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Fertility in Sub-Saharan Africa: the role of inheritance*

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Abstract

Fertility in Sub-Saharan Africa is the highest in the world and it should continue boosting population growth for decades to come. In this paper, we showcase a new driver of fertility decisions that has been largely overlooked by demographers and economists: inheritance rules. In particular, we demonstrate that impartible inheritance (i.e. transmission of the deceased's property to a single heir) does not incentivize households to limit their number of children. Our main empirical strategy links data from the past on deep-rooted inheritance customs for more than 800 ethnic groups with modern demographic surveys covering 24 countries in Sub-Saharan Africa. Our spatial Regression Discontinuity Design exploiting ancestral borders reveals that belonging to an ethnic group with impartible inheritance customs increases fertility by 0.85 children per woman. We also establish, both theoretically and empirically, that the fertility differences across inheritance rules are larger in lands that are less labor intensive.

JEL classification: J10, O10, K11
Keywords: *Fertility, Inheritance, Sub-Saharan Africa*

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1 Introduction

At 4.6 children per woman, the fertility rate in Sub-Saharan Africa is the highest in the world (United Nations 2022). While fertility is close to or below the population replacement rate in most countries, Sub-Saharan Africa is expected to double its population by 2050, surpassing 2 billion people. This high fertility and population growth creates a range of socioeconomic and environmental challenges, and will likely keep a brake on economic growth and poverty reduction.

Why is fertility so exceptionally high in Sub-Saharan Africa? A large body of work in economics and demography has highlighted explanations based on human capital (Vogl 2016; Baudin, de la Croix, and Gobbi 2020), technological progress (Guner, Delventhal, and Fernandez-Villaverde 2020), health improvements (Kalemli-Ozcan 2003; Cervellati and Sunde 2015), women empowerment (de la Croix and Brée 2019), family planning and contraception (Bhattacharya and Chakraborty 2017; Strulik 2017; de Silva and Tenreyro 2020; Cavalcanti, Kocharkov, and Santos 2021). Yet, these factors cannot fully explain Sub-Saharan Africa's differential fertility. Even after accounting for well-known determinants of fertility decline across the globe, the average woman in Sub-Saharan Africa will continue to give birth to 0.8 more children than women elsewhere in the developing world (Zipfel 2022).[1]

This paper showcases a new factor behind Sub-Saharan Africa's high fertility, which has been largely overlooked by economists and demographers alike: legal institutions regulating inheritance. We show that ancestral inheritance rules where property is transmitted to a single heir are still prevalent in most of modern Sub-Saharan Africa, and that these inheritance rules do not provide households economic incentives to limit their fertility. Across Sub-Saharan Africa, inheritance is often governed by a myriad of ancestral customary laws, a prerogative recognized in many constitutions. As a result, areas where land is transmitted to a single heir (henceforth, impartible inheritance) coexist in close proximity with areas where land is divided among several heirs (henceforth, partible inheritance). We examine how these deep-rooted inheritance rules affect today's fertility in Sub-Saharan Africa by linking two data sources: pre-industrial data on 842 ethnic groups from Murdock (1967), and modern Demographic and Health Surveys

[1] Similarly, the population projections by the United Nations Population Division (UNPD) have been repeatedly revised due lower-than-expected fertility decline, illustrating the fact that standard fertility determinants cannot fully account for Sub-Saharan Africa's experience.

(DHS) covering 24 countries from 1986 to 2019. OLS and regression-discontinuity estimates show that impartible inheritance substantially increases fertility, by as much as 0.85 children per woman. The magnitude of this effect closely matches the unexplained differential fertility of 0.8 children in Sub-Saharan Africa with respect to the rest of the world after accounting for human capital, technological progress, child mortality, women empowerment, family planning and contraception. Our results have important policy implications since impartible inheritance remains the prevailing custom in many ethnic groups across Africa and continues to rule the transmission of properties across generations.

Our empirical analysis encompasses two estimation strategies. The first is to compare the relationship between inheritance rules and women's fertility across ethnicities. We find that impartible inheritance is associated with higher fertility. The magnitude of the effect is comparable to other ethnic characteristics that have received more attention in the literature, such as polygamy (Tertilt 2005; Rossi 2019) or matrilineality (BenYishay, Grosjean, and Vecci 2017). The relationships are very similar when we control for an extensive set of covariates, including country and survey-year fixed effects, individual characteristics (age, religion, education, labor force participation, marital status, access to electricity), geographic covariates (rural area, latitude, longitude, population density, light intensity, soil and climate suitability for different crops, terrain ruggedness, slope), and historical controls (whether the ethnic group is patrilineal, authorizes polygynous unions, historical plow use, and the distance to missionary settlements, colonial railway lines, and explorers' routes). We also show that our estimated effect is similar when restricting the sample to women who have completed their reproductive lifespan.

Our second empirical strategy exploits ancestral ethnic borders in a spatial Regression Discontinuity Design (RDD), similar to Moscona, Nunn, and Robinson (2020). We restrict attention to women who live close to, but on opposite sides of, an ancestral border between two ethnic groups, where one ethnic group follows partible and the other ethnic group follows impartible inheritance. We find a sharp discontinuity in fertility at the ancestral ethnic border: belonging to an ethnic group with impartible inheritance customs increases fertility by 0.85 children per woman. Our RD estimates are qualitatively identical to those obtained using OLS and to the unexplained differential fertility in Sub-Saharan Africa after accounting for standard fertility determinants in the literature (human capital, technological progress, child mortality, women empowerment, family planning and contraception). The findings are robust to different bandwidths and specifications of the running variable. We also verify that the ancestral ethnic boundaries reported in Murdock (1959) still coincide with ethnic affiliation today.

The validity of our RD estimates rests on the assumption that omitted factors vary smoothly over space. We evaluate this assumption by conducting a balancing test for ethnic ancestral customs (polygyny, polygamy, patrilineality, patrilocality, religion, plow use, bride price, nomadism, pastoralism), historical factors (distance to missionary settlements, colonial railways, explorers' routes), and geographic characteristics (distance to equator, terrain ruggedness and slope, potential caloric yield, and land suitability for different crops). Some of these factors have been highlighted as important determinants for the emergence of inheritance systems, albeit in contexts outside of Africa. Specifically, the prevailing theories are that impartible inheritance arises: *(i)* in farming economies where land is the primary source of wealth and is subject to indivisibilities (Bertocchi 2017), *(ii)* in places that also adopted patrilineal family systems (Sabean and Teuscher 2007), or *(iii)* in places occupied by settlers who already followed such a rule (Chénon 1926). We show that, in Sub-Saharan Africa, the geographical determinants of inheritance systems are more prevalent. Because our RD estimates control for geographic characteristics that vary smoothly across space—e.g., because geographically close units have similar climate and terrain—this strategy allows us to effectively explore the causal link between inheritance customs and current fertility levels.

To better understand the mechanisms through which inheritance rules affect fertility decisions, we develop a conceptual framework of land production, inheritance, and fertility. Our model characterizes subsistence farming in Sub-Saharan Africa with a Stone-Geary production function subject to land indivisibility constraints over small plots of land. We incorporate impartible and partible inheritance rules governing the transmission of land and the use of labor provided by household members. We derive two predictions from the model that we bring to the data. The first prediction is that partible inheritance, by dividing land among several heirs, provides an economic incentive to limit fertility in order to avoid fragmenting the land into "inefficiently small parcels" (Baker and Miceli 2005). In contrast, impartible inheritance, by transmitting all lands to a single heir, is associated with high fertility rates. Because land is not divided, indivisibility constraints do not bind and do not reduce the household's economic incentives for having children and using them as labor input in the family farm. This prediction rationalizes our main findings described above. In addition, the second prediction provides comparative statics with respect to the output elasticity of labor. Specifically, we show that the partible-impartible fertility differential wanes as the farming production function becomes increasingly labor intensive. Intuitively, this result stems from the fact that, when the output elasticity of labor is large and land is less vital for production, the economic incentive for having children and using them as labor in the family farm more than compensates the the costs of dividing the land among many heirs. This prediction highlights that land indivisibility is the key mechanism through which inheritance rules affect fertility.

We perform two tests for the land-indivisibility mechanism highlighted by our conceptual framework. The first test exploits spatial variation in soil suitability for roots and tubers relative to cereals; the second variation with respect to terrain slope. These soil and terrain characteristics determine the degree of labor intensity of the agricultural production (Food and Agriculture Organization 1993), and hence, can be used to examine the model's second prediction. Consistent with our conceptual framework, we find that the partible-impartible fertility differential converges to zero under overly labor-intensive farming. These findings highlight how the relationship between inheritance rules and fertility is crucially affected by different characteristics of the lands transmitted across generations, which are associated with land indivisibilities at the heart of our theory.

Relative to previous literature, our main contribution is to uncover a novel determinant of fertility decisions: inheritance rules. The role of legal factors in general and of inheritance rules in particular has been largely overlooked by economists (Doepke et al. 2022), whose focus has been on human capital (Vogl 2016; Baudin, de la Croix, and Gobbi 2020), technological progress (Guner, Delventhal, and Fernandez-Villaverde 2020; Greenwood, Seshadri, and Vandenbroucke 2005), child mortality (Kalemli-Ozcan 2003; Cervellati and Sunde 2015), women empowerment (de la Croix and Brée 2019), and family planning (Bhattacharya and Chakraborty 2017; Strulik 2017; de Silva and Tenreyro 2020; Cavalcanti, Kocharkov, and Santos 2021). A recent strand of literature also explores the long-term effects of past colonial policies on fertility in Africa, such as family planning (Canning, Mabeu, and Pongou 2020; Guirkinger and Villar 2022), christian missions (Okoye and Pongou 2023), or forced labor migration (Dupas et al. 2023). In line with Godart and Rossi (2022), our paper suggests that institutions can play a major role in accelerating fertility declines and allowing Sub-Saharan African countries to grasp the benefits of a demographic dividend (Bloom, Kuhn, and Prettner 2017).[2]

Our paper also bridges two separate strands of the literature: one exploring fertility decisions (Doepke et al. 2023), another the role of inheritance and ancestral customs on current economic outcomes (Lowes 2021; Michalopoulos and Papaioannou 2020). Early studies on ancestral inheritance customs were based on ethnographic observations and were theoretical in nature. For instance, Guner (1999) provided a theoretical model where inheritance rules and marriage decisions are endogenously determined. Baker and Miceli (2005) compared "fixed" (i.e., equal or relatively equal distribution, primogeniture, and ultimogeniture) and "no fixed" (i.e., best-qualified) inheritance rules to study human capital investments related to land usage. Our theoretical model expands on such works and provides empirical support to its testable implications using data from ancestral characteristics in Sub-Saharan Africa. Since the seminal contribution by Nunn (2008), who digitized the map of ethnic boundaries from Murdock (1959), a large literature has flourished studying the long-run socio-economic consequences of ancestral ethnographic characteristics. For instance, Alesina, Giuliano, and Nunn (2013) study the consequences of historical plough-based agriculture on gender norms, Michalopoulos, Putterman, and Weil (2019) study the relationship between historical dependence on agriculture on income and education, or Becker (2022) studies the relationship between pastoralist societies and norms related to women's promiscuity. Our paper hence contributes to both the early theoretical studies looking at inheritance rules and to the later empirical contributions studying how ethnographic historical traits relate to the process of development.

Additionally, our paper highlights that the effects of institutions depend on local geographic conditions. We show both theoretically and empirically that fertility differences across inheritance rules are larger in less labor-intensive lands. IN this respect, our article relates to a literature studying the effects of institutions and geography on economic development (Acemoglu, Johnson, and Robinson 2002; Nunn and Puga 2012; Mayshar, Moav, and Pascali 2022). We show that the effectiveness of inheritance policies in the context of pre-industrialized societies will depend on the underlining geographic and soil characteristics.

Finally, our paper offers important policy implications for the potential effects of inheritance law reforms on the demographic transition in Sub-Saharan African.

[2]The demographic dividend corresponds to the economic growth potential from a shift in a population's age structure. When the working age population surpasses the rest, the dependency ratio falls, freeing resources to invest in essential infrastructure needed to develop.

A recent strand of the development economics' literature has examined various short-run consequences inheritance law reforms,[3] although the effects on fertility and family structure have been largely ignored.[4] In addition, these studies focus mostly on the inclusion or exclusion of women in the bequest. Our paper highlights another, potentially crucial, parameter for reforming inheritance laws: the division of the estate among *all* siblings. In this respect, we echo the results of Gay, Gobbi, and Goñi (2023), who show that the abolition of impartible inheritance during the French Revolution reduced fertility. Taken together, our results on modern Sub-Saharan Africa and Gay, Gobbi, and Goñi (2023) on 18C France suggest that abolishing impartible inheritance could be an important driver of the demographic transitions across time and space.

2 Background

2.1 Customary law in modern Sub-Saharan Africa

Inheritance in Sub-Saharan Africa is in general regulated by customary law. In fact, most countries recognize that customary land rights (Deininger et al. 2003) and land administration, including transfer following an inheritance, is effectively decentralized to traditional authorities (Byamugisha 2013).

Customs represent a set of long-established local rules emanating from traditional practices. They are not only a usage or a habit, but binding rules enforced by customary chiefs. For example, the constitution of Ghana says: "customary law means the rules of law which by custom are applicable to particular communities in Ghana" (article 11).

Customary law in Africa has its roots in the traditional laws in use prior to the colonial era. Although African colonies were ruled via imported common law or civil codes from the metropoles after the nineteenth century, customary law retained jurisdiction over African citizens under colonial supervision (Milner 1967).

[3]The 2005 Hindu Succession Act is probably the reform that has received most attention (Deininger, Goyal, and Nagarajan 2013; Roy 2015; Anderson and Genicot 2015; Bahrami-Rad 2019; Bhalotra, Brulé, and Roy 2020). Other inheritance reforms that have been studied include Ghana's Intestate Succession PNDC Law 111 of 1985 implemented by the Provisional National Defense Council (PNDC) (Aldashev et al. 2012; La Ferrara and Milazzo 2017), Kenya's Law of Succession Act of 1981 (Harari 2019), the Koranic inheritance exclusion rule among the Muslim population in Indonesia Carranza (2012), or the inheritance reform in Philippines Estudillo, Quisumbing, and Otsuka (2001).

[4]Mookerjee (2019) and Bose and Das (2023) are exceptions.

After independence, the resulting legal systems typically comprise a combination of pre-colonial customary law, civil or common law, and religious law. Figure 1 shows that most of Sub-Saharan Africa have mixed legal systems with a customary law tradition. Table A.1 shows that most of the constitutions of Sub-Saharan African political entities used in our analysis recognize customary law as a valid source of law. Customs are applicable to an ethnic group of origin (Gilissen 1960) and the application is ensured by traditional and customary authorities. Constitutions also recognize the role of customary authority: "The institution of Chieftaincy as established by customary law and usage and its non-abolition by legislation is hereby guaranteed and preserved" (article 72 of the constitution of Sierra Leone).

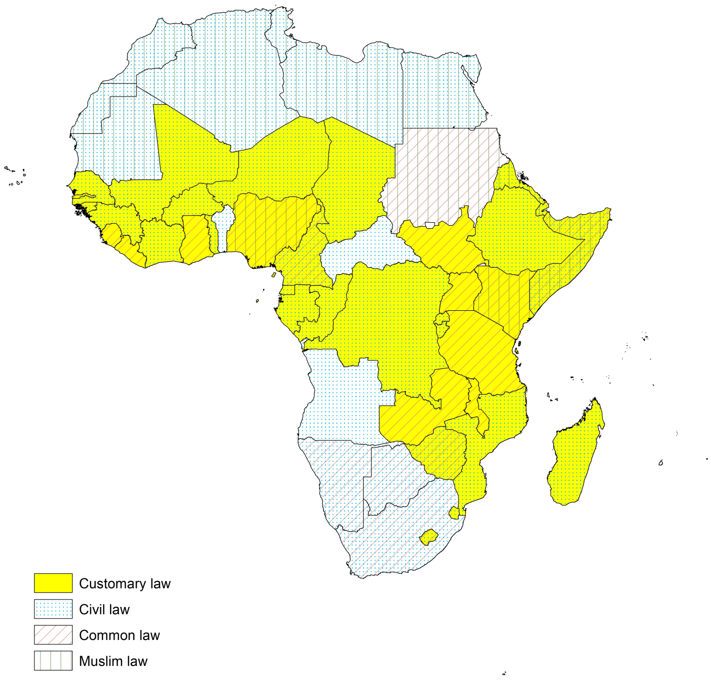


Figure 1: Legal systems in Africa

Source: JuriGlobe - World Legal Systems Research Group, University of Ottawa; Logo (2014).

Customary law plays a significant role in matters of family and personal status such as inheritance. This is recognized in the constitution of Sub-Saharan African countries, which defer to customary law to govern inheritance (Cooper 2010). For instance, article 162 of Chad's constitution says "The customary and traditional rules governing the matrimonial regimes and inheritance may only be applicable with the consent of the concerned parties. In default of consent, the national law alone is applicable." Moreover, in some Sub-Saharan African countries (such as

Ghana, Kenya, Zambia, or Zimbabwe), family law is completely excluded from non-discrimination clauses (UN Habitat 2006). This implies that siblings can be treated differently depending of their birth order or gender. The primacy of customary law is further reinforced by courts' ruling. A seminal example is the 1999 Zimbabwean case of *Magaya v. Magaya*. The Supreme Court ruled in favor of Nakayi Shonhiwa—who inherited all his father's estates—against his older sister Veneria arguing that "customary law is a long-standing, fundamental, and central aspect of African society" (Ndulo 2011). In some other countries (such as Ethiopia, Mozambique, Namibia, Nigeria, or Senegal), the constitution explicitly prohibits discrimination. However, in practice, inheritance remains regulated through the local customs and can be *de facto* discriminatory across siblings. Some countries have tried to implement legal reforms to limit the impact of customary laws on inheritance. For instance, the Ghana Children's Act 560 of 1998 was meant to guarantee that "no person shall deprive a child of reasonable provision out of the estate of a parent." However, in practice, these reforms had only a very limited impact (Kutsoati and Morck 2014). The reason is the lack of measures to ensure "social legitimation, implementation and enforcement" (Cooper 2010). In many instances, hence, it is the customary judge who continues to administer inheritance conflicts.

2.2 Origins of inheritance customs

What are the origins of these different ancestral inheritance systems? One prevailing theory highlights the role played by geographic characteristics (Bertocchi 2006; Huning and Wahl 2021). According to this theory, impartible inheritance is more likley to arise in farming economies where land is the primary source of wealth and is subject to indivisibilities (Bertocchi 2017). Another hypothesis is that impartible inheritance was adopted by societies that also had adopted patrilineal family systems (Sabean and Teuscher 2007). In addition, inheritance customs were sometimes determined by the groups of settlers that populated a certain territory and brought with them the customs and laws of their ancestral homelands (Chénon 1926).

Although these three main schools of thought are widely recognized, they draw on evidence from settings outside of Africa. We explore the prevalence of these determinants of inheritance systems in Sub-Saharan Africa, both theoretically and empirically. Specifically, we develop a theoretical framework that incorporates land indivisibilities and bring its predictions to the data. In addition, we perform an exploratory analysis by comparing the strength of the association between geographic and climatic determinants of land productivity and impartible inheritance to that of other ancestral characteristics, including patilineal family systems. Results are displayed in Appendix Table A.3. We document that, in Sub-Saharan Africa, geographic determinants seem to be more important predictors of inheritance customs, explaining 50 percent of the variation in inheritance customs among ethnic groups.

Motivated by this evidence on the origins of inheritance systems, our analysis checks for balance between partible and impartible ethnic groups across an extensive set of covariates, including geographic, ancestral, and historical characteristics that could have affected the propensity to adopt impartible inheritance (see Section 5.2). We find that these potential determinants of inheritance systems—especially the geographic factors that seem to be most relevant in our Sub-Saharan setting—vary smoothly at ethnic group boundaries. This lends credence to our RD estimation strategy, which allows us to effectively explore the causal link between past inheritance customs and current fertility levels as long as factors affecting them—e.g., confounders related to the origin of inheritances—are similar across geographically close units.

3 Conceptual framework

Setup. Consider an economy populated by adults who make decisions for their household. Households differ with respect to the inheritance rule i, that is customary in their ethnic group. We consider the two types of inheritance rules: partible ($i = P$) and impartible ($i = I$) inheritance.

Adults' utility is a function of the household's consumption, c, and the total endowments of their children:

$$u(c_i, n_i) = \ln c_i + \beta \ln \left(n_i y_i'\right), \tag{1}$$

where $n \geq 1$ is the number of children of the household; y' is the children's income; and $\beta > 0$ is an altruism parameter that reflects the household value attached to the next generation. We assume a "warm glow" type of altruism whereby households care directly about their children's endowments, as in a quantity-quality framework of human capital (de la Croix and Doepke 2003). Such assumption can be justified by the fact that "the motives which induce a man to accumulate personal capital *in* his son's education, are similar to those which control his accumulation of material capital *for* his son." (Marshall 1890, p. 549).

Consumption depends on the number of children and on the household's income derived from an agriculture-based production technology:

$$c_i = (1 - \phi n_i) y_i, \tag{2}$$

where $\phi \in (0, 1)$ is a fixed cost of raising children and y is the income.

Total household production is determined by two inputs: land, L, and labor, N. These are combined using a Stone-Geary production function f:

$$f(L, N_i) = \begin{cases} 0 & \text{for } L \leq \bar{L} \\ \left(L - \bar{L}\right)^{1-\alpha} N_i^{\alpha} & \text{otherwise.} \end{cases} \tag{3}$$

Two parameters pin down this production function. The first parameter is $\bar{L} > 0$, a fixed amount of land required for a farm to be productive: it is unlikely that a positive level of agricultural output is obtained with only a minuscule amount of land input. Stone-Geary technology is natural in agricultural-dependent economies, although underused in the literature (Beattie and Aradhyula 2015). In particular, the existence of a land threshold is consistent with the predominance of subsistence agriculture in developing economies. In Sub-Saharan Africa 80% of the farms are small, i.e. less than two hectares (Lowder, Skoet, and Raney 2016; Giller et al. 2021).[5]

The second parameter is $\alpha \in (0, 1)$, the output elasticity of labor. This parameter is determined by the available agricultural technology and captures the intensity with which each input is used in the production function. Specifically, larger values of α correspond to a labor-intensive production, while smaller values correspond to a land-intensive production. In our setting, where subsistence agriculture predominates, farms are generally small, and the majority of the labor is provided by household members, farming practices are typically labor intensive ($\alpha > 0.5$). The characteristics of the terrain and the suitability of the soil for different crops can further determine the relative importance of labor with respect to productive land. In particular, where soil is better suited for labor-intensive crops (e.g., sorghum) than for crops requiring little labor input (e.g., casava), or

[5] Although the 1970s and 80s saw efforts to move toward large-scale agriculture in Sub-Saharan Africa, these failed and small farming has persisted (Deininger and Byerlee 2012).

where the terrain is rugged and costly to farm or build on, we expect a more labor-intensive production (larger values of α).

Households pass down their land across generations following the inheritance rule i of their ethnic group. The distinction between partible and impartible inheritance rules follows two assumptions. First, we assume that there is no functioning land market so that land can only be acquired by a bequest, denoted L'_i. Such assumption is natural in the context of less developed countries (Basu 1986). And second, we assume that inheritance and the structure of households are the two sides of a same coin (Lanzinger 2003; Guirkinger and Platteau 2015b; Guirkinger and Platteau 2015a). In detail, under partible inheritance, land is transmitted equally to each child who forms a new (neolocal) household. Each child is hence a laborer on its own plot of land. Income is equal to the output of the production. This implies that

$$L'_P = \frac{L}{n_p} \ , \qquad N_p = 1 \ , \quad \text{and} \qquad y'_P = f\left(\frac{L}{n_p}, 1\right) \ . \tag{4}$$

Under impartible inheritance, land is never divided and therefore remains constant across generations. The household consists of an extended family, whose members, N'_I, work on a collective farm owned by the heir.[6] Total production is shared among all the adults of the extended family.[7] This implies that

$$L'_I = L \ , \qquad N'_I = n_I \ , \quad \text{and} \qquad y'_I = \frac{f(L, n_I)}{n_I} \ . \tag{5}$$

Both assumptions, on the absence of land markets and on the reliance on family members as workers, are supported in the context of Sub-Saharan. For instance, the Living Standards Measurement Study (LSMS) data for the years 2018-2019 suggest that around 80% of households received their land through inheritance, and all of them use family as labor.[8]

Before solving the model, we make the following assumption ensuring that fertility is above one in the interior case.

[6] Without loss of generality, we assume that all the offspring stay at the family farm. Assuming that a fraction of them leaves does not change the results.

[7] Note that adults care about total output and not its distribution (Equation 1), hence different distribution assumptions are neutral to our results.

[8] The LSMS is a nationally representative household survey conducted within the West Africa Economic Monetary Union. It contains harmonized information for Benin, Burkina Faso, Chad, Cote d'Ivoire, Guinea Bissau, Mali, Niger, Senegal and Togo.

Assumption 1 *The cost of a child is relatively low:*

$$\phi < \frac{\alpha\beta}{1+\alpha\beta} \quad . \tag{6}$$

Assumption 1 is consistent with the fact that fertility is above replacement rates in Sub-Saharan Africa.

Equilibrium. The equilibrium fertility decisions under impartible and partible inheritance rules are given by n_I^* and n_P^*, respectively. These are the optimal fertility choices that maximize the utility function in Equation (1) subject to the budget constraint in Equation (2), the production function in Equation (3), the inheritance rules in Equations (4) and (5), and the condition $n \geq 1$.[9] In detail, n_I^* and n_P^* depend on the size of the household's plot of land:

- If $L \leq \bar{L}$; $n_I^* = n_P^* = 1$.
- If $\bar{L} < L < \tilde{L}$; $n_I^* = \dfrac{\alpha\beta}{(1+\alpha\beta)\,\phi}$ and $n_P^* = 1$.
- If $L \geq \tilde{L}$; $n_I^* = \dfrac{\alpha\beta}{(1+\alpha\beta)\,\phi}$ and $n_P^* = \dfrac{\beta\bar{L} + (1+\alpha\beta)\phi L - \sqrt{\Delta}}{2(1+\beta)\phi\bar{L}}$

  where $\tilde{L} \equiv \dfrac{(\beta-(1+\beta)\phi)\,\bar{L}}{\alpha\beta-(1+\alpha\beta)\,\phi}$;

  and $\Delta \equiv (\beta\bar{L} + (1+\alpha\beta)\phi L)^2 - 4\alpha\beta(1+\beta)\phi\bar{L}L$.

The left panel of Figure 2 illustrates the model's equilibrium. It shows the relationship between fertility and the plot size under partible and impartible inheritance for certain parameter values. Intuitively, when the landholdings transmitted across generations is below $\bar{L}$, land is unproductive without resort of the labor input (i.e., number of children) or the inheritance regime (partible or impartible). Hence, the number of children is restricted to the minimum independently of the inheritance regime. For landholdings that are large enough to be productive, but small enough such that the indivisibility constraints are binding if land is further divided, i.e., when $\bar{L} < L < \tilde{L}$, fertility is higher under impartible than under partible inheritance and the fertility gap is at its maximum. The reason is that, under partible inheritance, further dividing such landholdings among several heirs can result in production falling below the subsistence level. This provides households under

[9] The details for solving the maximization problem are shown in Appendix A.3.

this inheritance regime a powerful incentive to limit their fertility. In contrast, under impartible inheritance, land is passed down unbroken, ensuring the maintenance of a productive land across generations even when fertility is high. The partible-impartible fertility gap gets smaller as the amount of land increases, i.e., in the $L \geq \tilde{L}$ region. This is because, as the size of the landholdings increase, the indivisibility constraint is less binding, in the sense that landholdings will remain above the productive threshold if they are split among few heir in partible inheritance regimes. That said, the incentive to limit fertility in order to avoid the fragmentation of land still exists, and the fertility gap between impartible and partible households remains positive. Proposition 1 generalizes the equilibrium and derives our first testable implication for the empirical analysis.

PROPOSITION 1 *Fertility is higher under impartible inheritance than under partible inheritance.*

Proof: When $L \leq \bar{L}$, $n_I^* = n_P^* = 1$. When $\bar{L} < L < \tilde{L}$ $n_P^* = 1$ and $n_I^* > 1$ by Assumption 1. When $L \geq \tilde{L}$, $n_I^* - n_P^* > 0$. ■

Proposition 1 follows directly from the Stone-Geary technology threshold that makes land unproductive when too little land inputs are used. Under partible inheritance, family landholdings are divided among all offspring. Hence, a high fertility decreases the amount of land available for the heirs and, eventually, can result in land inputs falling below the productive threshold and production below subsistence level. Under impartible inheritance, the transmission of land to a single heir prevents such land fragmentation, and the only factor limiting fertility is the cost of children in the budget constraint (Equation 2).[10] As a result, fertility is higher under impartible inheritance than under partible inheritance.

Comparative statics. Here, we show how fertility across all households, and how partible-impartible fertility differentials change for different labor-output elasticities (α). As explained above, larger values of α correspond to a labor-intensive production. Given the predominance of subsistence agriculture in Sub-Saharan Africa, farming practices are typically very labor intensive ($\alpha > 0.5$). That said, the varying characteristics of the terrain and the different soil suitability for specific crops generate heterogeneity in the labor-intensity of agricultural practices.

[10]We can check that the maximum fertility from the time constraint $1 - \phi n$ is never optimal; $1/\phi > n_I^* > n_P^*$ from Proposition 1.

Proposition 2 derives how fertility across all households depends on the output elasticity of labor.

PROPOSITION 2 *Fertility is higher when the production is more labor intensive (higher α).*

Proof: If $L \leq \bar{L}$; $n_I^* = n_P^* = 1$. If $L > \bar{L}$; $\frac{\partial n_I}{\partial \alpha} = \frac{\beta}{(1+\alpha\beta)^2\phi} > 0$, $\frac{\partial \tilde{L}}{\partial \alpha} < 0$, and

$$\frac{\partial n_P}{\partial \alpha} = \frac{L\beta\left(1 + \frac{\bar{L}(2+\beta) - L(1+\alpha\beta)\phi}{\sqrt{\Delta}}\right)}{2\bar{L}(1+\beta)} > 0 \iff L > \frac{\bar{L}}{\phi}\ .$$

Note that the last condition must hold in order for the production to be defined, otherwise $\frac{L}{n_P^*} - \bar{L} < 0$. Hence, $\frac{\partial n_P}{\partial \alpha} > 0$. ■

Intuitively, Proposition 2 shows that there is a positive relationship between fertility and the output elasticity of labor in both inheritance regimes. Under impartible inheritance, fertility determines the labor input in the production function. Hence, as the production function becomes more labor-intensive (higher α), the economic incentives to have children increase increase. Under partible inheritance, fertility determines the size of the land, as the family landholdings are divided among many children. Hence, as the production function becomes more labor-intensive the economic incentives to have children are less affected by the constraint from the Stone-Geary production. In other words, as land becomes relatively less important for production, so does the fact that dividing the land across many heirs fragments the family landholdings.

Although fertility increases in the output elasticity of labor under both partible and impartible inheritance regimes, note that it does so because of two different mechanisms. Which of these mechanisms provides stronger incentives to increase fertility as α increases? Proposition 3 derives our second testable implication by exploring how the partible-impartible fertility differential changes under different output elasticities.

PROPOSITION 3 *The fertility difference between partible and impartible inheritance becomes nil when production is highly labor intensive.*

Proof: We can re-write our equilibrium conditions as follows:

- If $\alpha \leq \bar{\alpha}$; $n_I^* = n_P^* = 1$.
- If $\bar{\alpha} < \alpha < \tilde{\alpha}$; $n_I^* = \frac{\alpha\beta}{(1+\alpha\beta)\,\phi}$ and $n_P^* = 1$.

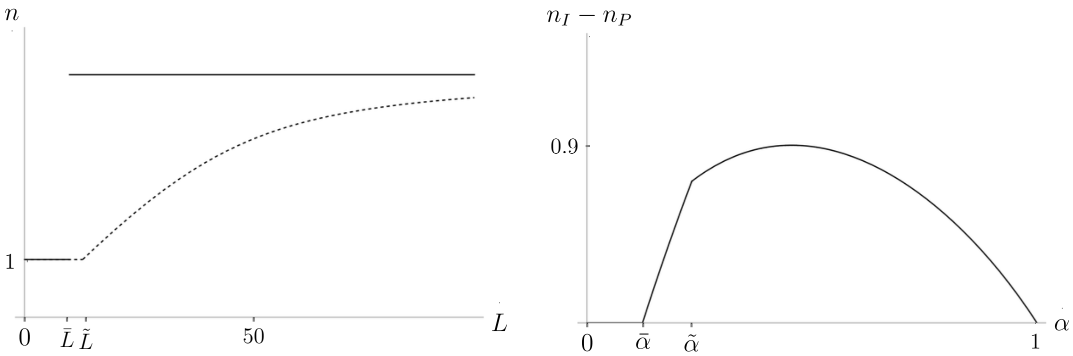


Figure 2: Left: Relationship between fertility (n) and land (L) under partible (dotted line) and impartible inheritance (solid line), with $\alpha = 0.8$, $\beta = 0.9$, $\phi = 0.1$, and $\bar{L} = 10$. Right: Relationship between the impartible-partible fertility difference ($n_I - n_P$) and the output elasticity of labor (α), with $L = 80$, $\bar{L} = 10$, $\beta = 0.9$, and $\phi = 0.1$.

- If $\alpha \geq \tilde{\alpha}$; $n_I^* = \dfrac{\alpha\beta}{(1+\alpha\beta)\,\phi}$ and $n_P^* = \dfrac{\beta\bar{L} + (1+\alpha\beta)\phi L - \sqrt{\Delta}}{2(1+\beta)\phi\bar{L}}$

where $\bar{\alpha} \equiv \dfrac{\phi}{\beta(1-\phi)}$ is the solution for $\dfrac{\alpha\beta}{(1+\alpha\beta)\,\phi} = 1$, and $\tilde{\alpha} \equiv \dfrac{\phi L - ((1+\beta)\phi - \beta)\bar{L}}{\beta(1-\phi)L}$ is the solution for $\tilde{L} = L$.

Hence, for $\alpha \leq \bar{\alpha}$, $n_I^* - n_P^* = 0$. For $\alpha > \bar{\alpha}$, $n_I^* - n_P^* \geq 0$ (Proposition 1) and

$$\frac{\partial n_I^*}{\partial \alpha} = \frac{\beta}{(1+\alpha\beta)^2\phi} > 0 \ .$$

Hence, for $\bar{\alpha} < \alpha < \tilde{\alpha}$, $\dfrac{\partial(n_I^* - n_P^*)}{\partial \alpha} > 0$.

For $\alpha \geq \tilde{\alpha}$, it is not possible to derive the sign of $\dfrac{\partial(n_I^* - n_P^*)}{\partial \alpha}$ but we can study the difference in fertility for large levels of the output-labor elasticity by doing a linear approximation of the optimal fertility decisions under partible and impartible inheritance at $\alpha = 1$.

For $\alpha = 1$, the maximization problem under partible and impartible inheritance is the same, so $n_I^* - n_P^* = 0$. Moreover,

$$\left.\frac{\partial n_I}{\partial \alpha}\right|_{\alpha=1} = \frac{\beta}{(1+\beta)^2\phi} \text{ , and}$$

$$\left.\frac{\partial n_P}{\partial \alpha}\right|_{\alpha=1} = \frac{L\beta\left((2+\beta)\bar{L}-(1+\beta)\phi L+\sqrt{(\beta\bar{L}-(1+\beta)\phi L)^2}\right)}{2(1+\beta)\bar{L}\sqrt{(\beta\bar{L}-(1+\beta)\phi L)^2}} \ .$$

If $\beta\bar{L}-(1+\beta)\phi L<0$, then

$$\left.\frac{\partial n_P}{\partial \alpha}\right|_{\alpha=1} - \left.\frac{\partial n_I}{\partial \alpha}\right|_{\alpha=1} = 2\beta\bar{L} > 0 \ .$$

And we can show that $\beta\bar{L}-(1+\beta)\phi L<0$ holds because we know that at $\alpha=1$, $n_I^*=n_P^*$, and hence $\frac{L}{n_I^*}-\bar{L}>0$ must hold, and

$$\frac{L}{n_I^*}-\bar{L}>0 \iff \beta\bar{L}-(1+\beta)\phi L<0 \ .$$

This implies that

$$n_P^*(\alpha=1)+\left.\frac{\partial n_P^*}{\partial \alpha}\right|_{\alpha=1}(\alpha-1) > n_I^*(\alpha=1)+\left.\frac{\partial n_I^*}{\partial \alpha}\right|_{\alpha=1}(\alpha-1) \ .$$

Hence, when the output-labor elasticity is large (close to 1), fertility under partible inheritance will grow faster as production becomes more labor intensive than under impartible inheritance. Given that the difference is nil when $\alpha=1$, this implies that the gap in fertility shrinks as the output-labor elasticity becomes large. ■

The right panel of Figure 2 illustrates Proposition 3 for certain parameter values and provides an intuition for why the partible-impartible fertility differential is reduced under more labor-intensive production. The figure shows the difference in fertility between impartible and partible inheritance regimes (vertical axis) against the output elasticity of labor (horizontal axis). When the output elasticity of labor is below $\bar{\alpha}$, the production function is very land-intensive and labor plays a minor role. Under this scenario, fertility is equal to the reproductive minimum ($n=1$) in both inheritance systems: Under impartible inheritance, because the incentive to have children and use them as labor input is very small; and under partible inheritance, because fragmenting family lands among more than one heir is extremely costly. When the output elasticity of labor is between $\bar{\alpha}$ and $\tilde{\alpha}$, the fertility differential between the impartible and partible inheritance systems increases. This is because production is sufficiently labor intensive such that there is an economic incentive to have children and use them as labor under impartible inheritance, but sufficiently land intensive such that there is an incentive to restrict fertility to avoid the fragmentation of land under partible inheritance. When the output elasticity of labor is sufficiently large, land is less vital for production and, hence, the costs of dividing the land are small. Hence, fertility under partible inheritance increases at a higher rate than under impartible inheritance, which closes the fertility gap between the two inheritance systems.

In the empirical analysis, we will test Proposition 3 exploiting spatial variation in soil suitability for different crops and terrain slope, which determine the degree of labor intensity of the agricultural production. Because, in our context, subsistence agriculture predominates, farms are generally small, and the majority of the labor is provided by household members, we expect the farming practices are typically relatively labor intensive ($\alpha > 0.5$), and hence, Proposition 3 to be in the parameter region where fertility differentials decrease in the labor intensity of the production function.

4 Data and sampling

This section provides an overview of the data sources used for the empirical analysis. We distinguish between contemporary sources on fertility across Sub-Saharan countries and historical records on ancestral ethnic characteristics, including deep-rooted inheritance customs. We conclude this section with some graphical explorations of the impact of inheritance rules on fertility decisions during women's reproductive lifespan.

4.1 Ancestral ethnic characteristics

The most compelling source for ancestral ethnic characteristics is the Ethnographic Atlas (EA) coded by Murdock (1967). Over the last decade, several researchers have relied on this anthropological database to study the influence of ancestral characteristics on modern outcomes.[11] The EA compiles information on societal characteristics, economic activities, and political organization of ethnic groups in the nineteenth and early twentieth centuries (i.e. in the pre-industrial period). For Sub-Saharan Africa, the database offers detailed information on pre-industrial characteristics for 842 different ethnic groups. Among other things, it reports the type of subsistence economy (hunting, fishing, animal husbandry or agriculture), the kinship systems (matrilineal or patrilineal), the domestic organization (nuclear, polygynous or extended family forms), and the inheritance rules.

[11]See Lowes (2021) for a review and a discussion on the limitations of the database.

We construct our main explanatory variable on inheritance customs from the variable "Inheritance distribution for real property (land)" of the EA (variable EA075). We build an indicator distinguishing between ethnic groups with partible and impartible inheritance. Partible inheritance corresponds to "Equal or relatively equal distribution among all members of the category."[12] Impartible inheritance includes (i) "Exclusive or predominant inheritance by the member of the category adjudged best qualified, either by the deceased or by his surviving relatives;" (ii) "Ultimogeniture, i.e., predominant inheritance by the junior member of the category;" and (iii) "Primogeniture, i.e., predominant inheritance by the senior member of the category."

We map the different inheritance rules across ethnic groups in the African continent using earlier work by Murdock (1959) drawing historical ethnic boundaries.[13] Figure 3 shows that there is ample variation in inheritance customs across Africa, but also within the borders of modern countries. The figure illustrates the wide variation in inheritance rules across space and within countries.

4.2 Contemporaneous survey data

We use the Demographic and Health Surveys (DHS) conducted in Sub-Saharan African countries over the last decades to highlight fertility decisions in modern times. The main advantages of the DHS is that it interviews a nationally representative sample of households and that it has the best coverage for Sub-Saharan Africa, both in terms of time and space. Indeed, we were able to include all survey waves conducted in the period 1986-2019 for which individuals' ethnicity and GPS coordinates were available. In total, we can observe fertility decisions in 24 countries covering a large part of Sub-Saharan Africa. Appendix Figure A.1 illustrates the geographical coverage of the data by mapping the coordinates of the DHS clusters. We pool together data from the different survey phases in each country. The sample size by phase ranges from about 4,500 respondents in Ghana surveyed during phase 2 (1993-1994) to more than 60,000 respondents in Senegal surveyed

[12]We classify ethnic groups where the EA reports an "absence of private property' ' as having partible inheritance. This concerns only 2 percent of our sample and our results are robust to excluding these ethnic groups from the analysis (see Section 5.3). The reason we classify absence of private property as partible inheritance is that, under this regime, everyone can access the land but none can sell it for their own benefit. For example, in the Bakuba ethnic group in the Democratic Republic of Congo, all the land belongs to the chief (the tribe's representative) and cannot be sold; the product of the land, in contrast, belongs to those who have sown it (Torday and Joyce 1910).

[13]We use the map digitized by Nunn (2008).

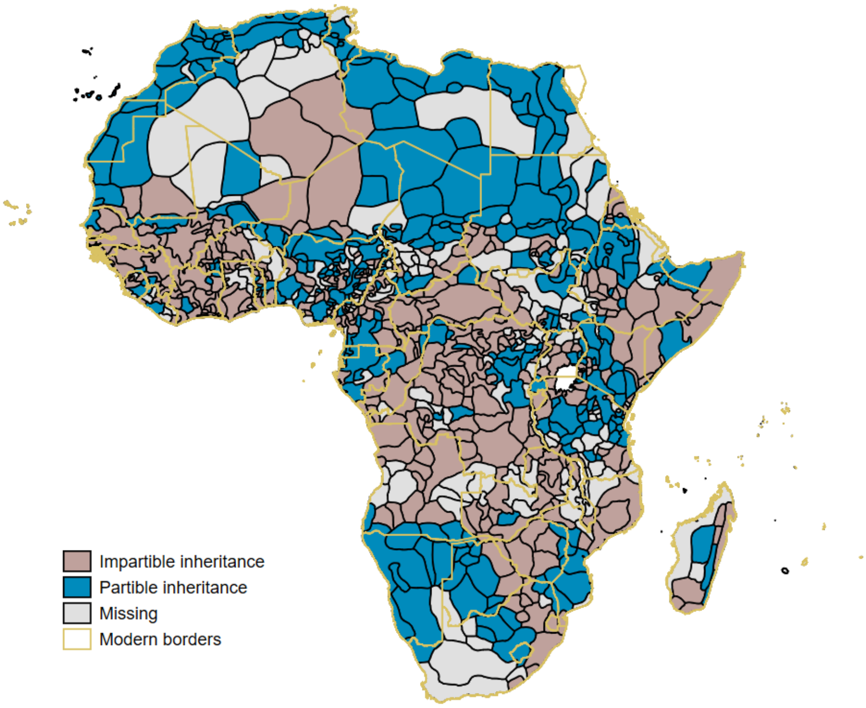


Figure 3: Ancestral inheritance customs in the Ethnographic Atlas.

during phase 6 (2010-2016). A description of the surveys available in each country is reported in Appendix Table A.2.

To link contemporaneous data on fertility with past inheritance customs, we match the respondents' self-reported ethnicity recorded in DHS (variable v131) with their ancestors' pre-industrial characteristics from the EA.[14] In many cases, the matching is straightforward, since the ethnic group's name in the two sources is the same or a close variation (e.g. the Wolof people in the coast of Senegal can easily be merged with the "Wolof" ethnic group reported in Murdock's EA). When an exact match cannot be found, we rely on the correspondence tables built by Teso (2019) and Michalopoulos, Putterman, and Weil (2019). In detail, these correspondence tables rely on several strategies to match past and present ethnic groups, such as using ethnolinguistic information[15] or the alternative ethnic groups' names from the Joshua project.[16] Relying on these methods, we are able

[14]For a limited number of surveys in Liberia, Namibia and Nigeria, ethnic groups were recorded based on their language (variables s119 for Liberia in 2006, s119 for Namibia in 2006, s114 for Namibia in 2013 and s118 for Nigeria in 2003).

[15]Ethnic groups are matched based on the lexicographic similarities of their language referenced in the Ethnologue database.

[16]Variations in ethnic groups' names are common and the Joshua project is a useful resource to find them. See www.joshuaproject.net.

to match 83% of our sample with their ancestral ethnic group recorded in the EA.

4.3 Sample description

Our sample comprises 651,148 women, whose residence can be precisely located and whose ethnicity can be matched with ancestral characteristics. Because deeply-rooted inheritance rules are less binding for migrants than for those living in the same place as their ancestors, we identify individuals who are born and raised in the same place they currently reside. Specifically, the DHS questionnaire asks respondents whether they have always resided in the same place and, if not, how long ago they moved. We use this variable to distinguish non-movers (184,270 women) from movers (208,479 women).[17] Our main analysis is based on the sample of non-movers. Appendix Tables A.4 and A.5 show the results when keeping both non/movers and movers in the sample.

Table 1 shows descriptive statistics on our main sample of women born and raised where they currently reside (column "Full sample"), of which 114,532 identify as a member of an ethnic group with impartible inheritance (62 percent) and 69,738 identify as a member of an ethnic group with partible inheritance (38 percent). Women who participate in the DHS survey are from all ages between 15 and 49 years old. In our sample, the average age is 27.6 years old. In addition, 56.7 percent of women are married, suggesting that younger women in this sample may have not found a reproductive partner yet. In our analysis, we account for this by showing the robustness of our results for a sub-group of women aged 40 and above. That is, for women who are closer to the end of their reproductive lifespan. 49.3 percent of women in our sample have received no formal education and 55.8 percent were working at the moment of the survey.

Interestingly, age, formal education, and the probability of being married or working are similar for women in impartible- and partible-inheritance ethnic groups. In contrast, religion varies systematically across groups. 59.0 percent of women in partible- and 45.4 percent impartible-inheritance ethnic groups are Muslim. In turn, christianity is less common in the partible subsample (39.2 percent) than in the impartible (48.0 percent) one. In addition, we observe differences across groups in the information on place of residence provided by the DHS questionnaire. Respondents from ethnic groups with impartible inheritance are slightly more likely to come from rural areas (70.6 vs. 63.6 percent) and less likely to have

[17] This variable (v104 in the DHS questionnaire) is missing for 258,399 women in our sample.

Table 1: Descriptive statistics from DHS surveys

		(1) **Full sample**	(2) **Impartible**	(3) **Partible**
Women	Age	27.6	27.7	27.6
		(9.8)	(9.8)	(9.8)
		184,270	114,532	69,738
	No education (0/1)	0.493	0.495	0.490
		(0.500)	(0.500)	(0.500)
		184,269	114,531	69,738
	Married (0/1)	0.567	0.568	0.566
		(0.495)	(0.495)	(0.496)
		184,268	114,532	69,736
	Working (0/1)	0.558	0.586	0.513
		(0.497)	(0.493)	(0.500)
		184,011	114,418	69,593
	Christian (0/1)	0.447	0.480	0.392
		(0.497)	(0.500)	(0.488)
		177,643	111,424	66,219
	Muslim (0/1)	0.505	0.454	0.590
		(0.500)	(0.498)	(0.492)
		177,643	111,424	66,219
Household	Electricity (0/1)	0.274	0.232	0.344
		(0.446)	(0.422)	(0.475)
		183,537	113,920	69,617
	Rural area (0/1)	0.679	0.706	0.636
		(0.467)	(0.456)	(0.481)
		184,270	114,532	69,738

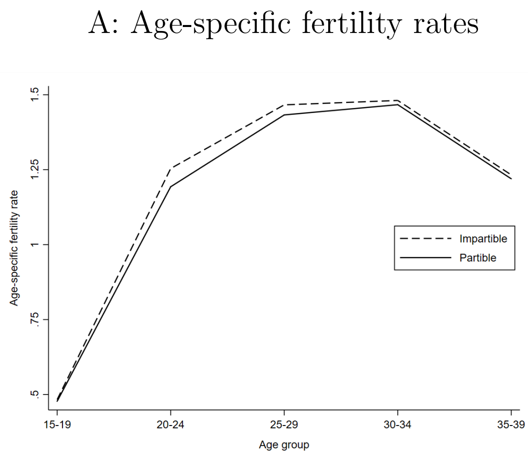
Notes: This table reports means, standard deviations (in parentheses), and number of observations. Column (1) considers the complete sample of women who were born and raised in the place where they currently live. Columns (2) and (3) consider women belonging to an ethnic group with impartible and partible inheritance customs, respectively. The top panel "Women" are individual-level outcomes. The bottom panel "Household" are outcomes at the household level.

access to electricity (23.2 vs. 34.4 percent) than respondents from ethnic groups with partible inheritance. To account for these differences, our estimates include individual-level controls on religion, living in rural areas, and having access to electricity, as well as all the other individual-level characteristics described above.

4.4 Descriptives on fertility rates by inheritance rules

Before turning to our main empirical analysis, we explore how fertility rates differ between women from ethnic groups with different inheritance rules. Figure 4 displays the age-specific fertility rates across all countries in Sub-Saharan Africa and for all DHS surveys available. In Panel A, we distinguish between women who belong to an ethnic group with partible (solid line) and impartible (dashed line) inheritance rules. In Panel B, we report the impartible-partible fertility differential for each groups, along with confidence intervals. To compute age-specific fertility rates, we consider a sub-sample of women aged more than 35 years old. That is, women who completed or are nearing the end of their reproductive lifespan. We reconstruct their complete birth history using the birth date of each child reported in the DHS survey. This allows us to observe the average number of births of women in different five-year periods since they turned 15.

The figure suggests that women from ethnic groups with impartible inheritance tend to have a higher fertility rate than those with partible inheritance. Differences are largest in the peak reproductive years, that is, between ages 20 and 29. This graphical exploration of the raw data provides some preliminary evidence that impartible inheritance rules play a role in fertility decisions.



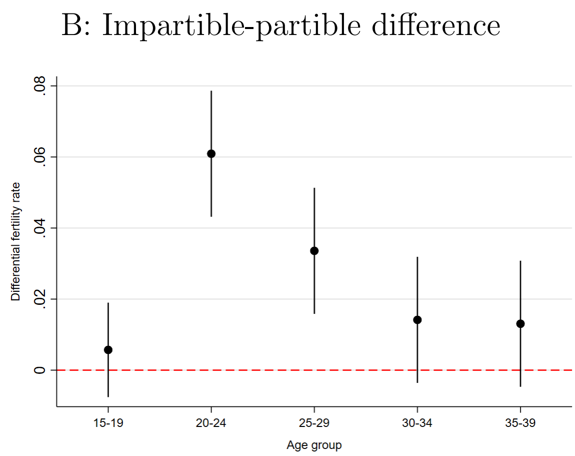


Figure 4: Age-specific fertility rates, by inheritance custom.

Notes: The age-specific fertility rates measure how many births a woman had on average during five-year periods from the moment she turned 15. In Panel A plots the age-specific fertility rates (y-axis) for women from ethnic groups with partible (solid) and impartible (dashed) inheritance customs. Panel B shows the impartible-partible difference in age-specific fertility rates and 95% confidence intervals. The sample is women over 35 years old at the time of the DHS interview for which we have reconstructed their complete birth history.

5 Empirical analysis

5.1 OLS estimates

Our main goal is to examine the hypothesis that fertility rates in Sub-saharan Africa are higher in ethnic groups practicing impartible inheritance than in ethnic groups practicing partible inheritance. We start our empirical analysis by presenting OLS estimates on the relationship between impartible inheritance customs and fertility. Our estimating equation takes the form:

$$y_{ict} = \alpha + \beta Impartible_i + \gamma X_i + \delta_c + \zeta_t + \epsilon_{ict} \tag{7}$$

where i denotes women, c denotes countries, and t DHS survey years. The variable y is the number of children ever born to a woman i in country c, as reported in the DHS survey year t; and is based on the variable v201 in the DHS. We use fixed effects for countries, δ_c, and DHS survey years, ζ_t. The indicator variable $Impartible_i$ is equal to 1 if woman i belongs to an ethnic group with impartible inheritance rules, and 0 otherwise. The vector X_i includes individual-level socio-economic charateristics, geographic covariates, ethnicity-level historical factors, and measures of colonial influence. The individual-level socio-economic charateristics include age, a set of indicator variables for religion,[18] and a set of indicator variables that equal 1 if a woman received no formal education, if she is working, or if she is married. Geographic covariates are measured at the individual and at the DHS-cluster level. We include an indicator variable for whether a woman lives in a rural area, an indicator variable for whether her household reports having access to electricity, the absolute value of latitude and longitude of the DHS cluster, the population density from the CIESIN's algorithm (2004), light intensity from satellite data (Ghosh et al. 2010), soil and climate suitability index for agriculture (based on Galor and Özak (2016), but for a subset of nine crops cultivated in Sub-Saharan Africa) and suitability for cereals relative to roots and tubers (more details in Subsection 6.1), and terrain ruggedness and slope from Nunn and Puga (2012) in the 1-km cell where the DHS cluster is located. The ethnicity level historical factors are an indicator variable for patrilineal ethnic groups, for ethnic groups that authorize polygynous unions, and for historical plow use. We also in-

[18] We distinguish between respondants' reporting her religion to be Islam, Christianity, another religion, or no religion.

clude controls for colonial influence, such as the distance to missionary settlements (Nunn 2010), colonial railway lines, and explorers' routes (Nunn and Wantchekon 2011). Our coefficient of interest, β, measures the effect of belonging to an ethnic group with impartible inheritance rules on fertility. A positive β-coefficient indicates that women who identify as a member of an impartible ethnic group have more children on average at the time of the DHS interview.

Table 2 reports estimates of Equation (7). We find that impartible inheritance rules are associated with higher fertility. Women from impartible-inheritance ethnic groups have 0.11 more children on average than women from partible-inheritance ethnic groups. Estimates are statistically significant and quantitatively meaningful. Compared to the average fertility of 2.86 children per woman, our estimate implies a 4-percent increase in fertility. This estimate is similar in magnitude to the effect of belonging to an ethnic group that allows polygynous unions, a factor that has received substantial attention in the literature (Tertilt 2005; Rossi 2019).

The estimated coefficients are similar across specifications. Column (1) reports estimates from the most parsimonious specification with country and year fixed effects. Column (2) adds individual-level socio-economic characteristics, Column (3) geographic covariates, and Column (4) ethnicity-level historical factors and measures of colonial influence. Our main estimate is unchanged after inclusion of these covariates. Some of the estimates on the additional controls are interesting in its own right. Consistent with previous research, we find that belonging to a patrilineal ethnic group is associated with higher fertility (BenYishay, Grosjean, and Vecci 2017). This estimate is similar in magnitude to that of impartible inheritance. In contrast, we do not observe a statistically significant association between history of plow agriculture and fertility today (Alesina, Giuliano, and Nunn 2011).

As explained above, DHS surveys recruit participants aged between 15 and 49 years old. Because of the survey design, many women in our main sample have not yet completed their reproductive lifespan, and some might not have started having children yet. To show that our estimates are not driven by this composition effect, we reproduce our analysis on a sub-sample of women aged 40 years old or older. That is, on women who have completed or are close to completing their reproductive lifespan. As expected, the average number of children is larger, around 6.4 children per woman.

Table 2: Impartible inheritance and fertility - OLS estimates

	Dep. Variable: Number of children ever born				
	All	All	All	All	>40 years old
	(1)	(2)	(3)	(4)	(5)
Impartible inheritance (0/1)	0.109 ***	0.122 ***	0.101 ***	0.106 ***	0.221 ***
	(0.026)	(0.017)	(0.016)	(0.016)	(0.058)
Patrilineal (0/1)				0.119 ***	0.304 ***
				(0.019)	(0.064)
Polygynous (0/1)				0.109 ***	0.284 ***
				(0.017)	(0.058)
Plow use (0/1)				0.019	0.264
				(0.055)	(0.175)
Country FE	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes
Individual controls	No	Yes	Yes	Yes	Yes
Geographical controls	No	No	Yes	Yes	Yes
Colonial controls	No	No	No	Yes	Yes
Mean Dep. Var.	2.85	2.86	2.86	2.86	6.37
R-squared	0.02	0.65	0.66	0.66	0.16
Observations	184,270	177,424	174,812	165,203	26,742

Notes: The unit of observation is a woman interviewed for the DHS survey. The sample includes all women born and raised in the place where they currently live. In column 1 we include country and DHS survey year fixed effects. In column 2, we add "individual controls," which include the respondent's age, dummies for education, marital and employment status. In column 3, we add "geographical controls," which include dummies for living in a rural area, access to electricity, the absolute values of latitude and longitude, population density, light intensity from satellite data, soil and climate suitability for agriculture, ruggedness index, and slope. In column 4, we add "historical controls," which include dummies for ethnic groups that are patrilineal and polygynous, that historically used the plow, distance to missionary settlements, colonial railway lines and explorers' routes. In column 5, we restrict the sample to women over 40 years, who are closer to the end of their fertile window. Robust standard errors, clustered by DHS sampling units, are reported in parentheses. *** p<0.01, ** p<0.05, * p<0.1.

Column (5) of Table 2 reports estimates of Equation (7) on this sub-sample. Our OLS estimates for the effect of impartible inheritance on fertility are positive and statistically significant, even if the sample size is substantially smaller. In terms of magnitude, our estimates are similar as before. We find that, among women who completed or are close to completing their reproductive lifespan, belonging to impartible inheritance groups increases fertility by 0.22 children. Relative to the sample mean, this corresponds, as before, to a 3.5-percent increase in fertility.

5.2 Spatial Regression Discontinuity Design

Our OLS estimates control for a wide range of observable characteristics and fixed effects. Nevertheless, some ethnic groups may have unobserved characteristics that affected their propensity to adopt impartible inheritance in the past and continue to affect fertility decisions today. For example, some ethnic groups may have adopted impartible inheritance because of geographic constraints related to farming production (Bertocchi 2017), which, in turn, could influence fertility levels in a Malthusian economy. Similarly, other ancestral characteristics—e.g., patrilineal family (Sabean and Teuscher 2007)—or historical experiences (Chénon 1926) may be related to the adoption of impartible inheritance and have direct effects on modern fertility.

To address these concerns, we turn to a spatial regression discontinuity design (RDD) that exploits variation across ancestral borders within modern Sub-Saharan African countries. We compare the fertility of women who live in DHS clusters that are geographically close, but where one DHS cluster is in the ancestral homeland of an ethnic group with impartible inheritance, while the other DHS cluster is in the ancestral homeland of an ethnic group with partible inheritance. Our unit of observation is women aged 15-49 interviewed for the DHS survey, and our sample is restricted—as in Moscona, Nunn, and Robinson (2020)—to pairs of contiguous ethnic groups with different ancestral characteristics—in our case, in inheritance customs.[19] The benefit of this strategy is that it accounts for unobservable factors that vary smoothly across space. By using a smaller sample of geographically close DHS clusters, we account for unobserved factors, e.g., geographic constraints, ancestral characteristics, or historical experiences, that may have affected both the adoption of impartible inheritance and fertility, as long as these factors and are similar across geographically close units.

Figure 5 illustrates our RDD setup in northern Senegal, above Gambia. It shows DHS clusters (dots) and ancestral borders of three ethnic groups: the Wolof, Toucouleur, and Serer peoples. The Wolof people (west) traditionally divided the inheritance among all surviving children and spouses, albeit women received a smaller share. Despite their islamization in the 11th century, the Toucouleur (east) ancestral inheritance customs favor the first-born male (Lafont 1939; Kane 1939). The Serer people (south) resisted the expansion of Islam, are traditionally

[19]Moscona, Nunn, and Robinson (2020) compare conflict across pairs of contiguous ethnic groups with different ancestral characteristics in segmentary lineage organization.

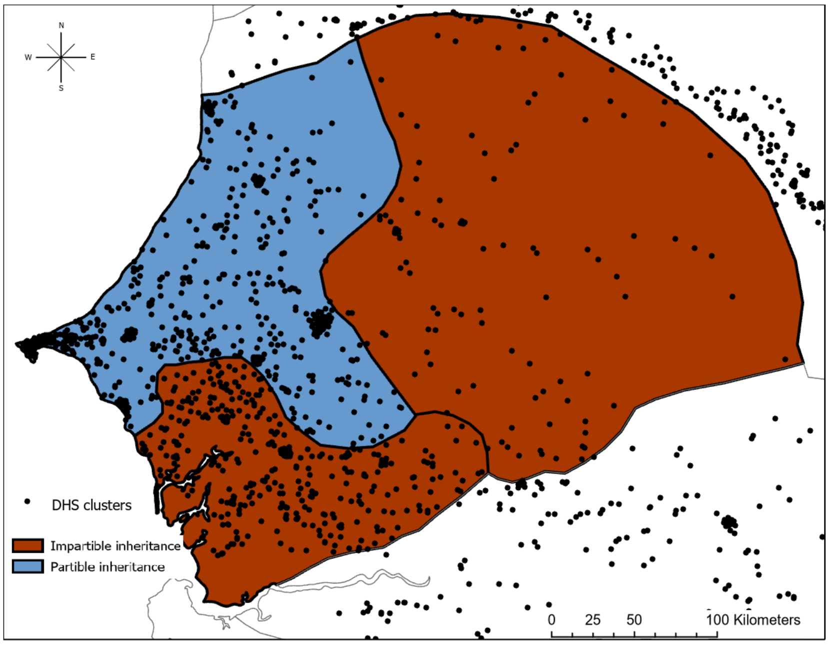


Figure 5: Illustration of the spatial RDD setting in the case of Senegal.

Notes: Dark lines delimit the ancestral ethnic boundaries of the Wolof on the West (partible inheritance), the Toucouleur on the East (impartible inheritance), and the Serer in the South (impartible inheritance). Dots represent DHS clusters where women have been interviewed.

matrilineal, and pass down all family assets to the first-born in the mother's line (Aujas 1931; Bourgeau 1933; Dulphy 1939; Fayet 1939). In our RDD, the Wolof and the Toucouleur form one pair, and the Wolof and the Serer form another pair. Even though the Toucouleur and the Serer share a border, they do not form a pair since they have the same inheritance customs. We then compare the fertiliy of women in each of these two pairs of ethnic groups in a RDD regression where the running variable is the distance from each DHS cluster to, respectively, the Wolof-Toucouleur and the Wolof-Serer ancestral border.[20]

Our RDD estimating equation is:

$$y_{ivpc} = \alpha + \beta I_v + f_l(dist_v, \gamma_l) \cdot [I_v = 0] + f_r(dist_v, \gamma_r) \cdot [I_v = 1] + \delta_c + \mu_p + \epsilon_{ivpc} \ , \quad (8)$$

where i denotes women, v DHS clusters, p ethnicity pairs where one ethnic group has impartible and the other partible inheritance customs, and c countries. The variable y is the number of children ever born to each woman i. We use fixed effects

[20]Note that some DHS clusters might be used more than once if an ethnic group borders more than one ethnic group with different inheritance customs. To account for this, we include ethnic pair fixed effects and cluster standard errors by DHS clusters.

for each ethnic pair, μ_p, and for countries, δ_c. The indicator variable I takes the value 1 if a DHS cluster v is located within the ancestral borders of an ethnic group with impartible inheritance, and 0 otherwise. f_l and f_r are unknown functions with parameter vectors γ_l and γ_r, controlling for the distance from the DHS cluster v to both sides of the ancestral border of ethnic pair p (i.e. the running variable). We use linear functions of the distance in kilometers in our baseline estimates, and provide additional estimates using quadratic polynomials for robustness. Our coefficient of interest, β, corresponds to the estimated discontinuity in the average fertility rate at the ancestral ethnic border.

The starting point of our identification strategy is to show that the ancestral ethnic boundaries reported in Murdock (1959) still coincide with ethnic affiliation today. Panel A of Figure 6 shows the relationship between ethnic affiliation and the distance to the ancestral border. The y-axis shows the share of women who identify as a member of an ethnic group with impartible inheritance customs. The x-axis is the distance in kilometers from the ancestral border, with positive (negative) values for impartible (partible) ethnic-group homelands. We observe a sharp discontinuity at the ancestral border: women who live in the ancestral homeland of an ethnic group with impartible inheritance customs are about 20 percentage points more likely to belong to an ethnic group with impartible inheritance customs (Table 3). In other words, even though individuals are free to move within the modern borders of their country, there is a strong persistence in the probability to live within the ancestral homeland of one's ethnic group. Below we use this discontinuity, which is driven by a non-negligible share of the population, as the first stage in our fuzzy RDD to measure the causal effect of inheritance rules on fertility today.

Our RDD strategy requires that unobservables vary smoothly across ancestral borders. We evaluate this assumption by conducting a balancing test on a wide range of observable ethnic ancestral customs (polygyny, polygamy, patrilineality, patrilocality, religion, plow use, bride price, nomadism and pastoralism), historical factors capturing European influence during the colonial period (distance to missionary settlements (Nunn 2010), colonial railways, explorers' routes (Nunn and Wantchekon 2011)), and geographic characteristics that have been deemed important for long-run economic development in Africa (distance to equator, terrain ruggedness and slope, potential caloric yield of land Galor and Özak (2016), and land suitability for different crops low-labor intensive roots and high-labor intensive cereals). As explained in Section 2.2, some of these factors—especially

Table 3: Balance checks for spatial RDD

Dep. Variable	Sample mean	Coef. (SE)
Impartible inheritance (0/1)	0.479	0.189 *** (0.014)
Polygyny (0/1)	0.869	-0.008 (0.009)
Patrilineal (0/1)	0.784	-0.007 (0.011)
Patrilocal (0/1)	0.961	-0.007 (0.006)
Bride price (0/1)	0.969	-0.002 (0.004)
Christian (0/1)	0.525	-0.013 (0.009)
Plow use (0/1)	0.053	0.007 (0.004)
Pastoralism (0/1)	0.087	0.013 (0.008)
Nomadic (0/1)	0.092	0.010 (0.008)
Distance to missionary settlement (km)	116.7	-0.634 (1.608)
Distance to colonial railway (km)	269.0	-1.027 (1.856)
Distance to explorers' routes (km)	242.4	-1.341 (1.792)
Distance to equator (km)	864.361	0.038 (2.055)
Terrain ruggedness (stdz)	-0.282	-0.015 (0.018)
Terrain slope (stdz)	-0.275	-0.016 (0.018)
Potential caloric yield - All crops (stdz)	-0.379	-0.004 (0.016)
Potential caloric yield - Diff. Roots - Cereals (stdz)	-0.360	-0.019 (0.017)

Notes: The unit of observation is a woman interviewed for the DHS survey. The first column lists ancestral, terrain, and soil characteristics. The second column reports their mean in the sample of women who were born and raised in the place where they currently live. The third column reports estimates of β from Equation (8), using the variable in the first column as dependent variable. It captures the discontinuity estimated at the ethnic border, after controlling for a linear polynomial in distance, ethnic pair fixed effects, and country fixed effects. The bandwidth is 120 kilometers on each side of the ethnic border. Robust standard errors, clustered by DHS sampling units, are reported in parentheses. *** p<0.01, ** p<0.05, * p<0.1.

those related to geography—have been highlighted as important determinants for the emergence of inheritance systems. Table 3 reports the estimates of β from Equation (8), using each of these characteristics as dependent variable. The results suggest that the only discontinuity at the ethnic border is the likelihood to belong to an ethnic group with impartible inheritance customs. For each of the other 16 ancestral, historic, and geographic characteristics, the RD estimate is always small in magnitude and never statistically different from zero. Altogether, this strongly suggests that our RD estimates allow to effectively explore the causal link between past inheritance customs and current fertility levels, and are not confounded by geographic, ethnographic, or historical factors that explain the origins of inheritance systems in Sub-Saharan Africa.

We begin our analysis of the effects of impartible inheritance rules on fertility decisions by exploring whether the raw data displays discontinuities at the ethnic border. Panel B of Figure 6 plots the unconditional relationship between the number of children and the distance from the ancestral border in 10-kilometers bins. The figure shows that, in the raw data, women born and raised within the territory of impartible ethnic groups (positive values on x-axis) have on average more children than those born and raised within the territory of partible ethnic groups (negative values on x-axis). In fact, we notice a clear discontinuity precisely at the ethnic pairs boundary.

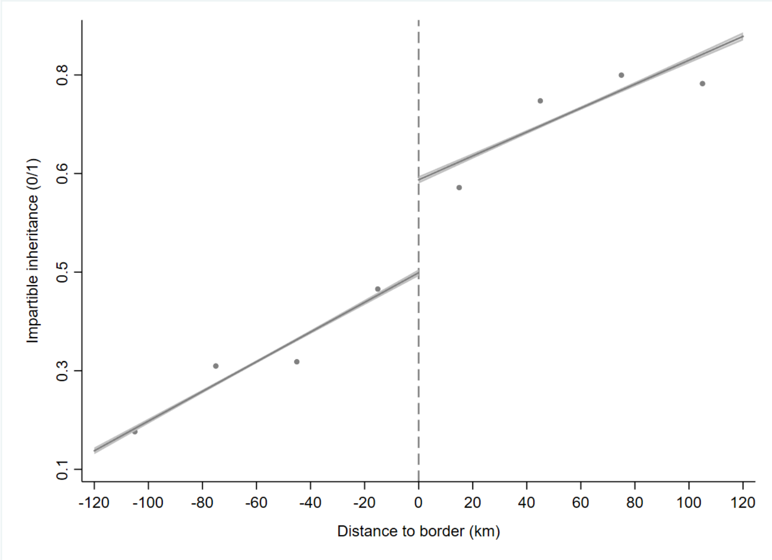
Next, we examine the RDD estimates of the discontinuity at the ethnic border. Table 4 provides estimates of Equation (8) for women living in DHS clusters that are within 60, 90 or 120 kilometers from an ancestral boundary where one ethnic group has an impartible inheritance custom, while the other has a partible inheritance custom. In all the three specifications, we find a positive coefficient for the link between impartible inheritance and fertility. The coefficients measured with the different bandwidths are relatively stable and always statistically significant.

To measure the Average Treatment Effect (ATE) of impartible inheritance, we need to account for the fact that the discontinuity at the ancestral boundary is not 100 percent sharp. That is, not all the women living in the homeland of an impartible ethnic group belong to this ethnic group or share the same customs. In fact, we showed in Figure 6 (Panel A) that the estimated discontinuity was about 20 percent. To account for this, we now turn to estimating a "fuzzy" RDD. The first stage takes the following form:

$$I_{ivpc} = \mu + \theta I_v + f_l(dist_v, \gamma_l) \cdot [I_v = 0] + f_r(dist_v, \gamma_r) \cdot [I_v = 1] + \delta_c + \mu_p + \eta_{ivpc}\ , \quad (9)$$

where the probability that a woman belongs to an ethnic group with impartible inheritance customs, I_{ivpc}, is instrumented with the indicator variable, I_v, which

Panel A: Likelihood to identify as a member of an impartible ethnic group



Panel B: Consequences on fertility

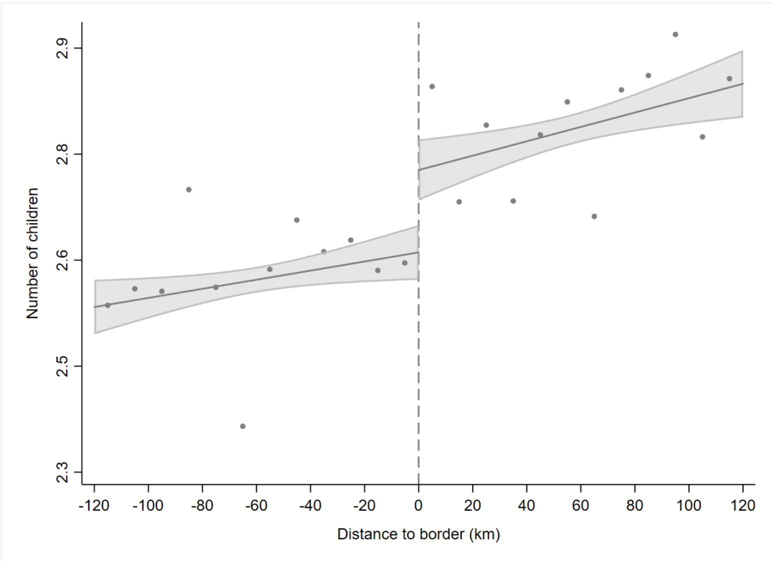


Figure 6: Unconditional relationship between outcome variables and distance to the ancestral boundaries.

Notes: We use 37.5-kilometers bins in Panel A and 10-kilometers bins in Panel B. Distance normalized to zero at the inheritance border, with positive (negative) values for the homeland of ethnic groups with impartible (partible) inheritance. The sample includes all women who were born and raised in the place where they currently live.

takes the value 1 if the DHS cluster v is located within the homeland of an ethnic group with impartible inheritance customs, and 0 otherwise. θ will therefore measure the discontinuity at the border in the share of the population with impartible inheritance customs.

Table 4: Impartible inheritance and fertility - RDD estimates

	Number of children ever born		
	60 km	90 km	120 km
	(1)	(2)	(3)
Impartible inheritance	0.163 ***	0.184 ***	0.161 ***
	(0.062)	(0.050)	(0.043)
Ethnic pairs FE	Yes	Yes	Yes
Country FE	Yes	Yes	Yes
Mean Dep. Var.	2.68	2.66	2.66
Nb. of pairs	270	286	294
Observations	89,361	138,819	173,883

Notes: The unit of observation is a woman interviewed for the DHS survey. The dependent variable is the number of children ever born from this woman. The sample includes all women who were born and raised in the place where they currently live. Estimates are from regressions that include a linear polynomial in distance to the border, ethnic pairs and country fixed effects ("Nb. of pairs" is reported in the bottom panel). The main coefficient of interest corresponds to β in Equation (8). It captures the discontinuity at the ethnic border in the number of children born from women living in the homeland of an impartible ethnic group, compared to those living in the homeland of a partible ethnic group. The bandwidth goes from 60 kilometers in the first column to 120 kilometers in the third column, in 30 kilometers increments. Robust standard errors, clustered by DHS sampling units, are reported in parentheses. *** p<0.01, ** p<0.05, * p<0.1.

The second stage of our fuzzy RDD takes the following form:

$$y_{ivpc} = \alpha + \beta \hat{I}_i + f_l(dist_v, \gamma_l) \cdot [I_v = 0] + f_r(dist_v, \gamma_r) \cdot [I_v = 1] + \delta_c + \mu_p + \epsilon_{ivpc} \ , \quad (10)$$

which takes the same form as Equation (8), but using as main variable of interest $\hat{I}$, the probability that a woman identifies as a member of an impartible ethnic group instrumented by the location of her DHS cluster. As before, we control for the distance to the ethnic borders, as well as for country and ethnic pairs fixed effects. Our coefficient of interest is still β, which now measures the ATE of belonging to an impartible ethnic group.

Table 5 shows estimates of this two-stage least-squares fuzzy RDD. We find that women who identify as a member of an impartible ethnic group have on average 0.85 more children (second panel).[21] This effect is larger in size than our previous OLS estimates, which is likely explained by the fact that the fuzzy RDD provides a local treatment effect, estimated on a sample of women close to the

[21] The ATE corresponds to the OLS estimate from Table 4 (column "120 kilometers") divided by the discontinuity in the fraction of the population that identifies as a member of an impartible ethnic group (so called "first-stage").

Table 5: Fuzzy Spatial RDD - Average Treatment Effects

	Bandwith = 120 km
	First stage: Impartible ethnic group
Impartible cluster	0.189 ***
	(0.014)
	ATE: Number of children
Impartible cluster	0.851 ***
	(0.237)
Ethnic pairs FE	Yes
Country FE	Yes
Mean Dep. Var.	2.66
Nb. of pairs	293
Observations	173,883

Notes: The unit of observation is a woman interviewed for the DHS survey. The dependent variable is the number of children ever born from this woman. The sample includes all women who were born and raised in the place where they currently live. The bandwidth used is 120 kilometers on each side of the ethnic border. The "first stage" estimate corresponds to the coefficient θ in Equation (9). It captures the discontinuity at the border in the fraction of women who identify as a member of an impartible ethnic group, after controlling for a linear polynomial in distance, as well as ethnic pairs and country fixed effects. The Average Treatment Effect ("ATE") is from an instrumental variable estimation (using two-stage least-squares regression) in which the endogeneous variable is the fraction of women who belong to an impartible ethnic group, instrumented with the indicator variable that equals one if they live inside the homeland of an impartible ethnic group, and zero otherwise (coefficient β in Equation (10)). Robust standard errors, clustered by DHS sampling units, are reported in parentheses. *** p<0.01, ** p<0.05, * p<0.1.

ancestral borders.[22]

The effect of impartible inheritance might be more diffused among those who have moved from their ancestral homeland. To explore this possibility, we estimate again our fuzzy RDD model on the complete sample of women, including those who were born in a different place than the one where they currently live. The results reported in Table A.5 in Appendix reveal indeed an ATE of 0.25 children, about three times smaller than on the restricted sample of non-movers. Of course, movers or non-movers might have different preferences in terms of fertility, especially those that move from rural areas to cities, and are therefore selected samples. That said, this evidence suggests that internal migrations might reduce the influence of impartible inheritance practices.

[22]Appendix Tables A.6 and A.7 show respectively the results of Tables 4 and 5 with standard errors clustered at the ethnicity level instead of the DHS sampling unit.

5.3 Robustness checks

We perform several robustness checks and extensions of the analysis. This section briefly describes them; the detailed results are available in the online Appendix.

Bandwidth sensitivity: We start by showing that our results are robust to different bandwidth definitions. In Appendix Figure A.2, we report reduced form estimates from Equation (8) with bandwidth varying from 20 to 150 kilometers on each side of the ancestral ethnic boundaries, in 5-kilometer increments. We observe that results are rather stable and the 95 percent confidence intervals exclude 0 for all bandwidths above 50 kilometers. Furthermore, because the ancestral ethnic boundaries reported in the the seminal work of Murdock (1959) might suffer from measurement errors due to the fact that many of the sources compiled are from the early twentieth century, we also perform a "donut hole" test excluding those DHS clusters that are located within 10 kilometers of the ancestral borders. In addition, this will account for the fact that the exact location of DHS clusters is offset by a random number of kilometers from their true location in order to preserve the anonymity of respondents (random offsetting can be up to 5 kilometers in rural areas). The estimates reported in the last column of Table A.8 in Appendix reveal highly similar results compared to the 120-kilometer bandwidth using all observations.

Functional form: We now test the sensitivity of our empirical strategy to different functional forms for the running variable. Table A.8 in Appendix shows results for both linear and quadratic polynomials of the running variable. While standard errors tend to increase with the quadratic polynomial, the coefficients remain highly similar across bandwidths. Only for the small 60-kilometer bandwidth, the estimated effect with a quadratic polynomial of the distance is not statistically significant, but it remains relatively close in magnitude to other estimates.

Outliers: We check the robustness of our estimates to outliers. More specifically, we re-estimate Equation (8) for a total of 294 times, leaving one pair of ethnic groups out each time. This type of "Leave-one-out" procedure ensures that our results are not driven by a specific pair of ethnic groups, and therefore that there are robust to outliers. Figure A.3 in Appendix shows the distribution of the 294 point estimates following this procedure. We can observe that all estimates are positive (min. = 0.132, max. = 0.196) and centered around our baseline estimate of 0.161, with very little dispersion. We therefore conclude that our results are not driven by some specific ethnic groups in a particular country.

Private property: Finally, we investigate the sensitivity of our results to alternative definition of our main explanatory variable. In particular, we explained in sub-section 4.1 that we added ethnic groups for which the EA reports an absence of private property to the partible inheritance category since, in many cases, all members have equal access to the land. Even though this concerns only a small share of our sample (less than 2 percent), we test the sensitivity of our results to the exclusion of these women. Tables A.9 and A.10 in Appendix show that the results are highly similar for both the OLS and RDD settings, respectively.

6 Mechanisms: Legal institutions and geography

So far, we have documented large fertility differentials between ethnic groups under different inheritance customs. We argued that partible inheritance reduces the economic incentives for having children to avoid the fragmentation of land into inefficiently small parcels. This incentive is not present under impartible inheritance, and thereby, the latter is associated with higher fertility rates. In this section, we provide further evidence supporting this mechanism. A testable prediction of this mechanism is that when the land passed on to the heirs is more labor intensive, the incentives to limit fertility under partible and partible inheritance become more similar, and therefore the partible-impartible fertility gap converges to zero (see Proposition 3). We test this prediction by exploring the heterogeneity of our results by soil and climate suitability for different crops and by terrain steepness—two characteristics determining how labor-intensive production is.

6.1 Soil and climate suitability for roots and tubers

We begin our heterogeneity analysis by looking at the soil and climate suitability for cultivating different crops. Different crops are associated with different labor requirements, determining how labor-intensive agricultural production is. Research in agricultural sciences shows that cassava, for instance, is a crop with low labor requirements (Cock 2019; Fresco 1986), suitable for labor-deficit and even for HIV-affected households (Nweke 1994). In contrast, cereals such as sorghum "requires a lot of handwork" (Klingaman 2009). Table 6 shows the yields of the most widely grown crops in Africa and their labor inputs relative to cassava. The monthly labor input for the cultivation of maize and sorghum is 2.5 to 3 times larger than for cassava, illustrating cassava's relatively low labor-intensive production (Fermont et al. 2010). More generally, the table shows that, in Africa, roots and tubers—such as cassava or sweet potato—have lower labor input requirements than cereals—such as sorghum or maize.

Table 6: Yields and labor input for major crops in Sub-Saharan Africa

Crops	Average output (tons per hectare)	Output in decile 90 (tons per hectare)	Energy (kilo calories per 100g)	Labor input (% of cassava)
Cereals:				
Maize	1324	3105	3.65	310
Sorghum	841	1993	3.39	245
Dryland rice	603	1491	3.7	
Wetland rice	763	2456	3.7	
Wheat	367	1244	3.47	
Roots and tubers:				
Cassava	1783	3912	1.6	100
Sweet potato	1539	3456	0.86	105
White potato	401	1461	0.77	
Yams	1201	2885	1.18	

Notes: Output corresponds to the average (90th decile) across raster points for the whole African continent, using data from the GAEZ project of the FAO. The calorie equivalent comes from the National Nutrient Database for Standard Reference of the United States Department of Agriculture. Labor input is relative to cassava (100) and is from Fermont et al. (2010).

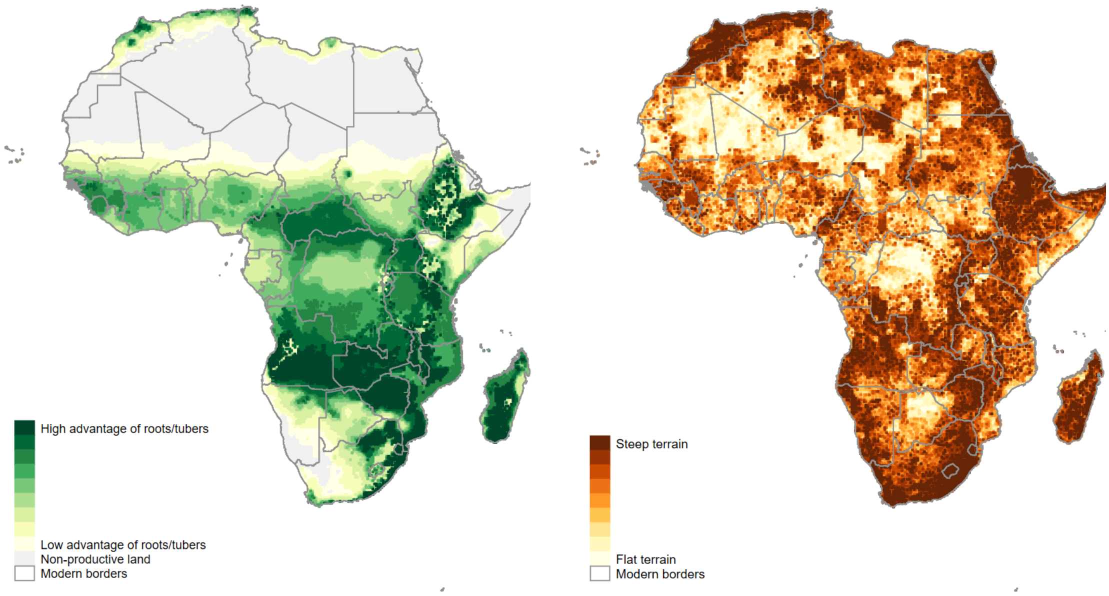
We exploit the soil and climate suitability for cereals relative to roots and tubers to construct an index, α_{soil}, capturing the potential labor-intensity of agricultural production. Because the crops cultivated are to some extent endogenous, we leverage exogenous variation in agro-climatic conditions across Africa. Our approach is similar to that of Mayshar, Moav, and Pascali (2022), but focusing on the potential yields of nine major crops grown in Sub-Saharan Africa: four roots and tubers (cassava, sweet potato, white potato, and yams) and five cereals (maize, sorghum, dryland rice, wetland rice, and wheat). Yields are from the Global Agro-Ecological Zones (GAEZ) project of the Food and Agriculture Organization (FAO). To prevent concerns of reverse causality, we consider potential yields under rain-fed low-input agriculture—that is, without irrigation or fertilizers, which would reflect human efforts. Following Galor and Özak (2016), we convert the FAO data from tons per year into calories using data from the National Nutrient Database for Standard Reference of the USDA. Our index therefore accounts for the fact that cassava requires less labor input, but also provides less calories, so that the yields per hectare must be higher to properly feed an entire household. Hence, our index will be similar to the one developed by Galor and Özak (2016), but for a subset of crops cultivated in Sub-Saharan Africa.[23] Our final index α_{soil} is the difference between the average potential caloric yield of the five major cereals and the four major roots and tubers cultivated in Sub-Saharan Africa. Hence, larger values of the index correspond to more labor-intensive production, while smaller values to less labor-intensive farming.

The map in Figure 7a shows our index of potential labor intensity α_{soil} for all the raster squares of 5' x 5' (ca. 100 km^2 at the equator). Darker squares represent areas with a comparative advantage in cultivating low labor-intensive roots and tubers relative to high labor-intensive cereals, based on exogenous variation in the suitability of the soil and climate. Lighter squares represent areas where there is no substantial difference between the potential yields of cereals vs. roots and tubers. While, e.g., cassava is grown in most of Sub-Saharan Africa and produces reasonable yields even on poor soils (Howeler, Lutaladio, and Thomas 2013), the crop thrives best on sandy clay loams and when rainfall is well distributed throughout the growing period and not erratic (Seesahai, Ramlal-Ousman, and Lalchan Vine 2008). Some parts of Sub-Saharan Africa have therefore a comparative advantage in producing this low labor input crop: It is easier to grow roots and tubers than cereals in the west of Zambia (dark red), while there is almost no difference in the potential caloric yield of these crops in Northern Senegal (light yellow). The map shows that there is large variation in the index within Africa.

Next, we test whether the fertility gap between partible and impartible ethnic groups is larger where the land is suitable for low labor-intensive crops (Proposition 3). Columns 1 and 2 of Table 8 report estimates of Equation (8) for two different sub-samples: women living in villages with a comparative advantage for cultivating low labor-intensive roots and tubers (α_{soil} below median) and women living in villages with a comparative advantage for cultivating high labor-intensive cereals (α_{soil} above median). The estimates show that the fertility differential between partible and impartible ethnic groups is six times higher where the climate and the soil is particularly suitable for growing less labor-intensive crops. Columns 3 and 4 of Table 8 present the corresponding estimates for extreme values of the index α_{soil} below and above the third quantile. The fertiltiy gap reaches 0.482 children among women who live in places where the comparative advantage of roots and tubers is above the third quantile. The table also reports two-sided z-tests confirming that the difference in coefficients is statistically significant.

This provides evidence for our theoretical mechanism emphasizing land in-

[23] Galor and Özak (2016) build a world-wide index with 48 crops.



(a) Potential yields of cereals vs. roots and tubers

(b) Terrain steepness

Figure 7: Characteristics affecting the labor-intensity of agricultural production

Notes: Panel (a) displays a standardized index measuring the difference in potential yields (calories per hectare) between 4 roots/tubers and 5 cereals, based on own computations using data from the GAEZ project of the FAO. Panel (b) displays the average terrain's steepness was computed by Nunn and Puga (2012) using elevation data from GTOPO30 (US Geological Survey 1996).

divisibilities for the partible-impartible fertility gap. In lands where the soil is suitable for growing cassava and other less-labor intensive tubers, the costs of dividing the land among many heirs are not compensated by the small economic incentive for using many children as labor in the family farm. Hence, the partible-impartible fertility gap is large. In contrast, where the soil is suitable for growing labor-intensive crops, the incentives for using children as labor dominate, and the partible-impartible fertility gap converges to zero.

6.2 Terrain steepness

Next, we provide further evidence for the land-indivisibilities mechanism by exploring the heterogeneous effects by terrain steepness. In addition to the soil suitability for different crops, the terrain's slope also affects how labor-intensive agricultural production is. Sloppy terrains tend to be more labor intensive and costly to farm (Food and Agriculture Organization 1993) or build on (Nogales, Archondo-Callao, and Bhandari 2002). For example, in the steep slopes of Ethiopian highlands, the

Table 7: Spatial RDD - Heterogeneity by potential yields of cereals vs. roots and tubers

	Dep. Variable: Number of children ever born			
	Suitable for low-labor roots & tubers ($\alpha_{soil} < Q50$) [1]	Suitable for high-labor cereals ($\alpha_{soil} > Q50$) [2]	Suitable for low-labor roots & tubers ($\alpha_{soil} < Q75$) [3]	Suitable for high-labor cereals ($\alpha_{soil} > Q75$) [4]
Impartible inheritance	0.309 ***	0.052	0.482 ***	0.075
	(0.059)	(0.063)	(0.084)	(0.052)
$\beta[1] - \beta[2]$ (z-stat)	2.975 ***		4.105 ***	
$\beta[1] - \beta[2]$ (p-value)	0.003		0.000	
Ethnic pairs FE	Yes	Yes	Yes	Yes
Country FE	Yes	Yes	Yes	Yes
Mean Dep. Var.	2.54	2.78	2.45	2.73
Nb. of pairs	251	184	173	244
Observations	86,866	87,017	43,430	130,453

Notes: The unit of observation is a woman interviewed for the DHS survey. The dependent variable is the number of children ever born from this woman. The sample includes all women who were born and raised in the place where they currently live. Estimates are from regressions that include a linear polynomial in distance to the border, ethnic pairs and country fixed effects ("Nb. of pairs" is reported in the bottom panel). The main coefficient of interest corresponds to β in Equation (8). It captures the discontinuity at the ethnic border in the number of children born from women living in the homeland of an impartible ethnic group, compared to those living in the homeland of a partible ethnic group. The bandwidth is 120 kilometers on each side of the ethnic border. The z-statistic and corresponding p-value are from a two-sided z-test for the difference between the coefficient estimated on the sub-sample of women living on a land with a low or high comparative advantage in producing low-labor input roots and tubers. Robust standard errors, clustered by DHS sampling units, are reported in parentheses. *** p<0.01, ** p<0.05, * p<0.1.

Konso people developed farming techniques which involve building stone-walled terraces to prevent land erosion, a considerably labor-intensive form of farming.

We follow Nunn and Puga (2012) to construct an index of terrain irregularity, α_{slope}, which partly captures the potential labor-intensity of agricultural production. Specifically, we measure the average slope of the earth within 30 by 30 arc-second cells (ca. 1 km^2) using data from GTOPO30 (US Geological Survey 1996). The map in Figure 7b shows the geographic distribution of this index across Africa, with darker colors marking steeper terrain. The figure illustrates the large amount of spatial variation across the continent, as well as within countries and smaller geographical units. Importantly, the spatial variation in terrain steepness does not overlap with our index measuring the variation in potential yields of cereals vs. roots and tubers reported in Figure 7a.

Table 8 reports estimates of Equation (8) for different sub-samples. We con-

Table 8: Spatial RDD - Heterogeneity analysis by terrain steepness

	Dep. Variable: Number of children ever born			
	Flat terrain low-labor ($\alpha_{slope} < Q50$) [1]	Steep terrain high-labor ($\alpha_{slope} > Q50$) [2]	Flat terrain low-labor ($\alpha_{slope} < Q75$) [3]	Steep terrain high-labor ($\alpha_{slope} > Q75$) [4]
Impartible inheritance	0.260 ***	0.062	0.221 ***	0.013
	(0.065)	(0.058)	(0.052)	(0.083)
$\beta[1] - \beta[2]$ z-stat	2.264 **		2.130 **	
$\beta[1] - \beta[2]$ p-value	0.024		0.033	
Ethnic pairs FE	Yes	Yes	Yes	Yes
Country FE	Yes	Yes	Yes	Yes
Mean Dep. Var.	2.71	2.61	2.69	2.57
Nb. of pairs	271	263	285	246
Observations	87,182	86,701	130,431	43,452

Notes: The unit of observation is a woman interviewed for the DHS survey. The dependent variable is the number of children ever born from this woman. The sample includes all women who were born and raised in the place where they currently live. Estimates are from regressions that include a linear polynomial in distance to the border, ethnic pairs and country fixed effects ("Nb. of pairs" is reported in the bottom panel). The main coefficient of interest corresponds to β in Equation (8). It captures the discontinuity at the ethnic border in the number of children born from women living in the homeland of an impartible ethnic group, compared to those living in the homeland of a partible ethnic group. The bandwidth is 120 kilometers on each side of the ethnic border. The z-statistic and corresponding p-value are from a two-sided z-test for the difference between the coefficient estimated on the sub-sample of women living in "flat terrain" and the coefficient estimated on the sub-sample of women living in "steep terrain." Robust standard errors, clustered by DHS sampling units, are reported in parentheses. *** p<0.01, ** p<0.05, * p<0.1.

sider women living in less labor-intensive areas where terrain steepness is below the median (column 1) vs. women living in more labor-intensive areas where terrain steepness is above the median (column 2). We also consider areas below vs. above the third quartile (columns 3 and 4) to highlight the effects of living in more extreme terrains. The effect of impartible inheritance customs on fertility is positive and highly statistically significant only in flatter lands. In very steep lands above the third quartile, where farming involves techniques which are very labor-intensive, the coefficient is almost zero. The table also reports two-sided z-tests confirming that the difference in coefficients is statistically significant.

Again, this heterogeneity analysis shows that, as predicted by our model, the effect of inheritance rules on fertility vanishes if the land passed down to the heirs is more labor-intensive, costly to farm, or build on. In such lands, the economic incentive for having children and using them as labor in the family farm more than compensates the costs of dividing the land among many heirs, hence reducing the partible-impartible fertility differentials.

7 Conclusion

Between now and 2050, the population of Sub-Saharan Africa is expected to almost double, surpassing 2 billion inhabitants. Among the major contributors to the population growth are the high fertility levels found in countries across the continent, which should remain close to 3 births per woman on average in 2050 (United Nations 2022).

This paper explores a new contributor to the high fertility in Sub-Saharan Africa: inheritance rules. The latter have been largely overlooked by previous research, which focused on well-known drivers of fertility decisions, such as human capital, technological progress, child mortality, women empowerment or family planning. We argue that inheritance rules, and especially impartible inheritance (i.e. transmission of the deceased's property to a single heir), are playing a major role in boosting the number of births in Sub-Saharan Africa.

We develop a theoretical model showing that, while partible inheritance (i.e. division among heirs) pushes individuals to limit their fertility to avoid fragmenting the land into "inefficiently small parcels" (Baker and Miceli 2005), impartible inheritance rules do not incentivize households to control their number of children. We test the model's predictions using pre-colonial data for 842 ethnic groups recorded by Murdock (1967) and modern demographic surveys covering 24 countries. Our first empirical strategy compares the fertility of women from ethnic groups with partible and impartible customs, controlling for a large set of individual, geographical and historical covariates. We confirm our model's predictions that impartible inheritance is associated with higher fertility. Our second empirical strategy exploits ancestral ethnic borders in a spatial Regression Discontinuity Design (RDD), which allows controlling for unobservable characteristics that vary smoothly across space. Comparing women who live within 60 kilometers of an ancestral border, we find that belonging to an ethnic group with impartible inheritance customs increases fertility by 0.85 children per woman.

We also establish, both theoretically and empirically, that impartible inheritance rules play an even bigger role when the land is less labor intensive. We proxy the labor intensity of the land with two indices: (1) the potential yields of cereals vs. roots and tubers, and (2) the terrain's steepness. We confirm our model's predictions that the effect of impartible inheritance on fertility is much stronger on flat lands, in which low-labor roots and tubers can be easily cultivated.

We believe that our study has important policy implications since impartible inheritance remains the prevailing custom in many ethnic groups across the African continent. Because many Sub-Saharan African countries' constitution defer to customary law to govern inheritance, rules such as primogeniture continue to rule the transmission of properties across generations. Our results suggest that reforming succession rules can play a major role in accelerating the fertility transition in Sub-Saharan African countries. This would allow them to grasp the benefits of a "demographic dividend," that is a shift in a population's age structure that can provide opportunities for rapid economic growth. However, because some legal reforms have been less than successful in the past (e.g. the Ghana Children's Act 560 passed in 1998), there should also be accompanied by measures to ensure social legitimization and enforcement (Cooper 2010).

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A Appendix

A.1 Tables

Table A.1: Customary law recognition in the constitutions of Sub-Saharan African countries

Country	Year	Article	Text
BEN	1990	98	“[...] customary laws shall be recorded and brought into harmony with the fundamental principles of the Constitution.”
BFA	1991	101	“The law establishes the rules concerning: [...] the procedure according to which custom may be asserted and harmonized with the fundamental principles of the Constitution.”
CAF	2016	24	“[...] recognizes and protects the traditional values in accordance with the law and the Customary Authorities.”
CIV	2016	24	“The State promotes and protects the cultural heritage as well as the habits and customs [...].”
CMR	1972	1, Part I	“The Republic of Cameroon [...] shall recognize and protect traditional values [...].”
COD	2005	204	“Without prejudice to the other provisions of this Constitution, the following matters are of the exclusive competence of the Provinces: [...] the execution of customary law;”
ETH	1994	9	“The Constitution is the supreme law of the land. Any law, customary practice or [...] which contravenes this Constitution shall be of no effect.”
GAB	1991		No reference to customary law.
GHA	1992	11	“The common law of Ghana shall comprise the rules of law generally known as the common law, the rules generally known as the doctrines of equity and the rules of customary law [...].”
GIN	2010		No reference to customary law.
KEN	2010	2	“Any law, including customary law, that is inconsistent with this Constitution is void to the extent of the inconsistency, [...]”
LBR	1986	65	“The courts shall apply both statutory and customary laws in accordance with the standards enacted by the Legislature.”
MLI	1992		No reference to customary law.
MOZ	2004	118	“The State shall recognise and esteem traditional authority that is legitimate according to the people and to customary law.”
MWI	1994	200	“Except in so far as they are inconsistent with this Constitution, all Acts of Parliament, common law and customary law in force on the appointed day shall continue to have force of law, [...]”

Country	Year	Article	Text
NAM	1990	66	"Both the customary law and the common law of Namibia in force on the date of Independence shall remain valid to the extent to which such customary or common law does not conflict with this Constitution or any other statutory law."
NER	2010	99	"The law establishes the rules concerning: [...] the procedure according to which customs [coutumes] will be declared and brought into harmony with the fundamental principles of the Constitution;"
NGA	1999	245	"An appeal shall lie from decisions of a customary Court of Appeal to the Court of Appeal as of right in any civil proceedings before the customary Court of Appeal with respect to any question of Customary law [...]"
SEN	2001		No reference to customary law.
SLE	1991	170	"in this Constitution unless a contrary intention appears [...] 'law' includes [...] customary law and any other unwritten rules of law;"
TCD	2018	161	"[...] the customary and traditional rules are only applicable in the communities where they are recognized."
TGO	1992	143	"The Togolese State recognizes the traditional chiefdom, guardian of use and customs."
UGA	1995	Political Objectives	"Everything shall be done to promote a culture of co-operation. Understanding, appreciation, tolerance and respect for each other's customs, traditions and beliefs."
ZMB	1991	7	"The Laws of Zambia consist of [...] Zambian customary law which is consistent with this Constitution;"

Table A.2: DHS surveys used for each country

Country ISO3	Phase 1	Phase 2	Phase 3	Phase 4	Phase 5	Phase 6	Phase 7
BEN			1996	2001		2011-2012	2017-2018
BFA		1992-1993	1998-1999	2003		2010	
CAF			1994-1995				
CIV			1994;1998-1999			2011-2012	
CMR				2004		2011	2018-2019
COD					2007	2013-2014	
ETH				2000	2005	2011	2016
GAB						2012	
GHA		1993-1994	1998-1999	2003	2008	2014	
GIN			1999	2005		2012	2018
KEN				2003	2008-2009	2014	
LBR	1986				2006-2007	2013	
MLI			1995-1996	2001	2006	2012-2013	2018
MOZ						2011	
MWI				2000;2004-2005	2010		2015-2016
NAM				2000	2006-2007	2013	
NER		1992	1998				
NGA				2003	2008	2013	2018
SEN		1992-1993;1997		2005		2010-2011;2012-2013;2014;2015;2016	2019
SLE					2008	2013	2019
TCD						2014-2015	
TGO	1988		1998			2013-2014	
UGA						2011	2016
ZMB					2007	2013-2014	

Table A.3: Determinants of impartible inheritance customs

	Impartible inheritance (0/1)			
	OLS		Probit	
	(1)	(2)	(3)	(4)
Potential yields of all crops (stdz)	0.146 ***	0.171 ***	0.761 ***	0.897 ***
	(0.018)	(0.019)	(0.088)	(0.096)
Potential yields of roots vs. cereals (stdz)	0.092 ***	0.116 ***	0.534 ***	0.649 ***
	(0.017)	(0.018)	(0.086)	(0.092)
Terrain's steepness (stdz)	-0.054 **	-0.045 *	-0.398 **	-0.403 **
	(0.027)	(0.025)	(0.165)	(0.159)
Patrilineal (0/1)		0.168 ***		0.848 ***
		(0.011)		(0.049)
Polygynous (0/1)		-0.055 ***		-0.333 ***
		(0.009)		(0.042)
Plow use (0/1)		0.196 ***		0.889 ***
		(0.025)		(0.107)
Country FE	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes
Individual controls	Yes	Yes	Yes	Yes
Geographical controls	Yes	Yes	Yes	Yes
Colonial controls	Yes	Yes	No	Yes
Mean Dep. Var.	0.63	0.63	0.59	0.59
(Pseudo) R-squared	0.50	0.51	0.42	0.44
Observations	174,812	174,812	158,540	158,540

Notes: The unit of observation is a woman interviewed for the DHS survey. The sample includes all women who currently live in the place where they were born. The dependent variable "Impartible inheritance" takes on a value 1 if the woman belongs to an ethnic group for which the Ethnographic Atlas coded by Murdock (1967) reports impartible inheritance customs, and 0 otherwise. Estimates are from OLS (columns 1 and 2) and Probit (columns 3 and 4) models. All specifications control for country and time fixed effects, as well as "individual controls" including the respondent's age, dummies for education, marital and employment status, "geographical controls" including dummies for living in a rural area, access to electricity, the absolute values of latitude and longitude, population density, light intensity from satellite data, ruggedness index, "colonial influence" including distance to missionary settlements, colonial railway lines and explorers' routes. Pseudo R-Squared is reported for the Probit models. Robust standard errors, clustered by DHS sampling units, are reported in parentheses. *** p<0.01, ** p<0.05, * p<0.1.

Table A.4: Effects of impartible inheritance rules on fertility - OLS estimates (Full sample - movers & non-movers)

	Number of children ever born				
	All ages				Over 40 years
	(1)	(2)	(3)	(4)	(5)
Impartible inheritance (0/1)	0.076 ***	0.099 ***	0.050 ***	0.050 ***	0.091 ***
	(0.013)	(0.009)	(0.009)	(0.009)	(0.029)
Polygynous (0/1)				0.094 ***	0.281 ***
				(0.012)	(0.038)
Patrilineal (0/1)				0.080 ***	0.126 ***
				(0.009)	(0.029)
Plow use (0/1)				-0.008	-0.005
				(0.039)	(0.115)
Country FE	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes
Individual controls	No	Yes	Yes	Yes	Yes
Geographical controls	No	No	Yes	Yes	Yes
Colonial controls	No	No	No	Yes	Yes
Mean Dep. Var.	2.96	2.96	2.96	2.96	6.17
R-squared	0.02	0.61	0.63	0.63	0.17
Observations	651,148	616,370	607,179	584,379	97,114

Notes: The unit of observation is a woman interviewed for the DHS survey. The sample includes all women, that is those who currently live in the place where they were born, as well as those who moved out. Estimates for "Impartible inheritance (0/1)" correspond to coefficient β from Equation (7) and capture the effect of being from an ethnic group with impartible inheritance customs. The first column controls for country and time fixed effects. The second column adds "individual controls," including the respondent's age, as well as dummies for education, marital and employment status. The third column adds a set of "geographical controls," including dummies for living in a rural area, access to electricity, the absolute values of latitude and longitude, population density, light intensity from satellite data, ruggedness index and slope of terrain. Column four corresponds to the complete specification, adding also pre-industrial characteristics of the ethnic group where the woman belongs, such as patrilineality, polygyny, as well as controls for "colonial influence," including distance to missionary settlements, colonial railway lines and explorers' routes. Column five restricts the sample to women over 40 years, who are closer to the end of their fertile window. Robust standard errors, clustered by DHS sampling units, are reported in parentheses. *** p<0.01, ** p<0.05, * p<0.1.

Table A.5: Fuzzy Spatial RDD - Average Treatment Effects
(Full sample - movers & non-movers)

	BW=120 km
	First stage: Impartible
Impartible cluster	0.180 ***
	(0.009)
	ATE: Number of children
Impartible cluster	0.245 *
	(0.133)
Ethnic pairs FE	Yes
Country FE	Yes
Mean Dep. Var.	2.85
Nb. of pairs	321
Observations	665,472

Notes: The unit of observation is a woman interviewed for the DHS survey. The dependent variable is the number of children ever born from this woman. The sample includes all women, that is those who currently live in the place where they were born, as well as those who moved out. The bandwidth used is 120 kilometers on each side of the ethnic border. The "first stage" estimate corresponds to the coefficient θ in Equation (9). It captures the discontinuity at the border in the fraction of women who identify as a member of an impartible ethnic group, after controlling for a linear polynomial in distance, as well as ethnic pairs and country fixed effects. The Average Treatment Effect ("ATE") is from an instrumental variable estimation (using two-stage least-squares regression) in which the endogeneous variable is the fraction of women who belong to an impartible ethnic group, instrumented with the indicator variable that equals one if they live inside the homeland of an impartible ethnic group, and zero otherwise (coefficient β in Equation (10)). Robust standard errors, clustered by DHS sampling units, are reported in parentheses. *** $p<0.01$, ** $p<0.05$, * $p<0.1$.

Table A.6: Impartible inheritance and fertility - RDD estimates
(SE clustered at the ethnicity level)

	Number of children ever born		
	60 km	90 km	120 km
	(1)	(2)	(3)
Impartible inheritance	0.163 *	0.184 **	0.161 **
	(0.095)	(0.082)	(0.076)
Ethnic pairs FE	Yes	Yes	Yes
Country FE	Yes	Yes	Yes
Mean Dep. Var.	2.68	2.66	2.66
Nb. of pairs	270	286	294
Observations	89,361	138,819	173,883

Notes: The unit of observation is a woman interviewed for the DHS survey. The dependent variable is the number of children ever born from this woman. The sample includes all women who were born and raised in the place where they currently live. Estimates are from regressions that include a linear polynomial in distance to the border, ethnic pairs and country fixed effects ("Nb. of pairs" is reported in the bottom panel). The main coefficient of interest corresponds to β in Equation (8). It captures the discontinuity at the ethnic border in the number of children born from women living in the homeland of an impartible ethnic group, compared to those living in the homeland of a partible ethnic group. The bandwidth goes from 60 kilometers in the first column to 120 kilometers in the third column, in 30 kilometers increments. Robust standard errors, clustered at the ethnicity level, are reported in parentheses. *** p<0.01, ** p<0.05, * p<0.1.

Table A.7: Fuzzy Spatial RDD - Average Treatment Effects (SE clustered at the ethnicity level)

	Bandwith = 120 km
	First stage: Impartible ethnic group
Impartible cluster	0.189 ***
	(0.038)
	ATE: Number of children
Impartible cluster	0.851 **
	(0.409)
Ethnic pairs FE	Yes
Country FE	Yes
Mean Dep. Var.	2.66
Nb. of pairs	293
Observations	173,883

Notes: The unit of observation is a woman interviewed for the DHS survey. The dependent variable is the number of children ever born from this woman. The sample includes all women who were born and raised in the place where they currently live. The bandwidth used is 120 kilometers on each side of the ethnic border. The "first stage" estimate corresponds to the coefficient θ in Equation (9). It captures the discontinuity at the border in the fraction of women who identify as a member of an impartible ethnic group, after controlling for a linear polynomial in distance, as well as ethnic pairs and country fixed effects. The Average Treatment Effect ("ATE") is from an instrumental variable estimation (using two-stage least-squares regression) in which the endogeneous variable is the fraction of women who belong to an impartible ethnic group, instrumented with the indicator variable that equals one if they live inside the homeland of an impartible ethnic group, and zero otherwise (coefficient β in Equation (10)). Robust standard errors, clustered at the ethnicity level, are reported in parentheses. *** p<0.01, ** p<0.05, * p<0.1.

Table A.8: Spatial RDD - Reduced form estimates - Robustness checks

	Number of children ever born			
	60 km	90 km	120 km	Donut hole
	(1)	(2)	(3)	(4)
	Linear			
Impartible inheritance	0.163 ***	0.184 ***	0.161 ***	0.168 ***
	(0.062)	(0.050)	(0.043)	(0.049)
	Quadratic			
Impartible inheritance	0.119	0.166 **	0.163 **	0.176 **
	(0.102)	(0.080)	(0.068)	(0.087)
Ethnic pairs FE	Yes	Yes	Yes	Yes
Country FE	Yes	Yes	Yes	Yes
Mean Dep. Var.	2.68	2.66	2.66	2.66
Nb. of pairs	270	286	294	294
Observations	89,361	138,819	173,883	162,679

Notes: The unit of observation is a woman interviewed for the DHS survey. The dependent variable is the number of children ever born from this woman. The sample includes all women who were born and raised in the place where they currently live. Estimates are from regressions that control for ethnic pairs and country fixed effects ("Nb. of pairs" is reported in the bottom panel). The first panel "Linear" includes linear polynomial in distance to the ethnic border, the second panel "Quadractic" includes quadractic polynomials in distance to the ethnic border. The main coefficient of interest corresponds to β in Equation (8). It captures the discontinuity at the ethnic border in the number of children born from women living in the homeland of an impartible ethnic group, compared to those living in the homeland of a partible ethnic group. The bandwidth goes from 60 kilometers in the first column to 120 kilometers in the third column, in 30 kilometers increments. The last column reports a "Donut hole" specification where women who live within 10 kilometers of the ethnic border are excluded. Robust standard errors, clustered by DHS sampling units, are reported in parentheses. *** p<0.01, ** p<0.05, * p<0.1.

Table A.9: Effects of impartible inheritance rules on fertility - OLS estimates (Sample excluding women from ethnic groups with no private property)

	Number of children ever born				
	All ages				Over 40 years
	(1)	(2)	(3)	(4)	(5)
Impartible inheritance (0/1)	0.112 ***	0.126 ***	0.112 ***	0.112 ***	0.229 ***
	(0.026)	(0.017)	(0.017)	(0.017)	(0.059)
Polygynous (0/1)				0.135 ***	0.300 ***
				(0.021)	(0.070)
Patrilineal (0/1)				0.090 ***	0.287 ***
				(0.018)	(0.064)
Plow use (0/1)				0.038	0.304 *
				(0.055)	(0.177)
Country FE	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes
Individual controls	No	Yes	Yes	Yes	Yes
Geographical controls	No	No	Yes	Yes	Yes
Colonial controls	No	No	No	Yes	Yes
Mean Dep. Var.	2.88	2.89	2.90	2.89	6.42
R-squared	0.02	0.65	0.66	0.66	0.16
Observations	177,463	170,679	168,116	158,507	25,686

Notes: The unit of observation is a woman interviewed for the DHS survey. The sample includes all women who were born and raised in the place where they currently live, but excludes those who live within the borders of an ethnic group for which the EA reports an "absence of private property." Estimates for "Impartible inheritance (0/1)" correspond to coefficient β from Equation (7) and capture the effect of being from an ethnic group with impartible inheritance customs. The first column controls for country and time fixed effects. The second column adds "individual controls," including the respondent's age, as well as dummies for education, marital and employment status. The third column adds a set of "geographical controls," including dummies for living in a rural area, access to electricity, the absolute values of latitude and longitude, population density, light intensity from satellite data, ruggedness index and slope of terrain. Column four corresponds to the complete specification, adding also pre-industrial characteristics of the ethnic group where the woman belongs, such as patrilineality, polygyny, as well as controls for "colonial influence," including distance to missionary settlements, colonial railway lines and explorers' routes. Column five restricts the sample to women over 40 years, who are closer to the end of their fertile window. Robust standard errors, clustered by DHS sampling units, are reported in parentheses. *** p<0.01, ** p<0.05, * p<0.1.

Table A.10: Spatial RDD - Reduced form estimates
(Sample excluding women from ethnic groups with no private property)

	Number of children ever born		
	60 km	90 km	120 km
Impartible inheritance	0.163 ***	0.184 ***	0.161 ***
	(0.062)	(0.050)	(0.044)
Ethnic pairs FE	Yes	Yes	Yes
Country FE	Yes	Yes	Yes
Mean Dep. Var.	2.68	2.67	2.68
Nb. of pairs	269	284	293
Observations	88,413	136,629	170,056

Notes: The unit of observation is a woman interviewed for the DHS survey. The dependent variable is the number of children ever born from this woman. The sample includes all women who were born and raised in the place where they currently live, but excludes those who live within the borders of an ethnic group for which the EA reports an "absence of private property." Estimates are from regressions that include a linear polynomial in distance to the border, ethnic pairs and country fixed effects ("Nb. of pairs" is reported in the bottom panel). The main coefficient of interest corresponds to β in Equation (8). It captures the discontinuity at the ethnic border in the number of children born from women living in the homeland of an impartible ethnic group, compared to those living in the homeland of a partible ethnic group. The bandwidth goes from 60 kilometers in the first column to 120 kilometers in the third column, in 30 kilometers increments. Robust standard errors, clustered by DHS sampling units, are reported in parentheses. *** p<0.01, ** p<0.05, * p<0.1.

A.2 Figures

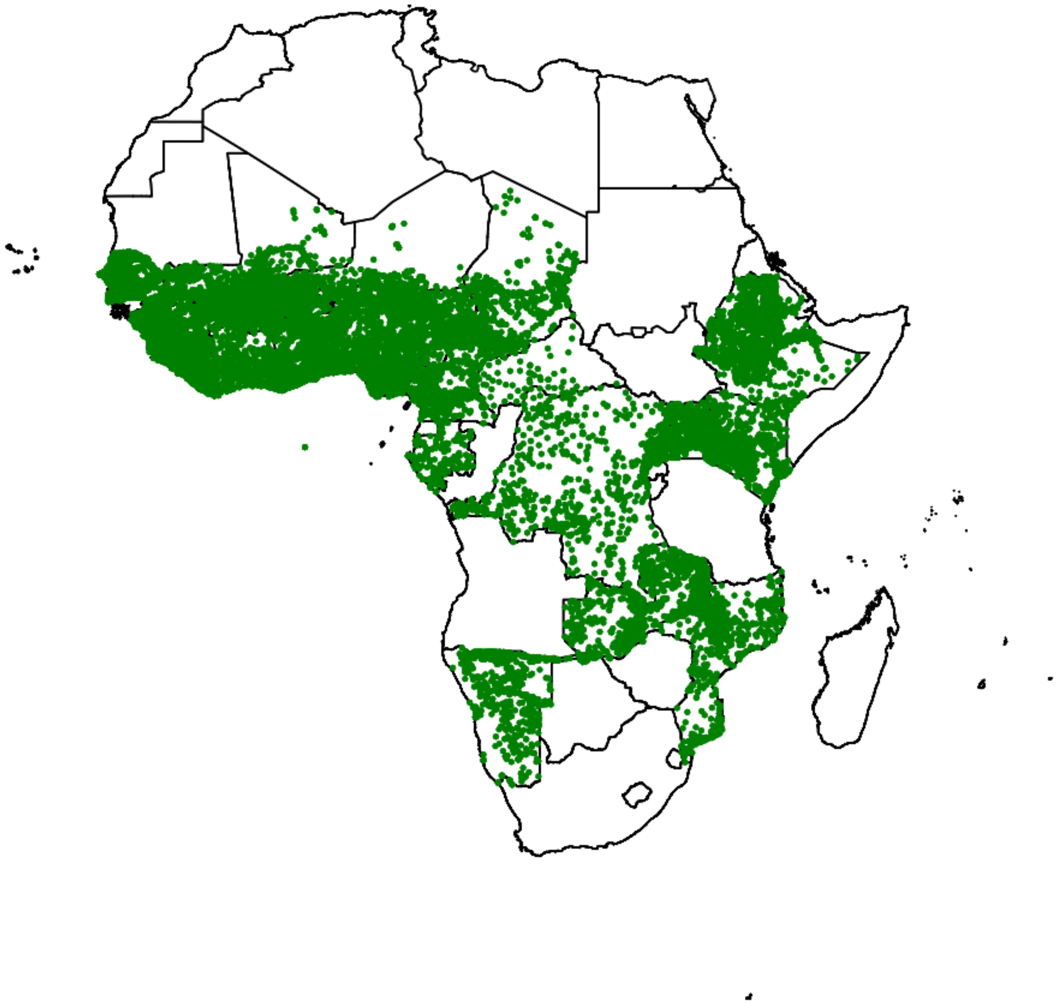

Figure A.1: Location of DHS clusters in Sub-Saharan African Countries

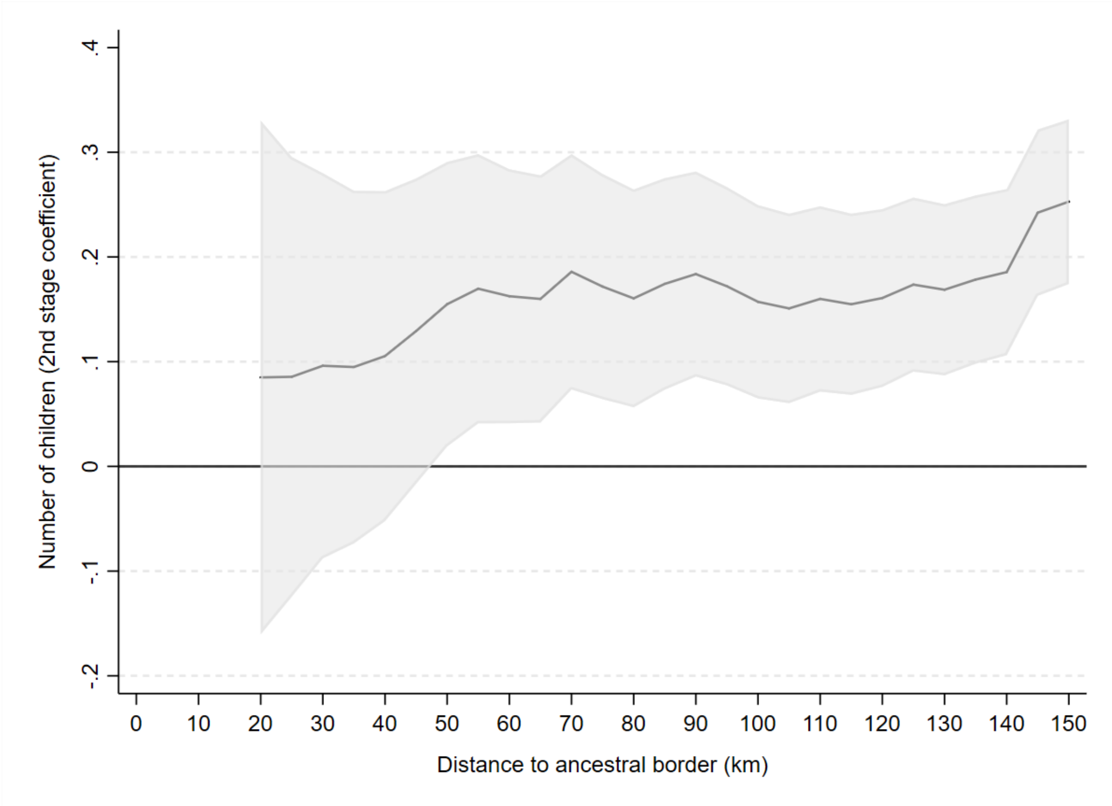

Figure A.2: Bandwidth sensitivity

Notes: The solid line plots reduced form estimates of the fertility effects (β in Equation (8)) from separate regressions with varying bandwidth around the ancestral border, from 20 to 150 kilometers in 5-kilometer increments. Regressions include a linear polynomial in distance to the border, ethnic pairs and country fixed effects. The sample includes all women who were born and raised in the place where they currently live. The shaded area represents 95 percent confidence intervals.

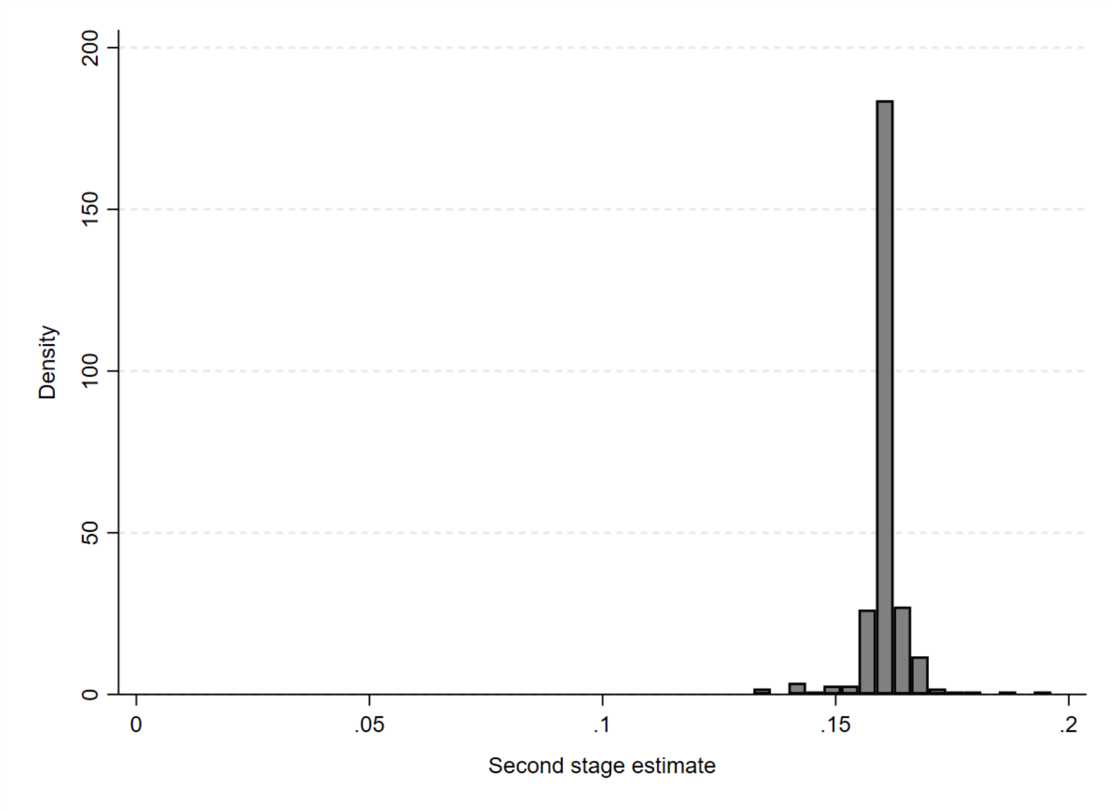

Figure A.3: Testing for outliers sensitivity using "Leave-one-out" procedure

Notes: Distribution of 294 point estimates (β in Equation (8)) from separate regressions, leaving one pair of ethnic groups out each time. Regressions include a linear polynomial in distance to the border, ethnic pairs and country fixed effects. Bandwidth is 120 kilometers and the sample includes all women who were born and raised in the place where they currently live. We observe that all estimates are centered around our baseline estimate of 0.16 (Table 4).

A.3 Maximization problems

Maximization problem under impartible inheritance. The maximization problem under impartible inheritance writes as follows

$$\max_{n_I} \ \ln\left((1-\phi n_I)y_I\right) + \beta \ln\left(\left(L-\bar{L}\right)^{1-\alpha} n_I^{\alpha}\right) \ ,$$

which can be rearranged as

$$\max_{n_I} \ \ln\left(1-\phi n_I\right) + \ln\left(y_I\right) + \alpha\beta \ln\left(n_I\right) + (1-\alpha)\beta \ln\left(L-\bar{L}\right) \ ,$$

and is only defined for $0 < n_I < \frac{1}{\phi}$.

The first order condition writes as follows,

$$-\frac{\phi}{1-\phi n_I}+\frac{\alpha\beta}{n_I}=0 \tag{11}$$

$$\iff n_I^*=\frac{\alpha\beta}{(1+\alpha\beta)\,\phi}\ ,$$

where n_I^*, is the solution to the maximization problem with impartible inheritance. Taking the derivative of Equation (11) with respect to n_I, we have

$$-\frac{\phi^2}{(1-\phi n_I)^2}-\frac{\alpha\beta}{n_I^2}<0\ ,$$

which satisfies the second order condition for a maximum.

Maximization problem under partible inheritance. The maximization problem under partible inheritance writes as follows

$$\max_{n_P}\quad \ln\left((1-\phi n_P)y_P\right)+\beta\ln\left(n_P\left(\frac{L}{n_P}-\bar{L}\right)^{1-\alpha}\right)\ ,$$

which can be rearranged as

$$\max_{n_P}\quad \ln\left(1-\phi n_P\right)+\ln\left(y_P\right)+\alpha\beta\ln\left(n_P\right)+(1-\alpha)\beta\ln\left(L-\bar{L}n_P\right)\ ,$$

and is only defined for $0<n_P<\min\left\{\frac{1}{\phi},\frac{L}{\bar{L}}\right\}$.

The first order condition writes as follows,

$$-\frac{\phi}{1-\phi n_P}+\frac{\alpha\beta}{n_P}-\frac{(1-\alpha)\beta\bar{L}}{L-\bar{L}n_p}=0 \tag{12}$$

$$\iff \frac{\alpha\beta}{n_P}-\left(\frac{\phi}{1-\phi n_P}+\frac{(1-\alpha)\beta\bar{L}}{L-\bar{L}n_p}\right)=0$$

$$\iff \alpha\beta(1-\phi n_P)(L-\bar{L}n_p)-n_P\left[\phi(L-\bar{L}n_p)+(1-\alpha)\beta\bar{L}(1-\phi n_P)\right]=0\ .$$

Where the left hand side of the first order condition is a second order polynomial and is negative for $n_P=\min\left\{\frac{1}{\phi},\frac{L}{\bar{L}}\right\}$. This implies that out of the two solutions to Equation (12) (respectively below and above $\min\left\{\frac{1}{\phi},\frac{L}{\bar{L}}\right\}$), only the one below, denoted n_P^*, is a solution to the maximization problem and equal to

$$n_P^* = \frac{\beta\bar{L} + (1+\alpha\beta)\phi L - \sqrt{(\beta\bar{L} + (1+\alpha\beta)\phi L)^2 - 4\alpha\beta(1+\beta)\phi\bar{L}L}}{2(1+\beta)\phi\bar{L}} \ .$$

Taking the derivative of Equation (12) with respect to n_P, we have

$$-\frac{\phi^2}{(1-\phi n_P)^2} - \frac{\alpha\beta}{n_P^2} - \frac{(1-\alpha)\beta\bar{L}^2}{(L-\bar{L}n_p)^2} < 0 \ ,$$

which satisfies the second order condition for a maximum.