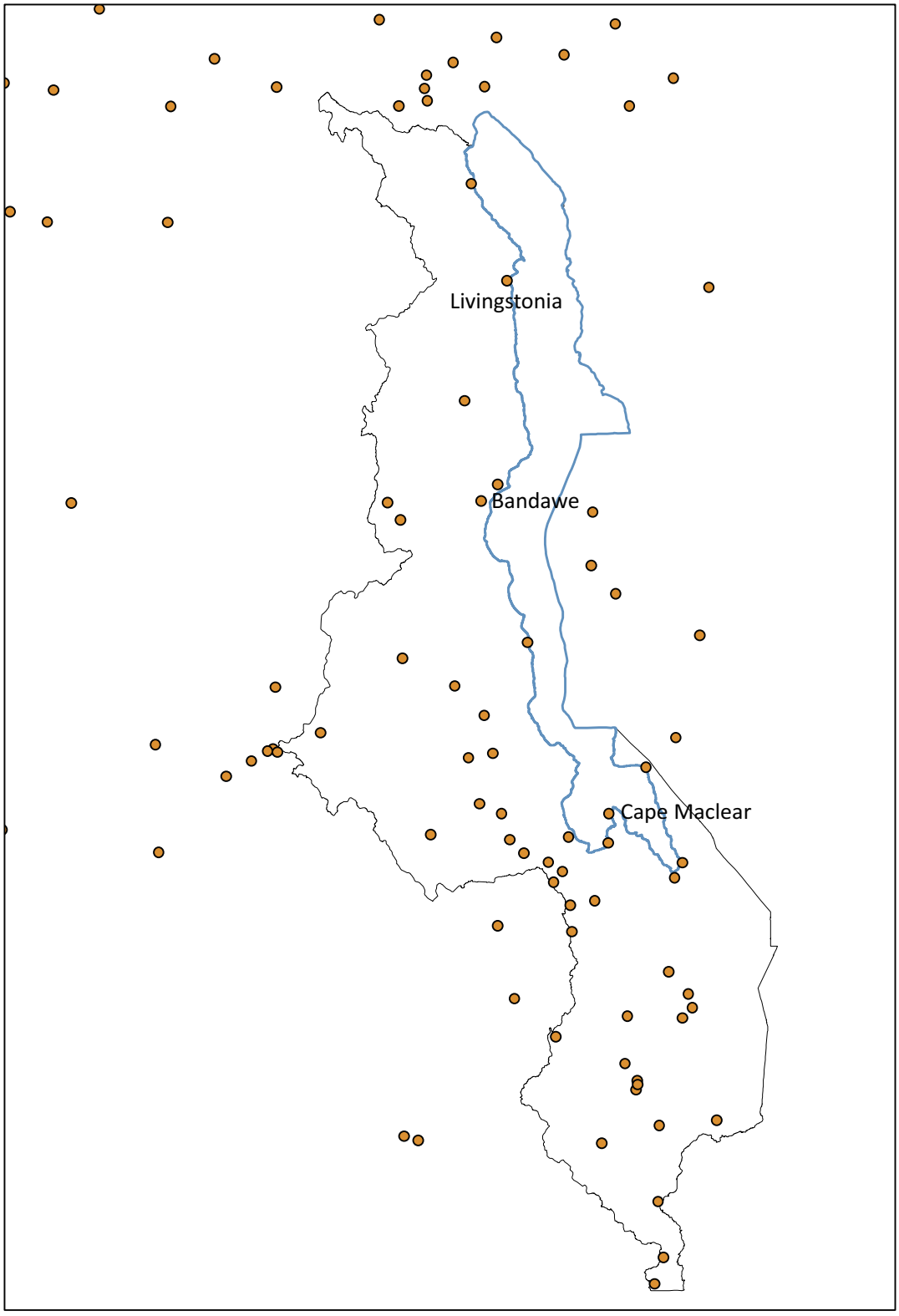

Figure 1: Early Mission Stations

Notes: (1) The location of the early mission stations was sourced from Nunn (2010). (2) The map of Malawi is sourced from DIVA-GIS (`http://www.diva-gis.org/datadown`). (3) In the above figure, Bandawe, Cape Maclear, and Livingstonia refer to 'Kasangazi', 'Mkope Hill', and 'Hondowe' named in Nunn (2010).

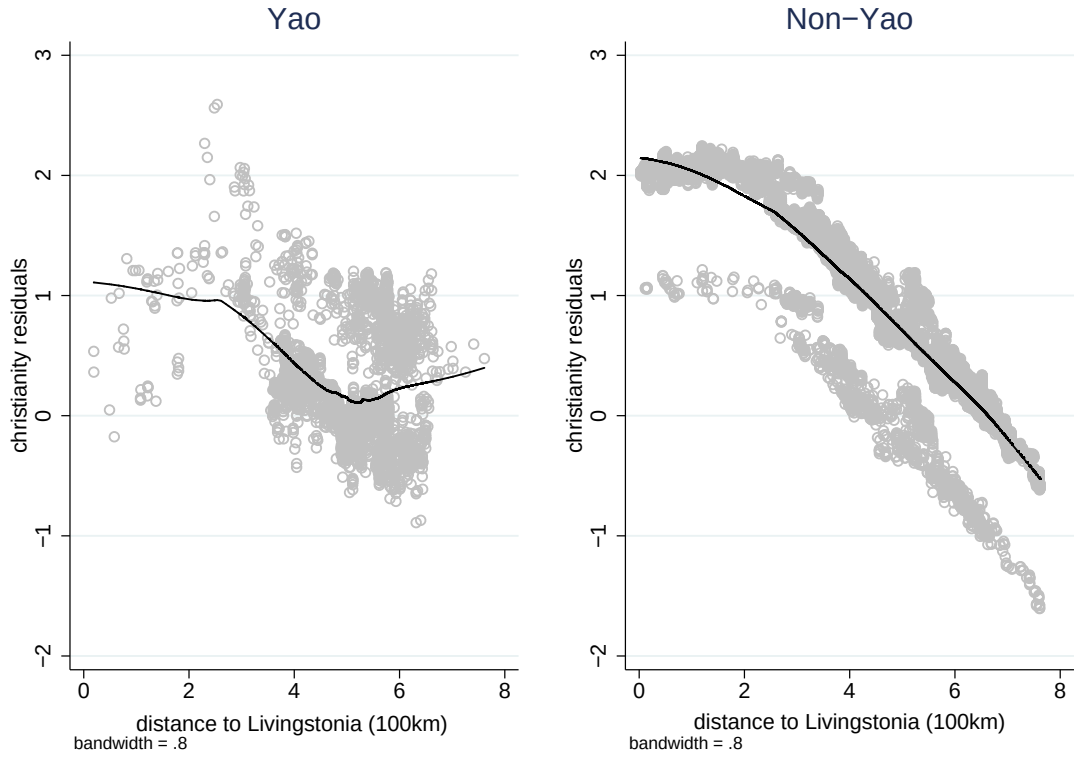

Figure 2: Semiparametric Regression Curve (Lowess): Christianity and Distance to Livingstonia

Notes :(1) This figure is based on Yatchew (1997, 1998)'s differenced-based semiparametric estimations of a partial lineal model. (2) Christianity residuals are c_{ij} minus the estimated parametric part. (3) Regressors in the parametric part contain age; age squared; education; education squared; birth order; no. of alive siblings at age 15; no. of elder late siblings at age 15; no. of young late siblings at age 15; a first-marriage dummy; no. of the early mission stations situated within 25 km radius from each community; a community's distance to the origin of the HIV virus in the Democratic Republic of the Congo; an urban indicator, a dummy for matrilineal communities; an indicator for a community's most common religion being Christianity; the number of churches and mosques in a community; the number of primary and secondary schools run by religious organizations in a community; an indicator for a community's nearest doctor being at religious facility; geographic coordinates; geographic and climate controls; and ethnicity-level historical controls. (4) The geographic and climate controls contain community-level information on climatology, landscape typology, soil & terrain, and crop season parameters. See Appendix B for the details. (5) The ethnicity-level historical controls include (i) a dummy variable, equal to one if a European explorer traveled through land historically inhabited by an ethnic group; (ii) a dummy variable, equal to one if any part of railway lines in the first decade of the 20th century drawn from Century Company (1911) passed through land historically inhabited by an ethnic group; and (iii) the total number of slaves taken from an ethnic group that was normalized by the area of land inhabited by the ethnic group during the 19th century (log of one plus the normalized slave export measure).

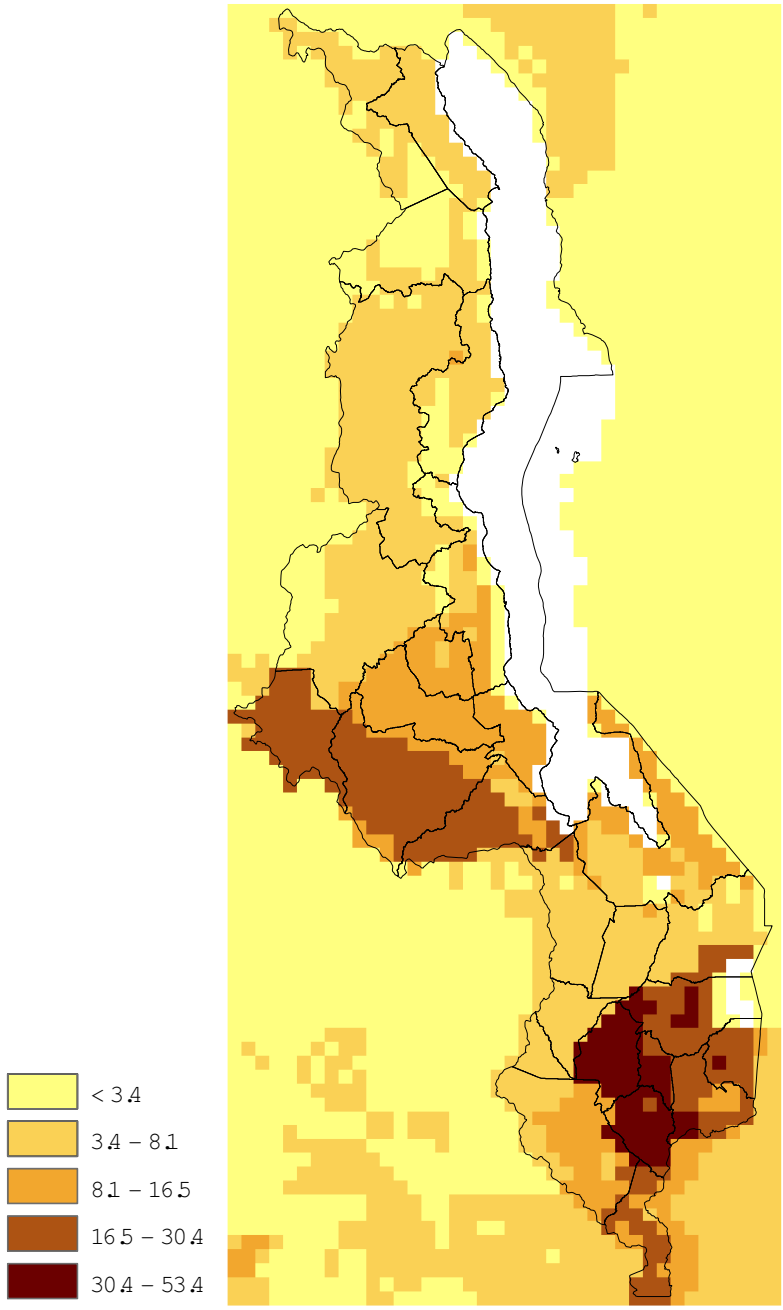

Figure 3: Historical Population Density in 1900 (inhabitants/km^2)

Notes: (1) The data on population density is sourced from History Database of the Global Environment (HYDE) version 3.1. (2) The map of Malawi is sourced from DIVA-GIS (`http://www.diva-gis.org/datadown`).

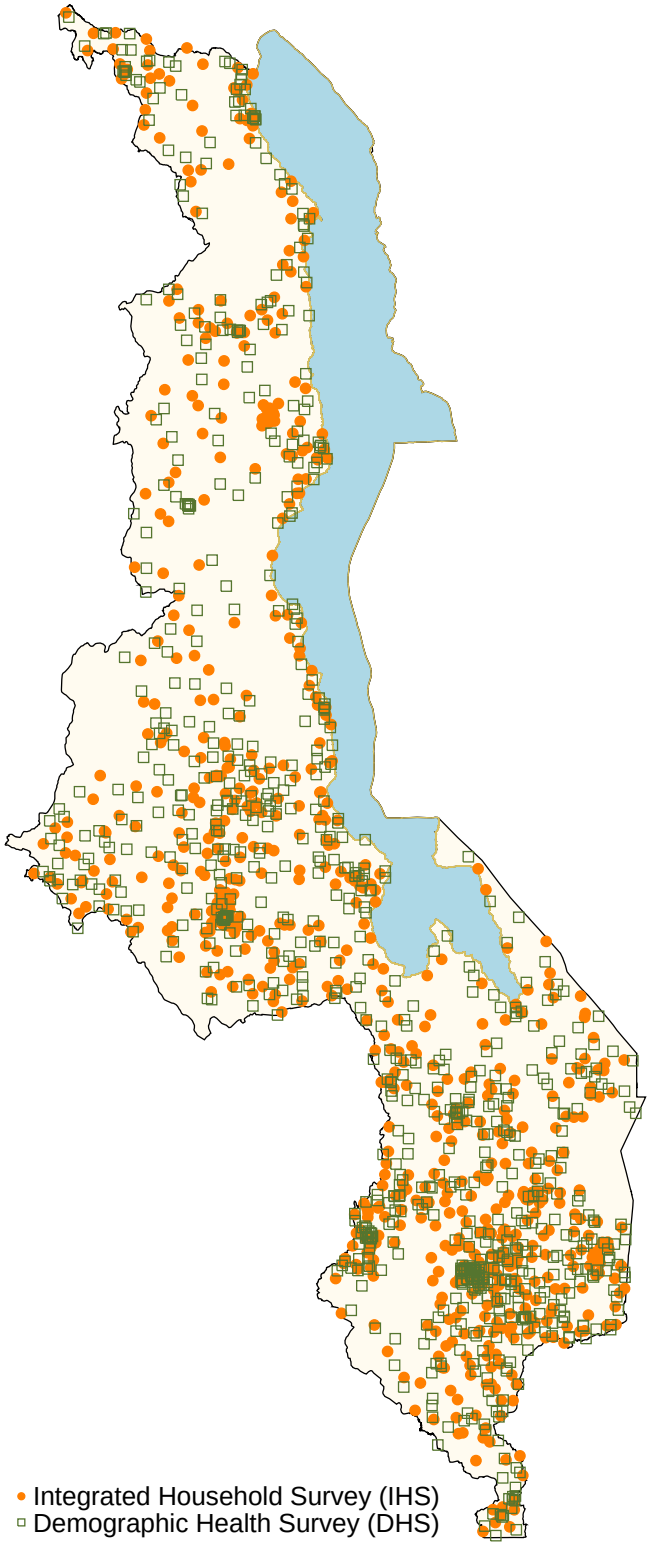

Figure A.1: Spatial Distribution of Sampled Communities: MDHS 2010 and IHS 2010-2011

Note: The background map is sourced from DIVA-GIS (`http://www.diva-gis.org/datadown`).

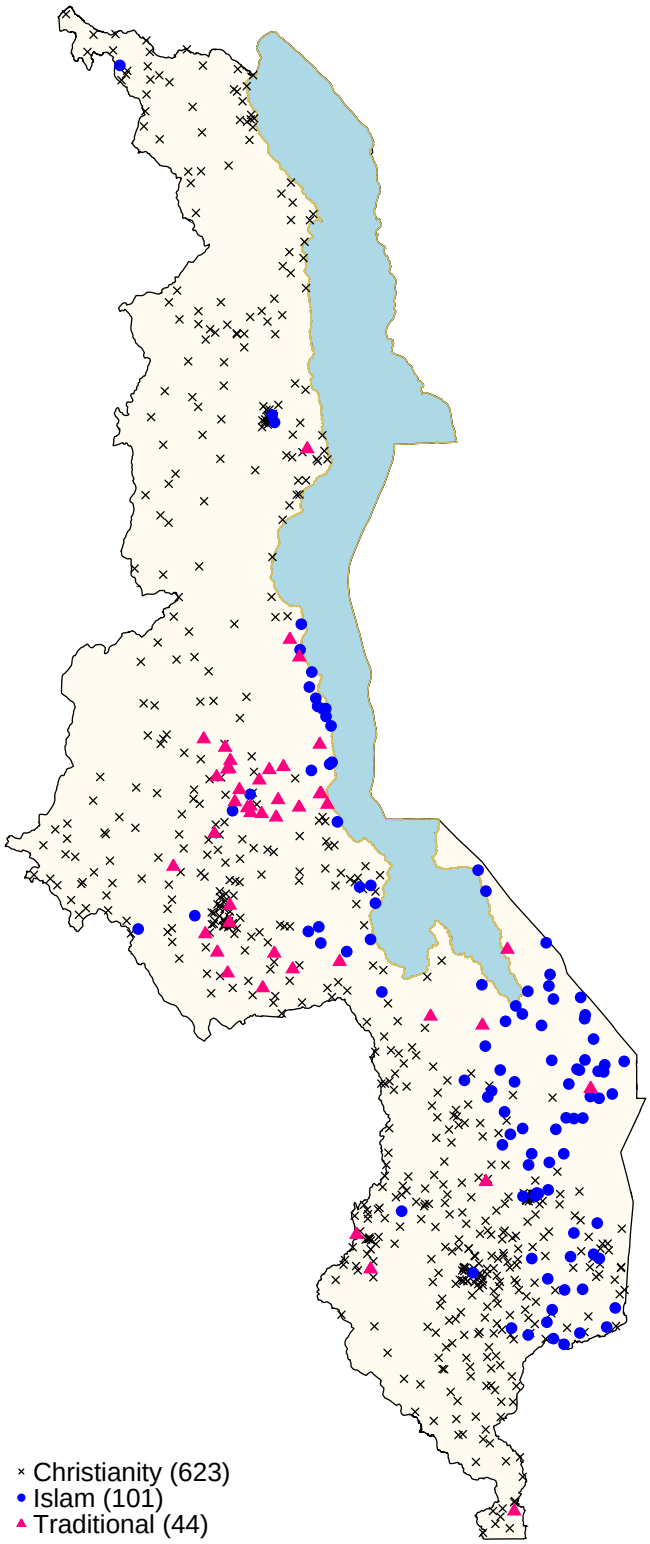

Figure A.2: Spatial Distribution of the Most Common Religion Practiced in a Community (IHS)

Notes: (1) Figure in ( ) is the number of communities. (2) The background map is sourced from DIVA-GIS (`http://www.diva-gis.org/datadown`).

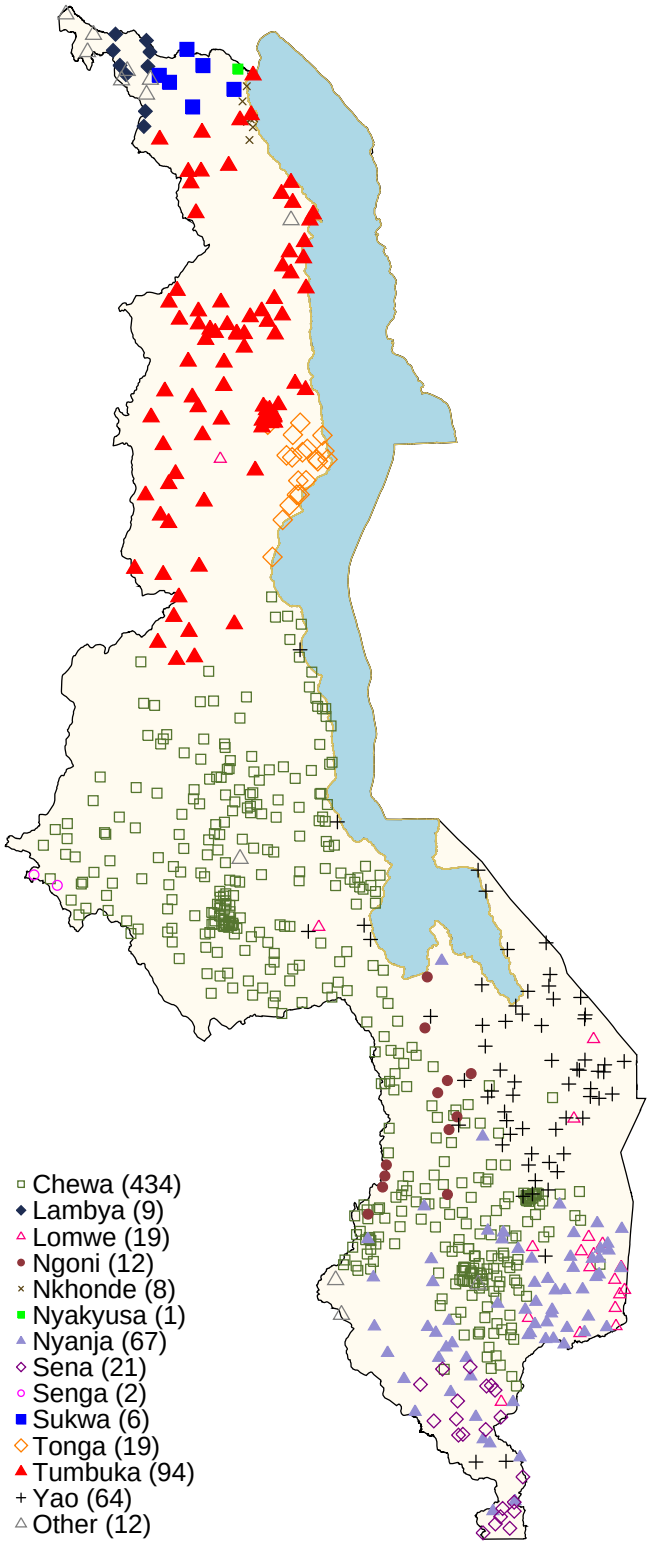

Figure A.3: Spatial Distribution of the Most Common Language Spoken at Home in a Community (IHS)

Notes: (1) Figure in ( ) is the number of communities. (2) The background map is sourced from DIVA-GIS (`http://www.diva-gis.org/datadown`).

Table 1: Proportion of Polygyny

	DHS year	Catholic	Other Christian	All Christian	Islam	Other or no religion	Total
Benin	2006	0.32	0.39	0.35	0.49	0.52	0.43
Burkina Faso	2010	0.29	0.29	0.29	0.46	0.55	0.42
Burundi	2010	0.05	0.06	0.05	0.18	0.13	0.06
Cameroon	2011	0.16	0.18	0.17	0.42	0.41	0.24
Central African Republic	1994-95	0.30	0.26	0.28	0.38	0.24	0.29
Chad	2004	0.39	0.30	0.35	0.40	0.45	0.39
Congo (Brazzaville)	2011-12	0.14	0.15	0.15	0.26	0.19	0.15
Congo Democratic Republic	2007	0.20	0.20	0.20	0.41	0.21	0.20
Côte d′Ivoire	2011-12	0.21	0.17	0.19	0.38	0.37	0.31
Ethiopia	2011	0.29	0.08	0.09	0.18	0.32	0.13
Gabon	2012	0.15	0.11	0.13	0.22	0.13	0.13
Ghana	2008	0.17	0.13	0.14	0.34	0.39	0.21
Guinea	2005	-	-	0.35	0.54	0.41	0.52
Kenya	2008-09	0.13	0.13	0.13	0.25	0.28	0.16
Liberia	2007	-	-	0.15	0.29	0.24	0.17
Madagascar	2008-09	0.03	0.03	0.03	0.04	0.05	0.04
Malawi	2010	0.11	0.15	0.14	0.23	0.28	0.15
Mali	2006	-	-	0.23	0.38	0.45	0.38
Mozambique	2011	0.14	0.21	0.18	0.20	0.27	0.20
Namibia	2006-07	0.06	0.06	0.06	NA	0.08	0.06
Niger	2006	-	-	0.35	0.35	0.35	0.35
Nigeria	2008	0.21	0.20	0.20	0.44	0.45	0.34
Rwanda	2010	0.06	0.09	0.08	0.18	0.14	0.08
Sao Tome and Principe	2008-09	0.25	0.15	0.23	0.00	0.23	0.23
Senegal	2005	-	-	0.20	0.40	0.25	0.39
Sierra Leone	2008	-	-	0.21	0.37	0.42	0.34
Swaziland	2006-07	0.09	0.19	0.18	0.25	0.16	0.18
Togo	1998	0.33	0.37	0.34	0.53	0.49	0.44
Uganda	2011	0.29	0.22	0.25	0.36	0.28	0.27
Zambia	2007	0.13	0.14	0.14	0.18	0.38	0.14
Zimbabwe	2010-11	0.08	0.11	0.11	0.16	0.15	0.11

Note: The number is the proportion of females in polygyny relative to the total number of married females in each religious denomination.

Table 2: Religious Identity in Malawi

	Total	Yao	Non-Yao
(1) Christianity			
Anglican	0.02	0.01	0.02
Catholic	0.21	0.05	0.23
Seventh Day Advent/Baptist	0.06	0.01	0.07
The Church of Central Africa, Presbyterian (CCAP)	0.17	0.04	0.18
Other Christian	0.37	0.09	0.42
(2) Islam	0.13	0.76	0.03
(3) Other or no religion	0.01	0.00	0.01
No. of respondents	47920	6171	41749

Note: The number is the proportion relative to the total number of respondents in each category. This is the unweighted proportion. In order to calculate the true proportion of the entire population from the sample data, appropriate sample weights need to be used.

Table 3: Descriptive Statistics of Married Females

	Christian			Non-Christian		
	Mean	Std.	No. of obs	Mean	Std.	No. of obs
(A) Individual controls						
Polygyny (dummy)	0.14***	(0.35)	28203	0.23	(0.42)	4976
Rank among the partner's wives	1.06***	(0.29)	26992	1.10	(0.43)	4611
Age (years)	29.74	(8.45)	28203	29.80	(8.65)	4976
Education (years)	4.62***	(3.59)	28202	2.92	(3.26)	4976
Yao (dummy)	0.03***	(0.18)	28194	0.68	(0.46)	4974
Birth order	3.66***	(2.40)	28121	3.51	(2.39)	4964
No. of alive siblings at age 15	4.47***	(2.17)	28121	4.17	(2.16)	4964
No. of older late siblings at age 15	0.61*	(1.27)	28121	0.65	(1.38)	4964
No. of younger late siblings at age 15	0.40	(0.83)	28121	0.40	(0.87)	4964
First marriage (dummy)	0.78***	(0.41)	29203	0.67	(0.46)	4976
(B) Selected community-level controls						
Distance to Livingstonia (100 km)	4.29***	(1.97)	27884	4.80	(1.02)	4935
No. of mission stations within 25 km radius	1.10	(1.20)	27884	1.09	(1.22)	4935
Distance to the origin of HIV virus (100 km)	14.75***	(1.69)	27884	15.50	(0.97)	4935
Urban (dummy)	0.14	(0.35)	28203	0.14	(0.34)	4976
Descent rule						
Patrilineal descent (dummy)	0.35***	(0.47)	27884	0.15	(0.35)	4935
Matrilineal descent (dummy)	0.56***	(0.49)	27884	0.77	(0.41)	4935
Dual descent (dummy)	0.08***	(0.27)	27884	0.06	(0.25)	4935
The most common religion = Christianity (dummy)	0.86***	(0.34)	27884	0.42	(0.49)	4935
No. of churches in a community	7.66***	(5.71)	27884	5.65	(5.02)	4935
No. of mosques in a community	0.79***	(1.73)	27884	4.40	(5.30)	4935
(C) Selected geographic and climate controls						
Latitude	34.43***	(0.76)	27884	35.01	(0.58)	4935
Longitude	-14.06***	(1.89)	27884	-14.54	(0.90)	4935
Annual mean temperature (Bio_1) ($\times$ 10 °C), 1960-1990	217.87***	(19.82)	27884	226.82	(16.08)	4935
Std. of temperature (Bio_4) ($\times$100), 1960-1990	2349.12***	(256.35)	27884	2287.29	(177.82)	4935
Mean precipitation (Bio_{12}) (mm), 1960-1990	1104.10***	(271.53)	27884	1062.84	(170.60)	4935
Coef. of Var. of precipitation (Bio_{15}), 1960-1990	102.89***	(13.38)	27884	109.09	(9.42)	4935
Elevation (m)	860.50***	(353.77)	27884	717.14	(250.47)	4935
Slople (percent)	5.03***	(4.38)	27884	3.96	(4.02)	4935
(D) Ethnicity-level historical controls						
European explorers (dummy)	0.78***	(0.40)	26463	0.93	(0.24)	4893
Railway networks (dummy)	0.06***	(0.25)	26463	0.01	(0.12)	4893
Slave exports normalized by land area	0.53***	(1.05)	26463	1.42	(0.88)	4893

Note: The equality of means between Christian and non-Christian females are examined by T-tests. *** denotes significance at 1%, ** at 5%, and * at 10%.

Table 4: Impacts of Christianity on Polygyny

Dependent variable:	One if polygyny													
	OLS				2SLS									
	(a)	(b)	(c)	(d)	(e)	(f)	(g)	(h)	(i)	(j)	(k)	(l)	(m)	(n)
One if Christian	-0.085***	-0.087***	-0.086***	-0.077***	-0.232***	-0.264***	-0.301***	-0.234***	-0.267***	-0.299***	-0.231***	-0.263***	-0.302***	-0.247**
	(0.008)	(0.008)	(0.008)	(0.009)	(0.087)	(0.089)	(0.089)	(0.088)	(0.090)	(0.089)	(0.088)	(0.089)	(0.090)	(0.103)
Distance to Livingstonia (100 km)	-	-	-	-	-	-	-	-0.005	-0.007	0.005	-	-	-	-
								(0.033)	(0.038)	(0.032)				
Non-Yao (dummy)	-0.005	0.002	-	-0.008	0.077	0.095**	-	0.078*	0.097**	-	0.077	0.095**	-	0.068
	(0.008)	(0.010)		(0.011)	(0.047)	(0.046)		(0.048)	(0.046)		(0.048)	(0.046)		(0.048)
Age (years)	0.022***	0.023***	0.022***	0.024***	0.022***	0.023***	0.023***	0.022***	0.023***	0.023***	0.022***	0.023***	0.023***	0.024***
	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)
Age squared	-0.000***	-0.000***	-0.000***	-0.000***	-0.000***	-0.000***	-0.000***	-0.000***	-0.000***	-0.000***	-0.000***	-0.000***	-0.000***	-0.000***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Education (years)	0.001	0.001	0.001	0.002	0.002	0.002	0.002	0.002	0.002	0.002	0.002	0.002	0.002	0.003
	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)
Education squared	-0.000***	-0.000***	-0.000***	-0.000**	-0.000***	-0.000***	-0.000***	-0.000***	-0.000***	-0.000***	-0.000***	-0.000***	-0.000***	-0.000**
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Birth order	0.001	0.001	0.001	0.002	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.002
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
No. of alive siblings	-0.002	-0.001	-0.001	-0.002	-0.001	-0.001	-0.001	-0.001	-0.001	-0.001	-0.001	-0.001	-0.001	-0.001
at age 15	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
No. of elder late siblings	-0.002	-0.003	-0.002	-0.004*	-0.002	-0.003	-0.002	-0.002	-0.003	-0.002	-0.002	-0.003	-0.002	-0.004**
at age 15	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)
No. of young late siblings	-0.003	-0.004*	-0.004	-0.005*	-0.004	-0.004*	-0.004	-0.004	-0.004*	-0.004	-0.004	-0.004*	-0.004	-0.005**
at age 15	(0.002)	(0.002)	(0.002)	(0.003)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)
First marriage	-0.144***	-0.144***	-0.144***	-0.143***	-0.141***	-0.141***	-0.140***	-0.141***	-0.141***	-0.140***	-0.141***	-0.141***	-0.140***	-0.142***
(dummy)	(0.006)	(0.006)	(0.006)	(0.006)	(0.006)	(0.006)	(0.006)	(0.006)	(0.006)	(0.006)	(0.006)	(0.006)	(0.006)	(0.005)
No. of mission stations	-0.010***	-0.010***	-0.010***	-	-0.010***	-0.010***	-0.010***	-0.010***	-0.010***	-0.010***	-0.010***	-0.010***	-0.010***	-
within 25 km radius	(0.003)	(0.003)	(0.003)		(0.003)	(0.003)	(0.003)	(0.003)	(0.003)	(0.003)	(0.003)	(0.003)	(0.003)	
Distance to the origin of the	0.140	0.161	0.195	-	0.148	0.167	0.221	0.157	0.180	0.211	0.148	0.167	0.221	-
HIV virus (100 km)	(0.176)	(0.189)	(0.177)		(0.176)	(0.189)	(0.178)	(0.187)	(0.200)	(0.187)	(0.176)	(0.189)	(0.178)	
Urban (dummy)	-0.048***	-0.046***	-0.047***	-	-0.050***	-0.048***	-0.050***	-0.050***	-0.048***	-0.050***	-0.050***	-0.048***	-0.050***	-
	(0.008)	(0.009)	(0.008)		(0.008)	(0.009)	(0.009)	(0.008)	(0.009)	(0.009)	(0.008)	(0.009)	(0.009)	
Matrilineal communities	0.011	0.010	0.011	-	0.011	0.010	0.011	0.011	0.010	0.011	0.011	0.010	0.011	-
(dummy)	(0.007)	(0.008)	(0.007)		(0.008)	(0.008)	(0.008)	(0.008)	(0.008)	(0.008)	(0.008)	(0.008)	(0.008)	
A community's most common	-0.007	-0.007	-0.007	-	-0.000	0.001	0.002	-0.000	0.001	0.002	-0.001	0.001	0.002	-
religion = Christianity (dummy)	(0.009)	(0.009)	(0.009)		(0.009)	(0.010)	(0.010)	(0.009)	(0.010)	(0.010)	(0.010)	(0.010)	(0.010)	
No. of churches in a community	0.000	0.000	0.000	-	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	-
	(0.000)	(0.000)	(0.000)		(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	
No. of mosques in a community	0.001	0.001	0.001	-	0.000	0.000	-0.000	0.000	0.000	-0.000	0.000	0.000	-0.000	-
	(0.001)	(0.001)	(0.001)		(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	
No. of primary schools run by	0.002	0.002	0.002	-	0.002	0.002	0.002	0.002	0.002	0.002	0.002	0.002	0.002	-
religious organizations	(0.002)	(0.002)	(0.002)		(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	
No. of secondary schools run by	-0.008	-0.009	-0.008	-	-0.008	-0.009	-0.008	-0.008	-0.009	-0.008	-0.008	-0.009	-0.008	-
religious organizations	(0.006)	(0.006)	(0.006)		(0.006)	(0.006)	(0.006)	(0.006)	(0.006)	(0.006)	(0.006)	(0.006)	(0.006)	
A community's nearest doctor	0.003	0.003	0.003	-	0.004	0.004	0.004	0.004	0.004	0.003	0.004	0.004	0.004	-
= religious facility (dummy)	(0.008)	(0.008)	(0.008)		(0.008)	(0.008)	(0.008)	(0.008)	(0.008)	(0.008)	(0.008)	(0.008)	(0.008)	
Longitude	-0.099	-0.117	-0.148	-	-0.124	-0.145	-0.196	-0.134	-0.158	-0.187	-0.124	-0.145	-0.197	-
	(0.153)	(0.165)	(0.154)		(0.153)	(0.165)	(0.155)	(0.165)	(0.176)	(0.166)	(0.153)	(0.165)	(0.155)	
Latitude	0.141	0.155	0.173*	-	0.148	0.161	0.191*	0.149	0.162	0.190*	0.148	0.161	0.191*	-
	(0.104)	(0.112)	(0.105)		(0.104)	(0.112)	(0.105)	(0.104)	(0.112)	(0.105)	(0.104)	(0.112)	(0.105)	
Ethnicity FE	No	No	Yes	No	No	No	Yes	No	No	Yes	No	No	Yes	No
Birth-cohort FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Geography & climate	Yes	Yes	Yes	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No
Historical controls	No	Yes	No	Yes	No	Yes	No	No	Yes	No	No	Yes	No	Yes
Community FE	No	No	No	Yes	No	No	No	No	No	No	No	No	No	Yes
District FE	Yes	Yes	Yes	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No
Round FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
1st-stage F-statistic	-	-	-	-	28.94	30.35	29.68	54.29	55.52	56.09	57.18	58.58	58.72	205.13
Hansen (p-values)	-	-	-	-	0.889	0.854	0.878	-	-	-	-	-	-	-
R-squared	0.102	0.102	0.103	0.173	0.093	0.088	0.083	0.092	0.088	0.083	0.093	0.088	0.083	0.162
No. of obs.	32635	30848	32635	31262	32635	30848	32635	32635	30848	32635	32635	30848	32635	30926

Notes: (1) Figures ( ) are standard errors. *** denotes significance at 1%, ** at 5%, and * at 10%. (2) Standard errors are robust to heteroskedasticity and clustered residuals within each community, exclusive of column (n). (3) In the analysis in columns (c), (g), (j), and (m) that controls for ethnicity-fixed effects, the ethnicity is categorized into 13 groups, i.e., Chewa, Lambya, Lomwe, mang'anja, Ndali, Ngoni, Nkhonde, Nyanja, Sena, Tonga, Tumbuka, Yao (reference group), and other. (4) The birth cohort is categorized into five groups of those that were born in the 1950s (reference group), 1960s, 1970s, 1980s, and 1990s. (5) The geographic and climate controls contain community-level information on climatology, landscape typology, soil & terrain, crop season parameters. See Appendix B for the details. (6) The ethnicity-level historical controls include (i) a dummy variable, equal to one if a European explorer traveled through land historically inhabited by an ethnic group; (ii) a dummy variable, equal to one if any part of railway lines in the first decade of the 20th century drawn from Century Company (1911) passed through land historically inhabited by an ethnic group; and (iii) the total number of slaves taken from an ethnic group that was normalized by the area of land inhabited by the ethnic group during the 19th century (log of one plus the normalized slave export measure).

Table 5: Robustness Checks

Dependent variables:	One if polygyny										Rank among the partner's wives				
											Natural #	Log #		Natural # (zero if not married)	
												2SLS	CF approach	aged < 25 & include single	
	DHS/IHS distance dif. < 10 km	In the 1st marriage	2000 & 2004	2010	Include ZM, ZW	Include ZM, ZW, & MZ	Only Non-yao	Bivariate probit (ME)	Remove e_{ij} from only the 2nd stage	Remove e_{ij} from the 1st & 2nd stages					
	2SLS	2SLS	2SLS	2SLS	2SLS	2SLS	2SLS		2SLS	2SLS	2SLS			OLS	2SLS
	(a)	(b)	(c)	(d)	(e)	(f)	(g)	(h)	(i)	(j)	(k)	(l)	(m)	(n)	(o)
One if Christian	-0.284***	-0.268***	-0.311***	-0.185	-0.188**	0.121	-0.265	-0.175***	-0.093***	-0.071***	-0.134**	-0.102**	-0.062***	-	-0.307**
	(0.088)	(0.072)	(0.118)	(0.134)	(0.074)	(0.080)	(0.513)	(0.031)	(0.020)	(0.019)	(0.062)	(0.041)	(0.017)		(0.120)
Distance to Livingstonia (100km) × Non-Yao	-	-	-	-	-	-	-	-	-	-	-	-	-	0.027**	-
														(0.011)	
Distance to Livingstonia (100km)	-	-	-	-	-	-	-	-	-	-	-	-	-	0.046	-
														(0.045)	
Non-Yao (dummy)	0.106**	0.104***	0.119**	0.048	0.053	-0.142***	-	0.049**	-	-	0.055*	0.043**	0.023**	-0.148***	0.154**
	(0.044)	(0.038)	(0.061)	(0.067)	(0.041)	(0.045)		(0.019)			(0.032)	(0.021)	(0.009)	(0.057)	(0.066)
Age (years)	0.022***	0.020***	0.020***	0.028***	0.021***	0.018***	0.023***	0.027***	0.023***	0.023***	0.004**	0.002**	0.002**	0.550***	0.543***
	(0.002)	(0.003)	(0.004)	(0.005)	(0.002)	(0.002)	(0.003)	(0.002)	(0.002)	(0.002)	(0.002)	(0.001)	(0.001)	(0.017)	(0.017)
Age squared	-0.000***	-0.000***	-0.000***	-0.000***	-0.000***	-0.000***	-0.000***	-0.000***	-0.000***	-0.000***	-0.000	-0.000	-0.000	-0.011***	-0.011***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Education (years)	0.002	-0.001	0.004	0.001	-0.002	-0.007***	0.003	0.004**	0.001	0.001	0.001	0.001	0.001	0.025***	0.028***
	(0.002)	(0.002)	(0.003)	(0.003)	(0.002)	(0.002)	(0.004)	(0.002)	(0.001)	(0.002)	(0.002)	(0.001)	(0.001)	(0.003)	(0.004)
Education squared	-0.000***	-0.000	-0.000**	-0.000	-0.000	0.000	-0.000**	-0.001***	-0.000***	-0.000***	-0.000	-0.000	-0.000	-0.005***	-0.005***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Birth order	0.001	0.001	0.001	0.001	0.002*	0.002	0.002	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.002
	(0.001)	(0.001)	(0.002)	(0.002)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.002)	(0.002)
No. of alive siblings	-0.001	-0.001	-0.000	-0.002	-0.002	-0.002*	-0.002	-0.001	-0.001	-0.001	-0.000	-0.000	-0.000	-0.003	-0.003
at age 15	(0.001)	(0.001)	(0.002)	(0.002)	(0.001)	(0.001)	(0.002)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.002)	(0.002)
No. of elder late siblings	-0.002	-0.001	-0.004	-0.002	-0.003	-0.003	-0.004	-0.003	-0.003	-0.003	0.001	-0.000	-0.000	-0.005	-0.006
at age 15	(0.002)	(0.002)	(0.003)	(0.003)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.001)	(0.001)	(0.004)	(0.004)
No. of young late siblings	-0.005**	-0.003	-0.007*	-0.003	-0.003	-0.003	-0.004	-0.004*	-0.004*	-0.004*	-0.001	-0.002	-0.002*	-0.009**	-0.008*
at age 15	(0.003)	(0.003)	(0.003)	(0.003)	(0.002)	(0.002)	(0.003)	(0.002)	(0.002)	(0.002)	(0.003)	(0.001)	(0.001)	(0.004)	(0.004)
First marriage	-0.136***	-	-0.144***	-0.139***	-0.135***	-0.131***	-0.142***	-0.115***	-0.144***	-0.144***	-0.163***	-0.107***	-0.107***	-	-
(dummy)	(0.006)		(0.009)	(0.009)	(0.006)	(0.005)	(0.012)	(0.004)	(0.005)	(0.006)	(0.007)	(0.004)	(0.003)		
No. of mission stations	-0.009***	-0.009***	-0.006	-0.012***	-0.009***	-0.010***	-0.007**	-0.012****	-0.010***	-0.010***	-0.004	-0.002	-0.002*	0.001	0.003
within 25 km radius	(0.003)	(0.003)	(0.004)	(0.004)	(0.002)	(0.002)	(0.003)	(0.003)	(0.003)	(0.003)	(0.002)	(0.001)	(0.001)	(0.005)	(0.005)
Distance to the origin of the	0.074	0.012	-0.124	0.511*	0.046***	-0.015***	0.207	-0.036	0.167	0.152	0.351**	0.196*	0.187**	-0.118	0.002
HIV virus (100 km)	(0.205)	(0.179)	(0.277)	(0.263)	(0.011)	(0.004)	(0.244)	(0.162)	(0.170)	(0.189)	(0.176)	(0.107)	(0.094)	(0.290)	(0.281)
Urban (dummy)	-0.047***	-0.052***	-0.048***	-0.048***	-0.046***	-0.063***	-0.054***	-0.057***	-0.046***	-0.046***	-0.011*	-0.008**	-0.008**	0.010	0.008
	(0.009)	(0.008)	(0.012)	(0.013)	(0.006)	(0.006)	(0.011)	(0.010)	(0.007)	(0.009)	(0.006)	(0.004)	(0.003)	(0.013)	(0.013)
Matrilineal communities	0.007	0.001	0.004	0.021*	-	-	0.009	0.008	0.010	0.010	0.005	0.003	0.003	0.001	0.001
(dummy)	(0.008)	(0.008)	(0.011)	(0.011)			(0.009)	(0.008)	(0.006)	(0.008)	(0.006)	(0.004)	(0.003)	(0.011)	(0.012)
A community's most common	-0.002	-0.014	0.021	-0.022*	-	-	-0.008	-0.004	-0.006	-0.007	-0.005	-0.002	-0.004	-0.011	0.001
religion = Christianity (dummy)	(0.010)	(0.010)	(0.014)	(0.013)			(0.021)	(0.009)	(0.008)	(0.009)	(0.008)	(0.005)	(0.004)	(0.014)	(0.015)
No. of churches in a community	0.001	0.001	-0.000	0.001	-	-	0.001	0.001	0.000	0.000	0.000	0.000	0.000	0.001	0.001
	(0.000)	(0.000)	(0.001)	(0.001)			(0.001)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.001)	(0.001)
No. of mosques in a community	0.001	-0.002	-0.001	0.002	-	-	-0.001	0.000	0.001	0.001	-0.001	-0.001	-0.001	0.000	-0.002
	(0.001)	(0.001)	(0.001)	(0.002)			(0.003)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.002)
No. of primary schools run by	0.003*	0.000	0.002	0.002	-	-	0.000	0.001	0.002	0.002	0.002	0.001	0.001	0.003	0.003
religious organizations	(0.002)	(0.002)	(0.002)	(0.002)			(0.003)	(0.001)	(0.002)	(0.002)	(0.001)	(0.001)	(0.001)	(0.002)	(0.002)
No. of secondary schools run by	-0.010	-0.002	-0.010	-0.008	-	-	-0.003	-0.010	-0.009*	-0.009	-0.006	-0.004	-0.004	0.006	0.005
religious organizations	(0.007)	(0.006)	(0.010)	(0.008)			(0.007)	(0.007)	(0.005)	(0.006)	(0.005)	(0.003)	(0.002)	(0.009)	(0.009)
A community's nearest doctor	0.005	0.000	-0.005	0.007	-	-	0.000	0.001	0.003	0.003	-0.002	-0.000	-0.000	0.004	0.007
= religious facility (dummy)	(0.008)	(0.008)	(0.010)	(0.012)			(0.009)	(0.008)	(0.007)	(0.008)	(0.007)	(0.004)	(0.003)	(0.013)	(0.013)
Longitude	-0.062	-0.019	0.089	-0.412*	-0.026***	0.002	-0.199	0.035	-0.124	-0.106	-0.273*	-0.154*	-0.140*	0.174	0.021
	(0.177)	(0.156)	(0.237)	(0.235)	(0.007)	(0.002)	(0.182)	(0.143)	(0.144)	(0.165)	(0.152)	(0.093)	(0.080)	(0.254)	(0.244)
Latitude	0.116	0.051	0.001	0.346**	0.040***	-0.006**	0.170	0.039	0.158	0.149	0.243**	0.138**	0.133**	0.066	0.078
	(0.122)	(0.107)	(0.165)	(0.152)	(0.009)	(0.003)	(0.135)	(0.094)	(0.103)	(0.112)	(0.105)	(0.064)	(0.056)	(0.163)	(0.166)
Correlation coefficient (ρ)	-	-	-	-	-	-	-	0.231***	-	-	-	-	0.020**	-	-
or Christianity control								(0.072)					(0.009)		
Birth-cohort FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No	No	Yes	Yes	Yes	Yes	Yes
Geography & climate	Yes	Yes	Yes	Yes	No	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Historical controls	Yes	Yes	Yes	Yes	No	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
District FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Round FE	Yes	Yes	Yes	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
1st-stage F-statistic	28.41	32.89	19.62	12.36	47.54	40.42	9.90	-	-	464.01	32.15	32.15	-	-	22.49
Hansen (p-values)	0.899	0.811	0.182	0.264	0.230	0.000	-	-	-	0.922	0.865	0.984	-	-	0.233
R-squared	0.083	0.048	0.083	0.102	0.084	0.064	0.085	-	0.099	0.102	0.080	0.095	0.106	0.381	0.369
No. of obs.	29065	23615	16655	14193	42385	51330	26536	30848	30848	30848	29368	29368	29368	18934	18932

Notes: (1) Figures ( ) are standard errors. *** denotes significance at 1%, ** at 5%, and * at 10%. (2) Standard errors are robust to heteroskedasticity and clustered residuals within each community, exclusive of the analysis in columns (i) and (m) that uses bootstrapping with 100 replications. (3) The birth cohort is categorized into five groups of those that were born in the 1950s (reference group), 1960s, 1970s, 1980s, and 1990s. (4) The geographic and climate controls contain community-level information on climatology, landscape typology, soil & terrain, crop season parameters. See Appendix B for the details. (5) The ethnicity-level historical controls include (i) a dummy variable, equal to one if a European explorer traveled through land historically inhabited by an ethnic group; (ii) a dummy variable, equal to one if any part of railway lines in the first decade of the 20th century drawn from Century Company (1911) passed through land historically inhabited by an ethnic group; and (iii) the total number of slaves taken from an ethnic group that was normalized by the area of land inhabited by the ethnic group during the 19th century (log of one plus the normalized slave export measure). (6) The ME stands for "marginal effects."

Table 6: Falsification Tests: Reduced-form/First-stage Regressions and Placebo Experiments (OLS)

Dependent variables:	One if Christian				One if polygyny								
	(a)	(b)	(c)	(d)	(e)	(f)	(g)	(h)	(i)	(j)	(k)	(l)	(m)
Distance to Livingstonia (100km)	-0.085***	-0.086***	-0.087***	-0.070***	0.020***	0.023***	0.026***	0.017**	-	-	-	-	-
× Non-Yao	(0.012)	(0.012)	(0.012)	(0.012)	(0.008)	(0.008)	(0.008)	(0.009)					
Random number × Non-Yao	-	-	-	-	-	-	-	-	-	-0.002	-0.001	-0.001	0.001
										(0.002)	(0.006)	(0.006)	(0.007)
Distance to Livingstonia (100km)	0.034	0.014	0.035	-	-0.013	-0.011	-0.006	-	-	-	-	-	-
	(0.024)	(0.027)	(0.025)		(0.034)	(0.039)	(0.033)						
Random number	-	-	-	-	-	-	-	-	-0.002	-	-0.000	-0.000	-0.002
									(0.002)		(0.006)	(0.006)	(0.006)
Non-Yao (dummy)	0.988***	0.962***	-	0.806***	-0.153***	-0.160***	-	-0.131***	-0.045***	-0.045***	-0.045***	-	-0.042***
	(0.057)	(0.058)		(0.061)	(0.041)	(0.043)		(0.048)	(0.010)	(0.010)	(0.010)		(0.011)
Age (years)	0.001	0.001	0.001	0.001	0.022***	0.023***	0.022***	0.023***	0.023***	0.023***	0.023***	0.022***	0.024***
	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)
Age squared	-0.000	-0.000	-0.000	-0.000	-0.000***	-0.000***	-0.000***	-0.000***	-0.000***	-0.000***	-0.000***	-0.000***	-0.000***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Education (years)	0.007***	0.007***	0.007***	0.005***	0.000	0.000	0.000	0.002	0.000	0.000	0.000	0.000	0.002
	(0.001)	(0.001)	(0.001)	(0.001)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)
Education squared	-0.000	-0.000	-0.000	0.000	-0.000***	-0.000***	-0.000***	-0.000**	-0.000**	-0.000**	-0.000**	-0.000***	-0.000**
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Birth order	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
No. of alive siblings	0.002***	0.002**	0.002***	0.001	-0.002	-0.001	-0.002	-0.001	-0.001	-0.001	-0.001	-0.002	-0.002
at age 15	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
No. of older late siblings	-0.000	-0.000	-0.000	-0.001	-0.002	-0.003	-0.002	-0.004*	-0.003	-0.003	-0.003	-0.002	-0.004*
at age 15	(0.001)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)
No. of younger late siblings	-0.001	-0.001	-0.001	-0.001	-0.003	-0.004*	-0.003	-0.005*	-0.004*	-0.004*	-0.004*	-0.003	-0.005*
at age 15	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.003)	(0.002)	(0.002)	(0.002)	(0.002)	(0.003)
First marriage	0.015***	0.014***	0.016***	0.008**	-0.145***	-0.145***	-0.145***	-0.144***	-0.145***	-0.145***	-0.145***	-0.145***	-0.144***
(dummy)	(0.004)	(0.004)	(0.004)	(0.004)	(0.006)	(0.006)	(0.006)	(0.006)	(0.006)	(0.006)	(0.006)	(0.006)	(0.006)
No. of mission stations	0.000	0.000	0.000	-	-0.010***	-0.010***	-0.010***	-	-0.010***	-0.010***	-0.010***	-0.010***	-
within 25 km radius	(0.003)	(0.003)	(0.003)		(0.003)	(0.003)	(0.003)		(0.003)	(0.003)	(0.003)	(0.003)	
Distance to the origin of the	0.089	0.109	0.141	-	0.135	0.150	0.167	-	0.155	0.155	0.155	0.184	-
HIV virus (100 km)	(0.142)	(0.154)	(0.144)		(0.186)	(0.199)	(0.186)		(0.189)	(0.189)	(0.189)	(0.177)	
Urban (dummy)	-0.007	-0.008	-0.008	-	-0.048***	-0.046***	-0.047***	-	-0.045***	-0.045***	-0.045***	-0.046***	-
	(0.009)	(0.009)	(0.009)		(0.009)	(0.009)	(0.009)		(0.009)	(0.009)	(0.009)	(0.009)	
Matrilineal communities	0.003	0.002	0.003	-	0.011	0.010	0.011	-	0.010	0.010	0.010	0.011	-
(dummy)	(0.009)	(0.009)	(0.009)		(0.008)	(0.008)	(0.007)		(0.008)	(0.008)	(0.008)	(0.008)	
A community's most common	0.038***	0.038***	0.037***	-	-0.009	-0.009	-0.009	-	-0.010	-0.010	-0.010	-0.010	-
religion = Christianity (dummy)	(0.011)	(0.011)	(0.010)		(0.009)	(0.009)	(0.009)		(0.009)	(0.009)	(0.009)	(0.009)	
No. of churches in a community	0.001*	0.001*	0.001*	-	0.000	0.000	0.000	-	0.000	0.000	0.000	0.000	-
	(0.000)	(0.000)	(0.000)		(0.000)	(0.000)	(0.000)		(0.000)	(0.000)	(0.000)	(0.000)	
No. of mosques in a community	-0.005***	-0.005***	-0.005***	-	0.001	0.001	0.001	-	0.001	0.001	0.001	0.001	-
	(0.001)	(0.001)	(0.001)		(0.001)	(0.001)	(0.001)		(0.001)	(0.001)	(0.001)	(0.001)	
No. of primary schools run by	0.002	0.002	0.002	-	0.001	0.002	0.001	-	0.002	0.002	0.002	0.002	-
religious organizations	(0.001)	(0.001)	(0.001)		(0.002)	(0.002)	(0.002)		(0.002)	(0.002)	(0.002)	(0.002)	
No. of secondary schools run by	-0.004	-0.003	-0.004	-	-0.007	-0.008	-0.007	-	-0.009	-0.009	-0.009	-0.008	-
religious organizations	(0.007)	(0.007)	(0.007)		(0.006)	(0.006)	(0.006)		(0.006)	(0.006)	(0.006)	(0.006)	
A community's nearest doctor	0.000	0.001	-0.001	-	0.004	0.003	0.004	-	0.003	0.003	0.003	0.003	-
= religious facility (dummy)	(0.007)	(0.007)	(0.007)		(0.008)	(0.008)	(0.008)		(0.008)	(0.008)	(0.008)	(0.008)	
Longitude	-0.206	-0.229	-0.251*	-	-0.084	-0.096	-0.111	-	-0.101	-0.101	-0.101	-0.127	-
	(0.129)	(0.140)	(0.131)		(0.164)	(0.175)	(0.164)		(0.165)	(0.165)	(0.165)	(0.155)	
Latitude	0.031	0.021	0.058	-	0.141	0.155	0.172	-	0.150	0.150	0.150	0.165	-
	(0.078)	(0.084)	(0.079)		(0.104)	(0.112)	(0.104)		(0.112)	(0.112)	(0.112)	(0.105)	
Ethnicity FE	No	No	Yes	No	No	No	Yes	No	No	No	No	Yes	No
Birth-cohort FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Geography & climate	Yes	Yes	Yes	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Historical controls	No	Yes	No	Yes	No	Yes	No	No	Yes	Yes	Yes	No	No
Community FE	No	No	No	Yes	No	No	No	No	No	No	No	No	No
District FE	Yes	Yes	Yes	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Round FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
R-squared	0.553	0.561	0.554	0.637	0.099	0.099	0.1	0.171	0.098	0.098	0.098	0.100	0.171
No. of obs.	32635	30848	32635	30926	32643	30856	32643	30934	30856	30856	30856	32643	31270

Notes: (1) Figures ( ) are standard errors. *** denotes significance at 1%, ** at 5%, and * at 10%. (2) Standard errors are robust to heteroskedasticity and clustered residuals within each community. (3) In the analysis in columns (c), (g) and (l) that controls for ethnicity-fixed effects, the ethnicity is categorized into 13 groups, i.e., Chewa, Lambya, Lomwe, mang'anja, Ndali, Ngoni, Nkhonde, Nyanja, Sena, Tonga, Tumbuka, Yao (reference group), and other. (4) The birth cohort is categorized into five groups of those that were born in the 1950s (reference group), 1960s, 1970s, 1980s, and 1990s. (5) The geographic and climate controls contain community-level information on climatology, landscape typology, soil & terrain, crop season parameters. See Appendix B for the details. (6) The ethnicity-level historical controls include (i) a dummy variable, equal to one if a European explorer traveled through land historically inhabited by an ethnic group; (ii) a dummy variable, equal to one if any part of railway lines in the first decade of the 20th century drawn from Century Company (1911) passed through land historically inhabited by an ethnic group; and (iii) the total number of slaves taken from an ethnic group that was normalized by the area of land inhabited by the ethnic group during the 19th century (log of one plus the normalized slave export measure).

Table 7: Falsification Test: Population Density in the Early and Mid-20th Century (OLS)

Dependent variable:	Log of population density									
	With non-Yao proportion in 1966					Without non-Yao proportion in 1966				
Data sources of population:	HYDE	Malawi Population Census 1966, Final report				HYDE	Malawi Population Census 1966, Final report			
	population in 1900	population in 1966				population in 1900	population in 1966			
		60 years or above		All			60 years or above		All	
	(a)	(b)	(c)	(d)	(e)	(f)	(g)	(h)	(i)	(j)
Distance to Livingstonia (100km)	-0.369	-0.821	0.194	-1.094	0.509	-	-	-	-	-
× Non-Yao (proportion)	(0.436)	(0.930)	(1.249)	(0.919)	(1.130)					
Distance to Livingstonia (100km)	0.577	1.256	0.269	1.603	-0.060	0.240	0.330	0.323	0.463*	0.327
	(0.475)	(0.972)	(1.245)	(0.952)	(1.111)	(0.196)	(0.230)	(0.260)	(0.243)	(0.257)
Non-Yao (proportion)	1.824	3.198	-2.071	4.843	-3.426	-	-	-	-	-
	(1.961)	(4.058)	(6.078)	(3.995)	(5.628)					
Male proportion	-	-	12.138	-	16.715	0.012	-	6.163	-	10.466
			(16.103)		(15.616)	(0.288)		(9.048)		(9.200)
Average age	-	-	4.051	-	4.330	-0.171	-	4.764	-	4.368
			(3.113)		(3.345)	(0.158)		(2.886)		(3.088)
Average age squared	-	-	-0.101	-	-0.112	-1.159	-	-0.118	-	-0.112
			(0.075)		(0.080)	(9.052)		(0.070)		(0.075)
Longitude	0.021	0.406	0.635*	0.398	0.805***	0.012	0.452	0.706*	0.398	0.841***
	(0.275)	(0.252)	(0.333)	(0.247)	(0.233)	(0.288)	(0.282)	(0.399)	(0.241)	(0.291)
Latitude	-0.179	-0.110	-0.129	0.067	-0.058	-0.171	-0.079	-0.048	0.083	0.012
	(0.157)	(0.195)	(0.204)	(0.182)	(0.227)	(0.158)	(0.186)	(0.197)	(0.171)	(0.210)
Constant	-3.340	-17.551*	-66.409**	-14.306	-70.490**	-1.159	-15.447*	-74.263**	-9.255	-71.792**
	(9.014)	(9.601)	(30.306)	(9.101)	(33.819)	(9.052)	(8.705)	(28.178)	(7.273)	(31.694)
Regional FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
R-squared	0.383	0.661	0.713	0.643	0.764	0.378	0.629	0.683	0.610	0.740
No. of obs.	1115	23	23	23	23	1115	23	23	23	23

Notes: (1) The unit of observations is a 5-by-5-minute cell demonstrated in Figure 3 in columns (a) and (f) and a district in all the other columns. (2) Figures ( ) are standard errors. *** denotes significance at 1%, ** at 5%, and * at 10%. (3) Standard errors are robust to heteroskedasticity and clustered residuals within each district. (4) The non-Yao proportion is the proportion of the non-Yao population relative to a district's overall population in 1966. See also subsection 4.4.2 for the details. (5) The latitude and longitude are the coordinates of (a centroid of) each cell in columns (a) and (f), and those of a district's capital city (major town) in all the other columns. (6) The distance is measured as that between Livingstonia and a centroid of each cell in columns (a) and (f), and that between Livingstonia and a district's capital city (major town) in all the other columns. (7) In columns (b) to (e) and (g) to (j), the population density is a district's population (African, European, Asian, and other) divided by land area (square mile). In columns (a) to (f), the density is evaluated per square kilometer. (8) In columns (c), (e), (h), and (j), a district's average age is calculated by weighting based on the population in each age category of below 5 years, assumed to be 1 year-old in the calculation; 5 to 9 years, assumed to be 5 year-old; 10 to 14 years, assumed to be 10 year-old; 15 to 19 years, assumed to be 15 year-old; 20 to 24 years, assumed to be 20 year-old; 25 to 29 years, assumed to be 25 year-old; 30 to 34 years, assumed to be 30 year-old; 35 to 39 years, assumed to be 35 year-old: 40 to 44 years, assumed to be 40 year-old; 45 to 49 years, assumed to be 45 year-old; 50 to 54 years, assumed to be 50 year-old; 55 to 59 years, assumed to be 55 year-old; 60 to 64 years, assumed to be 60 year-old; and 65 years or above, assumed to be 65 year-old. (9) The analysis uses three regional fixed effects (i.e., north, central, south).

Table 8: Heterogeneity of Christianity Effects (2SLS)

Dependent variable:	One if polygyny																		
	(a)	(b)	(c)	(d)	(e)	(f)	(g)	(h)	(i)	(j)	(k)	(l)	(m)	(n)	(o)	(p)	(q)	(r)	(s)
One if Christian	-0.142	-0.277***	-0.291***	-0.242***	-0.267***	-0.267***	-0.406***	-0.260***	-0.230	-0.305***	-0.290***	-0.273***	-0.267***	-0.256***	-0.265***	-0.266***	-0.269***	-0.450***	-0.353
Non-Yao (dummy)	0.097**	0.095**	0.096**	0.097**	0.096**	0.096**	0.110**	0.089*	0.125	0.106**	0.131***	0.096**	0.098**	0.098**	0.096**	0.092**	0.098**	0.105**	0.221
One if Christian																			
× Age (dummy)	-0.206***	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-0.099**
× Education (dummy)	-	0.036	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-0.075*
× Birth order	-	-	0.007	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.020**
× No. of alive siblings at age 15	-	-	-	-0.006	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-0.019**
× No. of elder late siblings at age 15	-	-	-	-	0.000	-	-	-	-	-	-	-	-	-	-	-	-	-	-0.025*
× No. of young late siblings at age 15	-	-	-	-	-	-0.001	-	-	-	-	-	-	-	-	-	-	-	-	0.004
× First marriage (dummy)	-	-	-	-	-	-	0.155***	-	-	-	-	-	-	-	-	-	-	-	0.109***
× No. of mission stations within 25 km radius	-	-	-	-	-	-	-	0.005	-	-	-	-	-	-	-	-	-	-	-0.012
× Distance to the origin of the HIV virus (100 km)	-	-	-	-	-	-	-	-	-0.006	-	-	-	-	-	-	-	-	-	-0.012
× Urban (dummy)	-	-	-	-	-	-	-	-	-	0.098**	-	-	-	-	-	-	-	-	0.083
× Matrilineal communities (dummy)	-	-	-	-	-	-	-	-	-	-	-0.059*	-	-	-	-	-	-	-	-0.048
× A community's most common religion = Christianity (dummy)	-	-	-	-	-	-	-	-	-	-	-	0.010	-	-	-	-	-	-	-0.046
× No. of churches in a community	-	-	-	-	-	-	-	-	-	-	-	-	0.010	-	-	-	-	-	-0.001
× No. of mosques in acommunity	-	-	-	-	-	-	-	-	-	-	-	-	-	-0.004*	-	-	-	-	-0.003
× No. of primary schools run by religious organizations	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-0.002	-	-	-	-0.003
× No. of secondary schools run by religious organizations	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.037	-	-	0.037
× A community's nearest doctor = religious facility (dummy)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-0.016		-0.046
× Born in the 1960s	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.077	0.098
× Born in the 1970s	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.130**	0.111
× Born in the 1980s	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.259***	0.192**
× Born in the 1990s	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.449***	0.348***
Age (dummy)	0.225***	0.051***	0.051***	0.051***	0.051***	0.051***	0.051***	0.051***	0.051***	0.051***	0.051***	0.051***	0.051***	0.051***	0.051***	0.051***	0.051***	0.050***	0.135***
Education (dummy)	-0.006	-0.037	-0.006	-0.006	-0.006	-0.006	-0.005	-0.007	-0.004	-0.006	-0.004	-0.006	-0.006	-0.006	-0.006	-0.006	-0.006	-0.004	0.067*
Birth order	0.001	0.001	-0.005	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	-0.016*
No. of alive siblings at age 15	-0.001	-0.001	-0.001	0.004	-0.001	-0.001	-0.001	-0.001	-0.001	-0.001	-0.001	-0.001	-0.001	-0.001	-0.001	-0.001	-0.001	-0.001	0.016**
No. of elder late siblings at age 15	-0.003	-0.003	-0.003	-0.003	-0.003	-0.003	-0.003	-0.003	-0.003	-0.003	-0.003	-0.003	-0.003	-0.003	-0.003	-0.003	-0.003	-0.003	0.019
No. of young late siblings at age 15	-0.005*	-0.004*	-0.004*	-0.004*	-0.004*	-0.004	-0.005*	-0.004*	-0.004*	-0.004*	-0.004*	-0.004*	-0.004*	-0.004*	-0.004*	-0.004*	-0.004*	-0.004*	-0.008
First marriage (dummy)	-0.142***	-0.144***	-0.144***	-0.144***	-0.144***	-0.144***	-0.269***	-0.144***	-0.143***	-0.144***	-0.143***	-0.144***	-0.144***	-0.144***	-0.144***	-0.144***	-0.144***	-0.142***	-0.226***
No. of mission stations within 25 km radius	-0.010***	-0.010***	-0.010***	-0.010***	-0.010***	-0.010***	-0.010***	-0.014	-0.010***	-0.009***	-0.010***	-0.010***	-0.010***	-0.010***	-0.010***	-0.010***	-0.010***	-0.009***	0.001
Distance to the origin of the HIV virus (100 km)	0.182	0.173	0.174	0.173	0.171	0.171	0.170	0.165	0.178	0.167	0.178	0.177	0.169	0.166	0.169	0.173	0.171	0.166	0.171
Urban (dummy)	-0.051***	-0.052***	-0.052***	-0.052***	-0.052***	-0.052***	-0.052***	-0.052***	-0.052***	-0.135***	-0.052***	-0.052***	-0.052***	-0.052***	-0.053***	-0.052***	-0.052***	-0.052***	-0.123**
Matrilineal communities (dummy)	0.010	0.011	0.011	0.011	0.011	0.011	0.011	0.010	0.011	0.010	0.061**	0.011	0.011	0.010	0.010	0.010	0.011	0.012	0.050
A community's most common religion = Christianity (dummy)	0.002	0.002	0.001	0.001	0.001	0.001	0.004	0.000	0.003	0.003	0.004	-0.007	0.001	-0.000	0.001	0.000	0.002	0.004	0.048
	(0.010)	(0.010)	(0.010)	(0.010)	(0.010)	(0.010)	(0.010)	(0.010)	(0.015)	(0.010)	(0.010)	(0.026)	(0.010)	(0.010)	(0.010)	(0.010)	(0.010)	(0.010)	(0.048)
No. of churches in a community	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.002
No. of mosques in a community	0.000	-0.000	-0.000	-0.000	-0.000	-0.000	-0.000	0.000	-0.000	-0.000	-0.000	-0.000	-0.000	0.001	-0.000	-0.000	0.000	0.000	0.000
No. of primary schools run by religious organizations	0.002	0.002	0.002	0.002	0.002	0.002	0.002	0.002	0.002	0.002	0.002	0.002	0.002	0.002	0.003	0.002	0.002	0.002	0.004
No. of secondary schools run by religious organizations	-0.009	-0.009	-0.009	-0.009	-0.009	-0.009	-0.010	-0.009	-0.009	-0.008	-0.010	-0.009	-0.009	-0.008	-0.008	-0.039*	-0.009	-0.009	-0.039
A community's nearest doctor = religious facility (dummy)	0.005	0.003	0.003	0.003	0.003	0.003	0.004	0.003	0.003	0.003	0.003	0.003	0.003	0.002	0.004	0.003	0.017	0.004	0.045
Born in the 1960s	0.024**	0.022**	0.021**	0.021*	0.021**	0.021**	0.024**	0.021**	0.022*	0.022**	0.022**	0.021**	0.021**	0.021**	0.021**	0.021**	0.021**	-0.038	-0.053
Born in the 1970s	0.005	0.003	0.002	0.002	0.002	0.002	0.004	0.002	0.002	0.003	0.002	0.002	0.002	0.002	0.002	0.002	0.002	-0.103*	-0.084
Born in the 1980s	-0.027**	-0.030**	-0.030**	-0.031**	-0.030**	-0.030**	-0.028**	-0.030**	-0.030**	-0.030**	-0.031**	-0.030**	-0.030**	-0.031**	-0.030**	-0.030**	-0.030**	-0.246***	-0.187**
Born in the 1990s	-0.075***	-0.075***	-0.076***	-0.076***	-0.076***	-0.076***	-0.073***	-0.076***	-0.076***	-0.075***	-0.076***	-0.076***	-0.076***	-0.076***	-0.076***	-0.076***	-0.076***	-0.455***	-0.368***
Longitude/Latitude	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Geography & climate	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Historical controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
District FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Round FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Hansen (p-values)	0.861	0.870	0.873	0.861	0.865	0.866	0.771	0.855	0.506	0.827	0.733	0.854	0.861	0.837	0.880	0.870	0.846	0.908	0.468
R-squared	0.081	0.086	0.086	0.086	0.086	0.086	0.077	0.088	0.076	0.082	0.074	0.087	0.086	0.087	0.086	0.087	0.086	0.078	0.011
No. of obs.	30848	30848	30848	30848	30848	30848	30848	30848	30848	30848	30848	30848	30848	30848	30848	30848	30848	30848	30848

Notes: (1) *** denotes significance at 1%, ** at 5%, and * at 10%. (2) Standard errors are robust to heteroskedasticity and clustered residuals within each community, but not reported for the visual simplification. (3) The birth cohort is categorized into five groups of those that were born in the 1950s (reference group), 1960s, 1970s, 1980s, and 1990s. (4) The geographic and climate controls contain community-level information on climatology, landscape typology, soil & terrain, crop season parameters. See Appendix B for the details. (5) The ethnicity-level historical controls include (i) a dummy variable, equal to one if a European explorer traveled through land historically inhabited by an ethnic group; (ii) a dummy variable, equal to one if any part of railway lines in the first decade of the 20th century drawn from Century Company (1911) passed through land historically inhabited by an ethnic group; and (iii) the total number of slaves taken from an ethnic group that was normalized by the area of land inhabited by the ethnic group during the 19th century (log of one plus the normalized slave export measure).

Table A.1: Informal Check of Goodness of the Fit of the IHS Community Characteristics to the MDHS Data: Religion and Ethnicity (OLS)

Dependent variables based on the MDHS:	One if practice Christianity	practice Islam	practice other or no religion	Chewa	Lambya	Lomwe	Ngoni	Nkhonde	Nyanja	Sena	Tonga	Tumbuka	Yao	Other ethnicity
	(a)	(b)	(c)	(d)	(e)	(f)	(g)	(h)	(i)	(j)	(k)	(l)	(m)	(n)
Independent variables based on the IHS:														
The most common religion practiced in a community														
Christianity	0.121***	-	-	-	-	-	-	-	-	-	-	-	-	-
	(0.019)													
Islam	-	0.137***	-	-	-	-	-	-	-	-	-	-	-	-
		(0.023)												
Traditional	-	-	0.009*	-	-	-	-	-	-	-	-	-	-	-
			(0.005)											
The most common language spoken at home in a community														
Chewa	-	-	-	0.074***	-	-	-	-	-	-	-	-	-	-
				(0.020)										
Lambya	-	-	-	-	0.108*	-	-	-	-	-	-	-	-	-
					(0.063)									
Lomwe	-	-	-	-	-	0.059	-	-	-	-	-	-	-	-
						(0.041)								
Ngoni	-	-	-	-	-	-	0.041	-	-	-	-	-	-	-
							(0.049)							
Nkhonde	-	-	-	-	-	-	-	0.301***	-	-	-	-	-	-
								(0.064)						
Nyanja	-	-	-	-	-	-	-	-	0.005	-	-	-	-	-
									(0.004)					
Sena	-	-	-	-	-	-	-	-	-	0.205***	-	-	-	-
										(0.050)				
Tonga	-	-	-	-	-	-	-	-	-	-	0.343***	-	-	-
											(0.097)			
Tumbuka	-	-	-	-	-	-	-	-	-	-	-	0.442***	-	-
												(0.042)		
Yao	-	-	-	-	-	-	-	-	-	-	-	-	0.180***	-
													(0.034)	
Other	-	-	-	-	-	-	-	-	-	-	-	-	-	0.228***
														(0.055)
Constant	0.865***	0.007	0.008***	-0.012	0.063**	0.004	0.009	0.015***	-0.010***	-0.001	0.005**	0.140***	0.007	0.567***
	(0.021)	(0.007)	(0.002)	(0.008)	(0.026)	(0.007)	(0.007)	(0.005)	(0.002)	(0.003)	(0.002)	(0.030)	(0.007)	(0.058)
District FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
R-squared	0.323	0.349	0.014	0.505	0.113	0.404	0.340	0.351	0.035	0.508	0.477	0.518	0.328	0.196
No. of obs.	47371	47371	47371	47369	47369	47369	47369	47369	47369	47369	47369	47369	47369	47369

Notes: (1) Figures ( ) are standard errors. *** denotes significance at 1%, ** at 5%, and * at 10%. (2) Standard errors are robust to heteroskedasticity and clustered residuals within each community.

Table A.2: Informal Check of Goodness of the Fit of the IHS Community Characteristics to the MDHS Data: Descent Rules and Migrant Probability of Married Females (OLS)

Dependent variable:	One if migrant														
Data sources:	IHS					MDHS matched with IHS									
Sample:						Females that resided in all the MDHS communities					Females that resided in the MDHS communities with distance to the nearest IHS communities < 10 km				
	(a)	(b)	(c)	(d)	(e)	(f)	(g)	(h)	(i)	(j)	(k)	(l)	(m)	(n)	(o)
Matrilineal descent community × A community's distance (km) to the nearest town having population > 20000															
1st quantile	0.165*	0.132	0.075	0.042	0.057	0.098**	0.090**	0.093***	0.054**	0.069***	0.081*	0.083**	0.083**	0.046*	0.064***
	(0.099)	(0.080)	(0.066)	(0.046)	(0.043)	(0.040)	(0.037)	(0.034)	(0.024)	(0.022)	(0.042)	(0.039)	(0.036)	(0.024)	(0.023)
2nd quantile	0.159**	0.142**	0.058	0.067*	-	0.103***	0.112***	0.060*	0.041**	-	0.088**	0.107***	0.059*	0.039**	-
	(0.076)	(0.067)	(0.058)	(0.036)		(0.040)	(0.036)	(0.033)	(0.018)		(0.042)	(0.037)	(0.034)	(0.019)	
3rd quantile	0.259***	0.198***	0.007	-	-	0.068*	0.043	-0.010	-	-	0.060	0.044	-0.008	-	-
	(0.072)	(0.070)	(0.054)			(0.038)	(0.035)	(0.029)			(0.040)	(0.037)	(0.030)		
4th quantile	0.208***	0.103*	-	-	-	0.020	-0.003	-	-	-	0.014	0.002	-	-	-
	(0.075)	(0.054)				(0.034)	(0.031)				(0.036)	(0.032)			
5th quantile	0.173***	-	-	-	-	0.019	-	-	-	-	0.009	-	-	-	-
	(0.059)					(0.034)					(0.036)				
A community's distance (km) to the nearest town having population > 20000															
1st quantile	-0.190*	-0.123	-0.140*	-0.026	-0.088**	-0.024	-0.015	-0.002	0.025	-0.040**	-0.017	-0.019	0.009	0.038*	-0.032
	(0.103)	(0.087)	(0.074)	(0.050)	(0.044)	(0.036)	(0.033)	(0.031)	(0.020)	(0.019)	(0.037)	(0.035)	(0.033)	(0.021)	(0.020)
2nd quantile	-0.138*	-0.130*	-0.152**	-0.062*	-	-0.057*	-0.051*	-0.031	-0.018	-	-0.043	-0.048	-0.029	-0.011	-
	(0.079)	(0.071)	(0.060)	(0.034)		(0.034)	(0.031)	(0.029)	(0.015)		(0.037)	(0.033)	(0.030)	(0.016)	
3rd quantile	-0.224***	-0.183***	-0.073	-	-	-0.032	-0.001	0.022	-	-	-0.025	-0.010	0.016	-	-
	(0.069)	(0.061)	(0.046)			(0.033)	(0.030)	(0.025)			(0.034)	(0.032)	(0.026)		
4th quantile	-0.122**	-0.148***	-	-	-	0.003	0.016	-	-	-	0.003	0.007	-	-	-
	(0.062)	(0.045)				(0.028)	(0.026)				(0.029)	(0.027)			
5th quantile	-0.131***	-	-	-	-	-0.016	-	-	-	-	-0.009	-	-	-	-
	(0.049)					(0.028)					(0.028)				
Matrilineal descent	-0.129**	-0.089*	-0.003	-0.008	0.000	-0.051*	-0.048*	-0.035	-0.033*	-0.033*	-0.045	-0.050*	-0.035	-0.033	-0.034*
	(0.055)	(0.049)	(0.047)	(0.039)	(0.040)	(0.029)	(0.028)	(0.026)	(0.020)	(0.018)	(0.030)	(0.029)	(0.027)	(0.020)	(0.018)
Deual descent	0.022	0.009	0.014	0.012	0.013	0.064***	0.063***	0.064***	0.069***	0.068***	0.070***	0.070***	0.070***	0.075***	0.074***
	(0.048)	(0.045)	(0.045)	(0.045)	(0.045)	(0.022)	(0.022)	(0.022)	(0.022)	(0.022)	(0.023)	(0.023)	(0.023)	(0.022)	(0.022)
Age	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Education	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Religion FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Ethnicity FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Household size	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Longitude/Latitude	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Community-level controls															
Geography & climate	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Other	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
District FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Round FE	-	-	-	-	-	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
R-squared	0.315	0.314	0.313	0.313	0.313	0.186	0.186	0.186	0.186	0.186	0.187	0.187	0.188	0.187	0.187
No. of obs.	6702	6702	6702	6702	6702	32761	32761	32761	32761	32761	30911	30911	30911	30911	30911

Notes: (1) Figures ( ) are standard errors. *** denotes significance at 1%, ** at 5%, and * at 10%. (2) Standard errors are robust to heteroskedasticity and clustered residuals within each community. (3) The geographic and climate controls contain a community-level information on climatology, landscape typology, soil & terrain, crop season parameters, and GPS-based coordinates. See Appendix B for the details. (4) The "Other" community controls are sourced from the IHS and contain characteristics identified at the point of the survey. They include (i) a community's population; (ii) a dummy for a major urban center; (iii) dummies for the most common religion practiced in a community, i.e., Christian, Muslim, or Traditional (reference group); and (iv) dummies for the most common language spoken at home in a community, i.e., Chewa, Lambya, Lomwe, Ngoni, Nkhonde, Nyakyusa, Nyanja, Sena, Senga, Sukwa, Tonga, Tumbuka, Yao, and other (reference group). (5) In columns (a) to (e), the completed level of education is measured by categorical variables of None (reference group), Primary School Leaving Certificate (PSLC), Junior Certificate Examination (JCE), Malawi School Certificate of Education (MSCE), non-university diploma, university diploma/degree, and post-graduate degree. On the other hand, the estimations in columns (f) to (o) use a continuous measure of the completed level of education (years). (6) In the IHS, an individual's ethnicity was not directly indicated by the survey responses. Thus, alternatively, the estimations in columns (a) to (e), the ethnicity is proxied by typical languages that a household head spoke at home.

Table A.3: Falsification Test: Population Density in the Early and Mid-20th Century, District-age-gender Cohorts (OLS)

Dependent variable:	Log of population density per square mile							
	With non-Yao proportion in 1966				Without non-Yao proportion in 1966			
Sample:	Age-cohorts aged 60 years or above		All age-cohorts		Age-cohorts aged 60 years or above		All age-cohorts	
	(a)	(b)	(c)	(d)	(e)	(f)	(g)	(h)
Distance to Livingstonia (100km)	-0.797	-0.797	-1.038	-1.038	-	-	-	-
× Non-Yao (proportion)	(0.764)	(0.773)	(0.750)	(0.759)				
Distance to Livingstonia (100km)	1.194	1.194	1.517*	1.517*	0.329	0.329	0.441*	0.441*
	(0.797)	(0.806)	(0.778)	(0.787)	(0.202)	(0.204)	(0.215)	(0.217)
Non-Yao (proportion)	3.319	3.319	4.627	4.627	-	-	-	-
	(3.346)	(3.387)	(3.266)	(3.302)				
Male proportion	-	-0.014	-	-0.146***	-	-0.014	-	-0.146***
		(0.034)		(0.022)		(0.034)		(0.022)
Age-cohort								
5-9 years	-	-	-	-0.219***	-	-	-	-0.219***
				(0.012)				(0.012)
10-14 years	-	-	-	-0.540***	-	-	-	-0.540***
				(0.024)				(0.024)
15-19 years	-	-	-	-0.630***	-	-	-	-0.630***
				(0.018)				(0.018)
20-24 years	-	-	-	-0.901***	-	-	-	-0.901***
				(0.024)				(0.024)
25-29 years	-	-	-	-0.969***	-	-	-	-0.969***
				(0.029)				(0.029)
30-34 years	-	-	-	-1.186***	-	-	-	-1.186***
				(0.022)				(0.022)
35-39 years	-	-	-	-1.192***	-	-	-	-1.192***
				(0.034)				(0.034)
40-44 years	-	-	-	-1.602***	-	-	-	-1.602***
				(0.027)				(0.027)
45-49 years	-	-	-	-1.446***	-	-	-	-1.446***
				(0.032)				(0.032)
50-54 years	-	-	-	-1.874***	-	-	-	-1.874***
				(0.041)				(0.041)
55-59 years	-	-	-	-2.019***	-	-	-	-2.019***
				(0.044)				(0.044)
60-64 years	-	-	-	-2.392***	-	-	-	-2.392***
				(0.050)				(0.050)
65 years or above	-	0.880***	-	-1.512***	-	0.880***	-	-1.512***
		(0.064)		(0.049)		(0.063)		(0.049)
Longitude	0.528**	0.528**	0.453**	0.453**	0.550**	0.550**	0.449**	0.449**
	(0.192)	(0.194)	(0.201)	(0.204)	(0.215)	(0.217)	(0.206)	(0.209)
Latitude	-0.082	-0.082	0.055	0.055	-0.061	-0.061	0.068	0.068
	(0.159)	(0.161)	(0.158)	(0.160)	(0.159)	(0.161)	(0.158)	(0.160)
Constant	-22.830***	-23.264***	-19.563**	-18.313**	-19.966***	-20.399***	-14.647**	-13.397**
	(7.387)	(7.471)	(7.397)	(7.484)	(6.544)	(6.612)	(6.221)	(6.294)
Regional FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
R-squared	0.483	0.732	0.373	0.782	0.466	0.715	0.356	0.765
No. of obs.	92	92	644	644	92	92	644	644

Source: Author's calculation based on Malawi Population Census 1966, Final Report.
Notes: (1) The unit of observations is a district-age-gender cohort. (2) Figures ( ) are standard errors. *** denotes significance at 1%, ** at 5%, and * at 10%. (3) Standard errors are robust to heteroskedasticity and clustered residuals within each district. (4) The latitude and longitude are the coordinates of a district's capital city (major town). (5) The distance is measured as that between a district's capital city (major town) and Livingstonia. (6) The population density is a cohort's population (African, European, Asian, and other) divided by land area (square mile). (7) The analysis uses three regional fixed effects (i.e., north, central, south).

Table A.4: Formality of Marriage

Dependent variable:	One if polygyny		
		formal	informal
	2SLS	Multinomial logit (ME)	
	(a)	(b)	(c)
One if Christian	-0.265***	-0.119	-0.006
or Estimated Christianity	(0.089)	(0.074)	(0.029)
Non-Yao (dummy)	0.095**	0.015	0.006
	(0.046)	(0.041)	(0.017)
Age (years)	0.023***	0.026***	0.001
	(0.002)	(0.002)	(0.001)
Age squared	-0.000***	-0.000***	-0.000
	(0.000)	(0.000)	(0.000)
Education (years)	0.002	0.004**	0.000
	(0.002)	(0.002)	(0.001)
Education squared	-0.000***	-0.001***	-0.000*
	(0.000)	(0.001)	(0.000)
Birth order	0.001	0.001	-0.000
	(0.001)	(0.001)	(0.000)
No. of alive siblings	-0.001	-0.000	-0.001*
at age 15	(0.001)	(0.001)	(0.000)
No. of elder late siblings	-0.003	-0.004*	0.000
at age 15	(0.002)	(0.002)	(0.001)
No. of young late siblings	-0.004*	-0.002	-0.002***
at age 15	(0.002)	(0.002)	(0.001)
First marriage	-0.140***	-0.098***	-0.015***
(dummy)	(0.006)	(0.004)	(0.002)
Informal marriage	0.041***	-	-
(dummy)	(0.009)		
No. of mission stations	-0.010***	-0.011***	-0.001
within 25 km radius	(0.003)	(0.003)	(0.001)
Distance to the origin of the	0.129	-0.199	0.136**
HIV virus (100 km)	(0.189)	(0.159)	(0.068)
Urban (dummy)	-0.049***	-0.063***	0.001
	(0.009)	(0.011)	(0.004)
Matrilineal communities	0.011	0.012	-0.003
(dummy)	(0.008)	(0.008)	(0.003)
A community's most common	0.002	0.003	-0.008**
religion = Christianity (dummy)	(0.010)	(0.009)	(0.003)
No. of churches in a community	0.001	0.000	0.000
	(0.000)	(0.000)	(0.000)
No. of mosques in a community	0.000	0.001	-0.001**
	(0.001)	(0.001)	(0.000)
No. of primary schools run by	0.002	0.001	-0.001
religious organizations	(0.002)	(0.001)	(0.001)
No. of secondary schools run by	-0.009	-0.012	0.000
religious organizations	(0.006)	(0.007)	(0.003)
A community's nearest doctor	0.003	0.000	0.002
= religious facility (dummy)	(0.008)	(0.008)	(0.003)
Longitude	-0.109	0.195	-0.128**
	(0.165)	(0.141)	(0.060)
Latitude	0.139	-0.065	0.087**
	(0.112)	(0.092)	(0.040)
Birth-cohort FE	Yes	Yes	Yes
Geography & climate	Yes	Yes	Yes
Historical controls	Yes	Yes	Yes
District FE	Yes	Yes	Yes
Round FE	Yes	Yes	Yes
1st-stage F-statistic	30.41	-	-
Hansen (p-values)	0.687	-	-
R-squared	0.089	-	-
No. of obs.	30848	30848	30848

Notes: (1) Figures ( ) are standard errors. *** denotes significance at 1%, ** at 5%, and * at 10%. (2) Standard errors are robust to heteroskedasticity and clustered residuals within each community, exclusive of the analysis in columns (b) and (c) that uses bootstrapping with 100 replications. (3) The birth cohort is categorized into five groups of those that were born in the 1950s (reference group), 1960s, 1970s, 1980s, and 1990s. (4) The geographic and climate controls contain community-level information on climatology, landscape typology, soil & terrain, crop season parameters. See Appendix B for the details. (5) The ethnicity-level historical controls include (i) a dummy variable, equal to one if a European explorer traveled through land historically inhabited by an ethnic group; (ii) a dummy variable, equal to one if any part of railway lines in the first decade of the 20th century drawn from Century Company (1911) passed through land historically inhabited by an ethnic group; and (iii) the total number of slaves taken from an ethnic group that was normalized by the area of land inhabited by the ethnic group during the 19th century (log of one plus the normalized slave export measure). (6) The ME stands for "marginal effects."