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Differences between sons and daughters in the intergenerational transmission of wealth

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Persistent interest lies in gender inequality, especially with regard to the favouring of sons over daughters. Economists are concerned with how privilege is transmitted across generations, and anthropologists have long studied sex-biased inheritance norms. There has, however, been no focused cross-cultural investigation of how parent–offspring correlations in wealth vary by offspring sex. We estimate these correlations for 38 wealth measures, including somatic and relational wealth, from 15 populations ranging from hunter–gatherers to small-scale farmers. Although small sample sizes limit our statistical power, we find no evidence of ubiquitous male bias, at least as inferred from comparing parent–son and parent–daughter correlations. Rather we find wide variation in signatures of sex bias, with evidence of both son and daughter-biased transmission. Further, we introduce a model that helps pinpoint the conditions under which simple mid-point parent–offspring wealth correlations can reveal information about sex-biased parental investment. Our findings are relevant to the study of female-biased kinship by revealing just how little normative descriptors of kinship systems, such as patrilineal inheritance, capture intergenerational correlations in wealth, and how variable parent–son and parent–daughter correlations can be.

This article is part of the theme issue 'The evolution of female-biased kinship in humans and other mammals'.

1. Introduction

Sex-biased differentials in wealth and power have long engaged philosophers [1], political scientists [2] and comparative social scientists [3]. The prominent bias

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towards males is widespread, illustrated by the fact that post-marital residence is predominantly virilocal [4,5] and property inheritance is most commonly biased towards patrilineally related kin [6]. This means that women at marriage typically leave their natal homes for their husband's place of residence, and that resources are passed primarily between fathers and their sons. Such systems allow for men to form coalitions with their kin rather than women with their kin [7]. Many regions in south and southeast Asia offer classic examples of male-biased sex ratios, son-biased inheritance norms and discrimination against daughters (e.g. [8]). Even more broadly, and with major implications for human rights, such institutional tendencies have led to the identification of 'missing women' across much of the Middle East, North Africa, India, China and other parts of Asia [9,10].

Sex-biased kinship organization is probably both a manifestation of—and a mechanism for—gender inequality, with 'patriliny' (often used to depict norms of patrilineal inheritance and descent group membership, see [11]) protecting male privilege. By contrast, 'matriliny' (often erroneously associated with notions of matriarchy, see [12]) conjures up expectations of gender equality or muted sex-biases [13–17]. In 'matrilineal' societies, women are key to the determination of descent and typically have greater support from their natal kin than do women in 'patrilineal' societies. Furthermore, matrilineally biased inheritance describes a range of normative patterns of intergenerational wealth transmission in which women, as sisters and daughters, play key mediating roles. Such practices include a man giving wealth to his sisters' sons, as in many African Bantu examples (e.g. [18]), grandparents investing in grandchildren born to their daughters [19], or parents bestowing inheritances directly on their daughters, as in many other southern African populations ([20], see also [21]).

In reality, we know little about how parental privilege is associated with the differential outcomes for their daughters and sons, either as recipients or mediators of investment and resources. While normative patterns of intergenerational wealth transmission capture the ideology of how resources and status should be transmitted, they are unlikely to capture the full set of influences whereby opportunity in one generation is passed to that of the next. It is also unclear the extent to which such norms might account for gendered inequalities, insofar as the patterning, causality and implied mechanisms in son preference are highly variable globally (e.g. [16,22,23]). It is nevertheless clear that wealth, material or other, is often very faithfully transmitted across generations [24], a phenomenon popularly recognized as a child of the wealthy being born with a 'silver spoon' in their mouth. Accordingly, we take a close look here at how parental wealth correlates with that of their sons and their daughters. In so doing, we offer an empirical lens through which to analyse a key relationship (parent–offspring) in any kinship system, here with a focus on the relevance of offspring sex to the intergenerational transmission of wealth and privilege.

In examining gender bias with data on the intergenerational transmission of material, somatic and relational wealth from parents to their sons and daughters, we diverge somewhat from conventional focus on key aspects of kinship organization—descent (social identity based on filiation), post-marital residence and property transmission (reviewed in, [12]). Rather our approach aligns more closely with the interest of evolutionary biologists in how parental quality is transmitted across generations [25] and the concern of economists with respect to the persistence of inequality [26,27].

We present our argument as follows. First, we review how gender differentials have been studied by comparative social scientists, paying particular attention to intersections with gender-biased intergenerational norms of matrilineally and patrilineally biased inheritance, and the importance of individual-level data (§2). We then turn to the methods (§3) and results (§4) of our study that examines how parental wealth, using mid-point parental values, is associated with the wealth of their sons and daughters across a sample of 15 populations. In the Discussion (§5), we explore the generality of our results and consider the implications of our findings for the understanding of sex-biased kinship organization. We also present a model (detailed in the electronic supplementary material, S1) that addresses the limitations of making inferences about sex-biased parental investment from parent–offspring wealth correlations.

2. Intergenerational transmission of gender inequality

Gendered inequalities in rights, employment, education, autonomy and access to resources are widely recognized across the globe (e.g. [16]), persist in (sometimes) subtle but clearly recognizable patterns in industrialized contemporary populations (e.g. in the USA, [28]), and are shaped by a diverse set of ecological, historical, institutional, evolutionary and developmental influences. These include the existence of private property [2], gender-differentiated contributions to subsistence [29–31], psycho-cultural features of how children are socialized [32,33], marital strategizing [34], taboos and other culturally transmitted proscriptions [35], regional politics [13,36], colonial policies [37] and both biological [38] and a broader range of ecological constraints and opportunities [39].

An important mechanism contributing to gender inequality is sex-biased parental investment, particularly in the form of intergenerational wealth transmission. There is a widespread and strongly supported claim that sons in many human societies are typically preferred as inheritors over daughters (e.g. [6]). While competition among females has long been recognized (see e.g. [40] for humans, [41] for other species), features of mammalian reproductive biology typically favour more competition among males than females over access to mates (e.g. [42]), a bias that will nevertheless vary in strength across populations [43]. As such it is generally expected that parents will invest more heavily in the competitive traits of their surviving sons than those of their surviving daughters. In humans, this has been studied from both macro- and micro-perspectives.

From the macro-perspective, sociocultural anthropologists, as the natural historians of our species, have for well over a century recognized the importance of sex-biased intergenerational transmission of property (e.g. [44]). Economists too have begun to study how gender-biased inheritance and post-marital residence patterns affect women's well--being [17] (S. Lowes 2018, unpublished manuscript). Quantitative support for such biases (and their patterning) relies mainly on analyses that use cross-cultural codes capturing the norms and/or institutions that shape gender inequalities, such as matrilineal versus patrilineal inheritance [45,46] or uxorilocal versus virilocal post-marital residence [47,48], rather than actual patterns of behaviour or residence. Informative as analyses of normative patterns can be [49,50], such descriptors of populations can obscure many of the choices and strategies of individuals, as suggested by the unexpectedly poor fit of Y chromosome data with normative residential patterns [51]. The persistent critique of studies based on normative codes is that it is often unclear how far the coded variable state reflects a unique institutional solution and/or how seriously it is followed (but see [52]). At minimum, studies based on these codes should be supplemented by studies using individual-level measures to determine the fidelity of behaviour to stated norms.

At the micro-level, evolutionary anthropologists have examined the conditions that affect sex-biased parental preferences both within and between populations, using either individual investment behaviour or individual outcomes [53–62]. Strangely, empirical evidence for sex differences in parent–offspring similarity, or the extent to which parents transmit their traits to their offspring, is rarely the focus of investigation, or is simply assumed to ensue from differential parental allocations. This is surprising, insofar as a fundamental assumption underlying tests for adaptive variation in parental investment turns on how effective parents can be in transmitting their traits to their offspring of each sex [25,53,63].

Economists, by contrast, have focused more specifically on intergenerational wealth transmission (e.g. [26]), with the specific goal of revealing the transmission of inequality rather than the patterning of parental investment *per se*. They ask whether all children have an equal chance for a successful life, or whether children's fates are limited by the same opportunities (or constraints) as their parents. To answer such questions, individual-level data are used to estimate intergenerational elasticities (child's adult log measures of human capital regressed on parent's adult log measures of human capital). Such studies show, for example, how high parent–offspring similarities (elasticities) in education play a key role in contributing to income inequality in developed [64] and developing nations [65]. These studies focus primarily on income and education differentials (e.g. [66]), and mainly in (developed) nations with reliable panel data [67]. Furthermore, they typically look only at men (e.g. [68]). This is in part because women's labour force participation can be a poor indicator of her economic status (if only poor women work), and in part because until recently often only few women in developing nations are educated or earn incomes.

Chadwick & Solon [69] broke the mould with a sophisticated analysis of income elasticities for sons and daughters, using panel data on income for the USA. They found somewhat higher elasticities for sons (0.55) than daughters (0.35–0.49), and showed that much of the daughters' elasticity was attributable to assortative marriage—daughters of the rich marrying into rich families (see also [23]). More recent studies show smaller differences in gender-specific income elasticities—e.g. in Spain (0.39 versus 0.40) [70] and Japan (0.39 versus 0.34) [71], for daughters and sons, respectively.

Perhaps unsurprisingly from an anthropological perspective, quantitative surveys of sex differences in intergenerational transmission suggest that customary norms regarding property transfers are not the whole story. Irrespective of the formal institutions of lineality and post-marital residence, parents appear to strategize, bargain with one another and make compensatory allocations that often run counter to expectations regarding gender preferences based simply on inheritance or post-marital residential norms [62,72,73]. For example, using the Indonesia Family Life Survey, Levine & Kevane [22] show that neither female disadvantage in education, female disadvantage in growth, nor 'missing daughters' are related to the regional norms of post-marital residence and inheritance.

Here we study a key set of relationships within any kinship system—between parents and sons, and parents and daughters—to identify gender differences in the extent to which offspring resemble their parents with respect to different kinds of wealth (for a somewhat similar approach, see [74]). In so doing, we move away from normative accounts of gender-biased inheritance systems. Rather we present individual-based data on parent–offspring wealth correlations, using mid-point parental values, for 38 wealth measures from 15 populations around the world, representing different modes of economic production. As in Borgerhoff Mulder *et al.* [24], we examine a range of wealth variables that capture holistic indicators of well-being, and include material assets, physical health, skills and social capital, greatly expanding the previous focus among economists on income and education. We include reproductive success (RS) in this examination of the multiple dimensions of wealth insofar as it captures aspects of somatic wealth (such as health and nutrition) that influence an individual's ability to produce and successfully raise offspring [75,76]. Furthermore, individuals in most of our samples generally view children (and large families) as a manifestation of prosperity, despite the fact that most sampled societies are no longer characterized by natural fertility.

While we start from the assumption that sex-biased parental investment can be detected from parent–offspring wealth correlations, we recognize that inferring parental discrimination *per se* from such data can be problematic [53,77]. This is because many dynamics can contribute to offspring resembling their parents. These include: first, genetic inheritance that can influence a person's ability to produce wealth via heritable traits like health or stature; second, cultural transmission whereby offspring learn the beliefs, values and behaviour of their parents and thus achieve similar wealth outcomes; and third, direct parental investment, including investment in education as well as direct bequests, thereby influencing an offspring's subsequent wealth. Accordingly, we include a model in the electronic supplementary material (S1) that identifies the conditions under which this inference might be accurate, as reported in the Discussion.

The logic of our approach can be illustrated with the following example: suppose that parents of all wealth levels invest most of their resources in daughters. The rich, having more wealth to invest, will produce daughters who are much wealthier than the daughters of the poor. This creates a strong correlation between a daughter's wealth and that of her parents. By contrast, because relatively little is invested in sons, regardless of parent wealth, the sons of wealthy parents will tend to be only slightly more wealthy than the sons of poor parents. Son's wealth will therefore be only weakly correlated with parent wealth. The general result is that the sex in which parents invest more heavily will be the sex with a larger parent–offspring correlation. As noted above, this logic does assume that other mechanisms leading to parent–offspring wealth correlations (e.g. genetic and cultural transmission for wealth productivity [26]) will not upend the influence of direct parental investment, an assumption we return to in the Discussion in connection with our model.

We find that mid-parent–offspring correlations show wide variation in inferred parental investment across different populations, thereby failing to support the common expectation that son preference is more common than daughter preference. We estimate that roughly 40% of the datasets show little evidence of sex-biased transmission as indicated by parent–offspring wealth correlations. The remaining datasets fall about equally into son-biased versus daughter-biased categories, although material wealth measures are more often son-biased in our sample.

3. Methods

(a) Data

The data represent a convenience sample of 15 populations assembled to test a model for the relationship between inequality and intergenerational transmission across a range of different subsistence systems [24,75]. Two of our populations are settled foragers (Lamalera, Ust'-Avam), four horticulturalists (Chewa, Gambia, Pimbwe, Tsimane), two pastoralists (Datoga, Himba) and seven agriculturalists (Bangladesh, Bengaluru, Kipsigis, Krummhörn, Maya, Mosuo, Poland). For somatic wealth (capital accrued in a person's body and brain), our measures include education (in years), height, RS (measured as the number of offspring surviving to age 5), weight, and ethnographically appropriate measures of productive skill or knowledge. For relational wealth, our measures are social network size and cattle partners (the latter an indicator of the cattle-loaning networks that exist among pastoralist populations [78]); and for material wealth, our measures include household wealth, house quality, income, land, livestock, and boat shares (the latter a form of partial ownership of sea-going craft among whaling populations [79]). These variables (listed in table 1) were chosen on the basis of availability in the original dataset. Although these data were collected for other purposes, in each case the ethnographer endorses the value of these measures as indicators of well-being or success in the population. For some material wealth variables (especially land and livestock), men are often the primary owners and inheritors. In such cases, we assigned to women the material wealth of their husbands. We recognize that this assignment is somewhat artificial; for example, that a husband and wife live on the same amount of land does not imply equal control over it. However, this procedure does accurately capture the availability of land and livestock to women for their use in these populations.

Insofar as differential outmigration dependent on wealth might bias estimates of intergenerational wealth correlations [80], we note that in the original study [24] all study sites were examined for this possibility and dropped if rates of outmigration were likely to be wealth-dependent [75]. Furthermore, for some fieldsites, quantitative analyses confirm that parents with resident and non-resident offspring do not differ in terms of wealth [24].

We use standardized wealth scores to compare an individual's wealth relative to others of his or her same age and sex. In other words, we are not comparing the wealth of males to females, but rather the extent to which the relative fates of sons, and the relative fates of daughters, are determined by that of their parents. This allows for standardized comparisons across societies. Accordingly, whether our wealth measures have different practical meanings between the sexes is irrelevant so long as the values assigned to women reflect some measure of advantage relative to other women, and similarly men relative to other men. In the electronic supplementary material, (S2b; table 1), we present the standardized difference in mean wealth between sons and daughters, along with descriptive statistics on our samples. We nevertheless caution that although the standardized difference in mean wealth between sons and daughters appears to provide a measure of gender inequality with respect to the variable in question, any simple interpretation of these values is problematic because of the complex causes underlying them (discussed in more detail in the electronic supplementary material, S2b). Population-specific analyses, and qualitative data, are needed to throw more light on sex differences generally.

(b) Statistical inference

Our goal is to estimate the correlation between parent wealth and offspring wealth. Only adults (age ≥ 18) were used in paired parent–offspring analyses. Still, because our data contain individuals of varying ages and because age often strongly predicts wealth, we compute deviations from age-specific (and sex-specific) distributions. An individual i's relative wealth deviation, D_i, is his or her standardized deviation of wealth W_i relative to other individuals of the same age, a_i, and sex, s_i:

$$D_i = \frac{W_i - \mu(a_i,s_i)}{\sigma(a_i,s_i)}, \tag{3.1}$$

where μ and σ are functions specifying the mean and standard deviation, respectively, for each age and sex. Their functional forms for each population were chosen via Bayesian information criteria (BIC). We then used a Bayesian Hamiltonian Monte Carlo algorithm to infer posterior estimates of D for every individual. See further statistical details in the electronic supplementary material (S2c).

The parent–offspring wealth correlation, ρ, is the correlation between offspring D on mid-parent D. The mid-parent D, or D_{mp}, is the mean D of an individual's two parents; we use mid-parent wealth under the assumption that both parents play a role in investment. We compute ρ separately for sons and daughters, yielding ρ_s and ρ_d, respectively. We refer to the difference between son and daughter correlations as Δ_ρ. That is

$$\Delta_\rho = \rho_s - \rho_d. \tag{3.2}$$

To understand the use of D, the wealth deviations, consider the following example: suppose men and women tend to acquire more wealth (of unspecified kind) as they age. Comparing a young woman to an old woman, we will probably find that the latter is more wealthy. But suppose the young woman has acquired more wealth than is common for women of her age, while the old woman has less than average. Then the young woman's wealth deviation, D, will be positive and larger than that of the older woman's, whose D will be negative. The young woman will be counted as wealthier in this analysis. As an example, we show the estimated relationship between mid-parent son and mid-parent daughter land ownership in our Bangladeshi sample in figure 1.

For all datasets, we checked whether the parent wealth distribution deviated from that of the offspring distribution, even when controlling for age. For RS, this will clearly tend to be true, because parents necessarily have at least one offspring, but their children may not. We identified such cases by comparing models with and without a generation effect via BIC. For such cases, each individual's deviation is taken with respect to his or her own generation rather than with respect to the full sample from that population.

For several datasets, we use the D of one parent rather than the mid-parent value. Because of sample size restrictions, the Chewa and Himba datasets used mother's wealth; for the Datoga, Kipsigis and Krummhörn datasets, only information for father's wealth was available. The ρ produced by the single-parent method tends to differ from the ρ produced by the mid-parent method. For example, simple quantitative genetic models suggest that single-parent–offspring correlations are of smaller magnitude relative to mid-parent values, but the precise effect depends on the form of inheritance and is moderated by assortative mating (e.g. [81]). Furthermore, the single-parent method will overestimate the wealth of polygynously married women, at least for rival wealth divided among co-wives [82]. Although we cannot calculate the

Table 1. Wealth variables and ethnographic data for 15 populations.

population	wealth variables	marriage[a]	lineality[b]	post-marital residence[c]	inheritance biases[d]	subsistence[e]
Bangladesh	education, income, land	monogamy	patrilineal	virilocal	patrilineal; largely egalitarian by birth order; primarily to males but females get dowry and sometimes other inheritances	agriculture
Bengaluru	education, social networks, RS	monogamy	patrilineal	virilocal	patrilineal; largely egalitarian by birth order; male bias in inheritance but females get dowry	agriculture, commercialism
Chewa	education, land, RS	monogamy	matrilineal	uxorilocal	matrilineal (land inheritance from mother to daughters, political office from maternal uncle to sisters' sons); no strict birth order rules	horticulture
Datoga	livestock, RS	polygyny	patrilineal	virilocal	patrilineal; largely egalitarian; primarily to males though females get special livestock	agropastoral/pastoral
Gambia	height, weight, RS	polygyny	patrilineal	virilocal	patrilineal; no strict birth order rules; primarily to males	horticulture
Himba	RS	polygyny	double descent	virilocal	patrilineal for political power and residential buildings, but cattle mainly from maternal uncle to sisters' sons	agropastoral/pastoral
Kipsigis	cattle partners, land, livestock, RS	polygyny	patrilineal	uxorilocal	patrilineal; egalitarian; only to males	agropastoral
Krummhörn	land	monogamy	patrilineal	virilocal	patrilineal; weak ultimogeniture, although elder sons compensated with cash; bias to males but females inherit smaller portions	agriculture
Lamalera	boat shares, house quality, RS	monogamy	patrilineal	neolocal	patrilineal; generally egalitarian for material wealth, with ultimogeniture for houses	maritime foraging
Maya	education, height, weight, RS	monogamy	double descent	virilocal followed by neolocal; some uxorilocal	community land collectively owned as part of post-revolutionary land tenure (ejido) system	agriculture
Mosuo	education, RS	polygyny permitted but rare	matrilineal and patrilineal (village-level)	uxorilocal and virilocal	some villages with matrilineal inheritance, egalitarian and to females only, others with patrilineal descent, ultimogeniture, and to males only	agriculture
Pimbwe	farm skill, household wealth, RS	polygyny permitted but rare	weakly patrilineal	virilocal, uxorilocal, neolocal	patrilineal/matrilineal; generally egalitarian; to males and females	horticulture
Poland	education	monogamy	patrilineal	virilocal, uxorilocal, neolocal	patrilineal; ultimogeniture of land and property preferred; some women inherit land	agriculture

(*Continued.*)

Table 1. (*Continued.*)

population	wealth variables	marriage[a]	lineality[b]	post-marital residence[c]	inheritance biases[d]	subsistence[e]
Tsimane	knowledge, weight, RS	polygyny permitted but rare	double descent	uxorilocal then virilocal	patrilineal/matrilineal; generally egalitarian; to males and females	horticulture
Ust'-Avam	education, RS	monogamy	cognatic	virilocal, uxorilocal, neolocal	patrilineal with some matrilineal transmission to sons-in-law; largely egalitarian; male biased	foraging

[a]Marriage type based on rule and prevalence.
[b]Descent group membership based on rule and prevalence. Patrilineal, membership through father's group; matrilineal, membership through mother's descent group; double descent, membership of both matrilineal descent and patrilineal descent groups; cognatic, membership of a single descent group consisting of mothers and fathers family.
[c]Postmarital residence based on rule and general practice. Virilocal, with husband's family members; uxorilocal, with wife's family members; neolocal, with no family members nearby.
[d]Gender-biased transmission of resources and status between generations (as defined in text), with additional notes (if relevant) on whether intergenerational transmission is affected by birth order (egalitarian, ultimogeniture or primogeniture) and whether there is a strong male or female bias to ownership or control of inheritances.
[e]Primary form(s) of subsistence during study period.

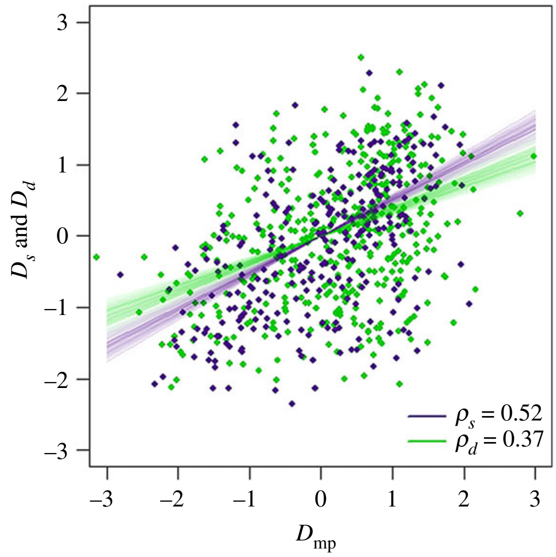

Figure 1. Plots of ρ_s and ρ_d estimated for land ownership in Bangladesh. The steeper slope for sons (in purple) is consistent with son-biased parental investment. D_s, D_d and D_{mp} are standardized wealth deviations of sons, daughters and midparents, respectively (see equation (3.1)).

expected error, we expect single-parent correlations to be of the same sign as the true mid-parent correlation. We thus feel that these datasets are appropriate to include and do not separate them from other populations in our figures.

4. Results

(a) Parent–son and parent–daughter wealth correlations

Statistical estimates of the parent–offspring wealth correlations for sons (ρ_s) and daughters (ρ_d), and their differences (Δ_ρ) are summarized in table 2. The estimates of ρ_s and ρ_d are also plotted (along with 90% confidence intervals) in figure 2, with populations sorted by mean correlation across both sexes. The plots show that many of our estimates are not very precise; only about one half (37 of 76) have standard errors less than 0.1. For most of the populations, then, we are moderately uncertain about where ρ_s and ρ_d lie.

Taking sons and daughters together, we can be 90% confident that wealth is positively transmittable ($\rho > 0$) for just over half of the estimates (40 of 76). Weight shows consistent positive parent–offspring correlation, probably owing in large part to genetic transmission. Land, too, is consistently positive, and education is also positive for most datasets. Few correlations show strong evidence of being negative. This is as expected, because a negative ρ would imply that wealthy parents tend to have poor offspring. Only Chewa male RS has a $\rho < 0$ including the 90% confidence intervals. Visual inspection of figure 2 suggests that RS tends to be over-represented among low correlations.

(b) Estimates of sex differences in intergenerational transmission

Figure 3 shows plots of Δ_ρ, the difference between parent–son and parent–daughter wealth correlations, with 90% confidence intervals. Because these estimates compound the

Table 2. Estimates of parent–offspring correlations for each sex (ρ_s and ρ_d) and their difference (Δ_ρ), with standard errors of the estimates (s.e.).

population	wealth type	ρ_s	s.e.	ρ_d	s.e.	Δ_ρ	s.e.	*n* sons	*n* daus
Bangladesh	education	0.47	0.03	0.54	0.03	−0.07	0.05	596	516
	income	0.29	0.05	0.22	0.04	0.07	0.07	298	584
	land	0.52	0.04	0.37	0.04	0.14	0.06	283	436
Bengaluru	education	0.67	0.03	0.71	0.03	−0.04	0.04	263	299
	social networks	0.12	0.07	0.12	0.07	0.00	0.10	162	183
	RS	0.21	0.06	0.12	0.06	0.10	0.08	291	355
Chewa	education	0.28	0.07	0.24	0.09	0.04	0.11	147	98
	land	−0.14	0.25	0.06	0.10	−0.20	0.27	33	118
	RS	−0.41	0.16	0.08	0.09	−0.49	0.19	35	132
Datoga	livestock	0.54	0.08	0.54	0.12	−0.01	0.13	95	40
	RS	0.18	0.13	0.20	0.17	−0.02	0.21	95	40
Gambia	height	0.44	0.04	0.56	0.03	−0.12	0.05	390	427
	weight	0.37	0.04	0.44	0.04	−0.08	0.06	390	427
	RS	0.15	0.07	−0.03	0.05	0.18	0.09	87	220
Himba	RS	0.15	0.13	0.19	0.11	−0.04	0.17	54	92
Kipsigis	cattle partners	−0.02	0.15	0.16	0.21	−0.18	0.25	61	41
	land	0.63	0.06	0.16	0.11	0.47	0.12	161	109
	livestock	0.46	0.07	0.09	0.10	0.37	0.12	161	109
	RS	0.06	0.11	0.03	0.13	0.03	0.17	160	108
Krummhörn	land	0.60	0.02	0.52	0.03	0.08	0.03	708	744
Lamalera	boat shares	0.15	0.15	0.12	0.14	0.03	0.20	64	55
	house quality	0.14	0.14	0.12	0.16	0.03	0.21	53	40
	RS	−0.14	0.13	0.42	0.11	−0.56	0.18	64	55
Maya	education	0.12	0.12	0.30	0.10	−0.18	0.15	106	103
	height	0.40	0.10	0.63	0.07	−0.23	0.11	63	78
	weight	0.25	0.13	0.23	0.11	0.02	0.16	61	74
	RS	0.07	0.12	−0.01	0.11	0.07	0.16	99	88
Mosuo	education	0.26	0.09	0.30	0.07	−0.05	0.11	141	156
	RS	−0.13	0.11	0.06	0.07	−0.20	0.13	134	146
Pimbwe	farm skill	0.08	0.14	0.21	0.12	−0.13	0.18	61	71
	household wealth	0.33	0.10	−0.08	0.11	0.41	0.15	77	92
	RS	−0.04	0.06	0.04	0.07	−0.07	0.09	226	215
Poland	education	0.30	0.01	0.28	0.01	0.02	0.02	5781	7274
Tsimane	knowledge	0.03	0.15	−0.02	0.14	0.05	0.20	41	68
	weight	0.35	0.09	0.22	0.10	0.13	0.13	110	107
	RS	0.05	0.05	0.09	0.05	−0.04	0.07	435	406
Ust′-Avam	education	0.53	0.12	−0.15	0.18	0.68	0.22	55	45
	RS	−0.15	0.15	−0.14	0.12	−0.01	0.19	77	54

uncertainty in both male and female ρ, their errors are greater. We are therefore unable to precisely identify Δ_ρ for most datasets. For example, only 12 of 38 estimates, about a third of the total, have a standard error of less than 0.1.

Nonetheless, in some cases we can be quite certain that $\Delta_\rho > 0$, and, for others, $\Delta_\rho < 0$. We are 90% confident that $\Delta_\rho > 0$ for Ust Avam education, Kipsigis land and livestock, Pimbwe household wealth, Gambia RS, Bangladesh land and Krummhörn land (figure 3). We are 90% confident that $\Delta_\rho < 0$ for Lamalera RS, Chewa RS, Maya height, Gambia height and Bangladesh education. The fact that a difference exists does not imply that the difference is very large, however. For example, while we can be confident that parent–offspring land correlations are greater for sons than daughters in the Krummhörn, the absolute difference in correlation is 0.08.

Although most confidence intervals overlap zero, we caution against embracing the null hypothesis ($\Delta_\rho = 0$); many

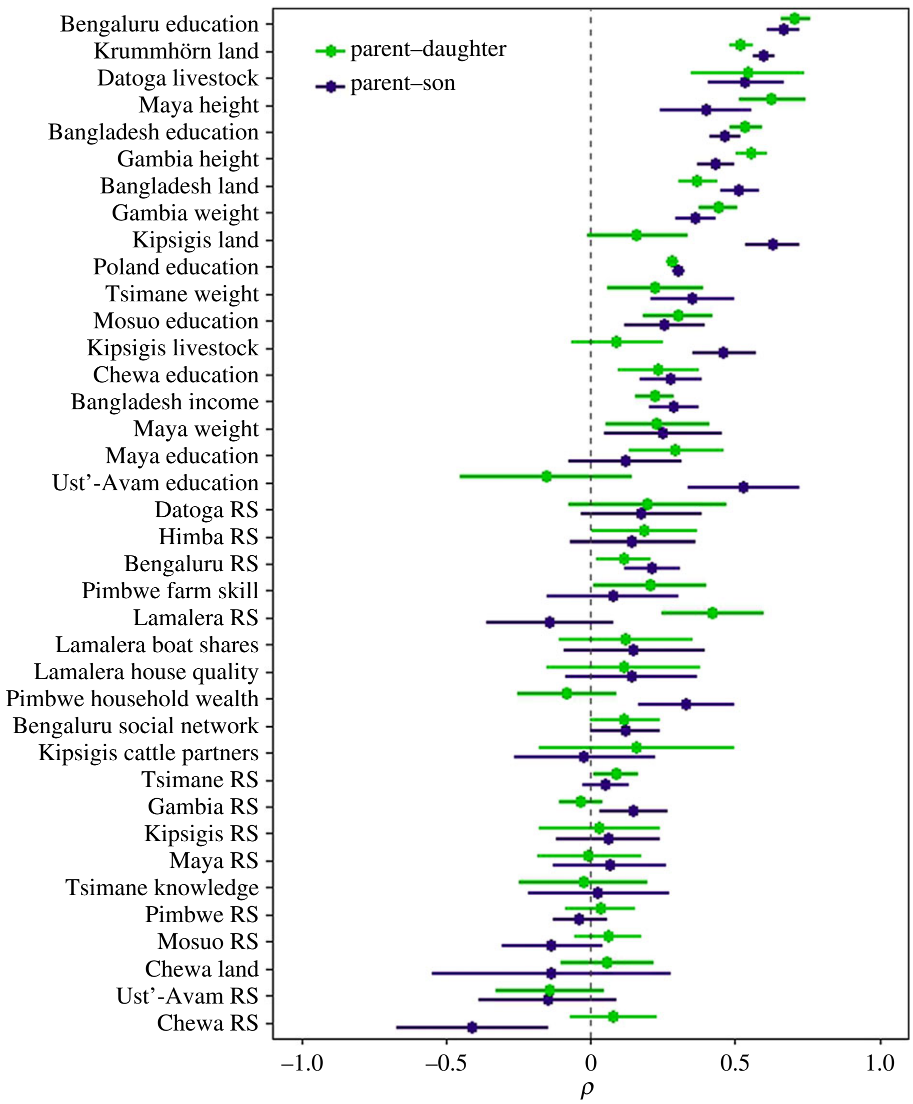

Figure 2. Parent–son and parent–daughter correlations (ρ_s and ρ_d), with 90% confidence intervals. The datasets are sorted by the mean correlation across both sexes.

estimates that overlap zero still allow for the possibility of moderate to large Δ_ρ. Increased precision would require larger samples. In fact, only a few datasets are both very precise and overlap with zero. These include Poland education, Bengaluru education and (perhaps) Bangladesh education, which are among our largest samples. Our inability to identify populations with small Δ_ρ is owing to our wide confidence intervals, not because the evidence points away from it, as we reveal below.

Do particular wealth types, inheritance norms, marriage patterns or production systems show any tendencies towards son or daughter bias? Given our opportunistic sample, we cannot provide systematic analysis of these questions. The data do suggest a few possibilities. First, five of the 10 material wealth measures (land, livestock, household wealth, income and boat shares) are convincingly son-biased, while none are clearly daughter-biased. Mechanistically, this may arise from male-biased norms of property transmission; furthermore, this pattern would be expected evolutionarily if sons use inherited resources to enhance fitness more effectively than daughters (see Discussion). Second, daughter bias is observed only for somatic wealth (RS, height and education). In fact, several of the 12 measures of RS are reliably daughter-biased, showing that the mechanistic argument above for sons is not a given. Third, the populations with matrilineal inheritance norms (Chewa and Mosuo) appear to show a slight tendency towards daughter bias; these populations together account for only five wealth measures, however, so this pattern must be viewed with caution. No pattern emerges with respect to marriage patterns: the most polygynous populations (Chewa, Datoga, Gambia and Kipsigis) show both son-biased and daughter-biased correlations. Finally, there is no clear patterning by production system.

(c) Estimating the extent of sex bias

Although our estimates for each dataset are imprecise, we can nevertheless simulate the distribution of Δ_ρ for the whole group of datasets using the computed posterior probabilities. We can ask, for example, how many datasets are expected to be strongly son-biased with respect to intergenerational transmission, or how many show little bias in either direction. Table 3 shows how many datasets are expected to show little sex bias ($-0.1 < \Delta_\rho < 0.1$), son bias ($\Delta_\rho > 0.1$) and daughter bias ($\Delta_\rho < -0.1$). These numbers are calculated by independently drawing estimates from the distributions depicted in

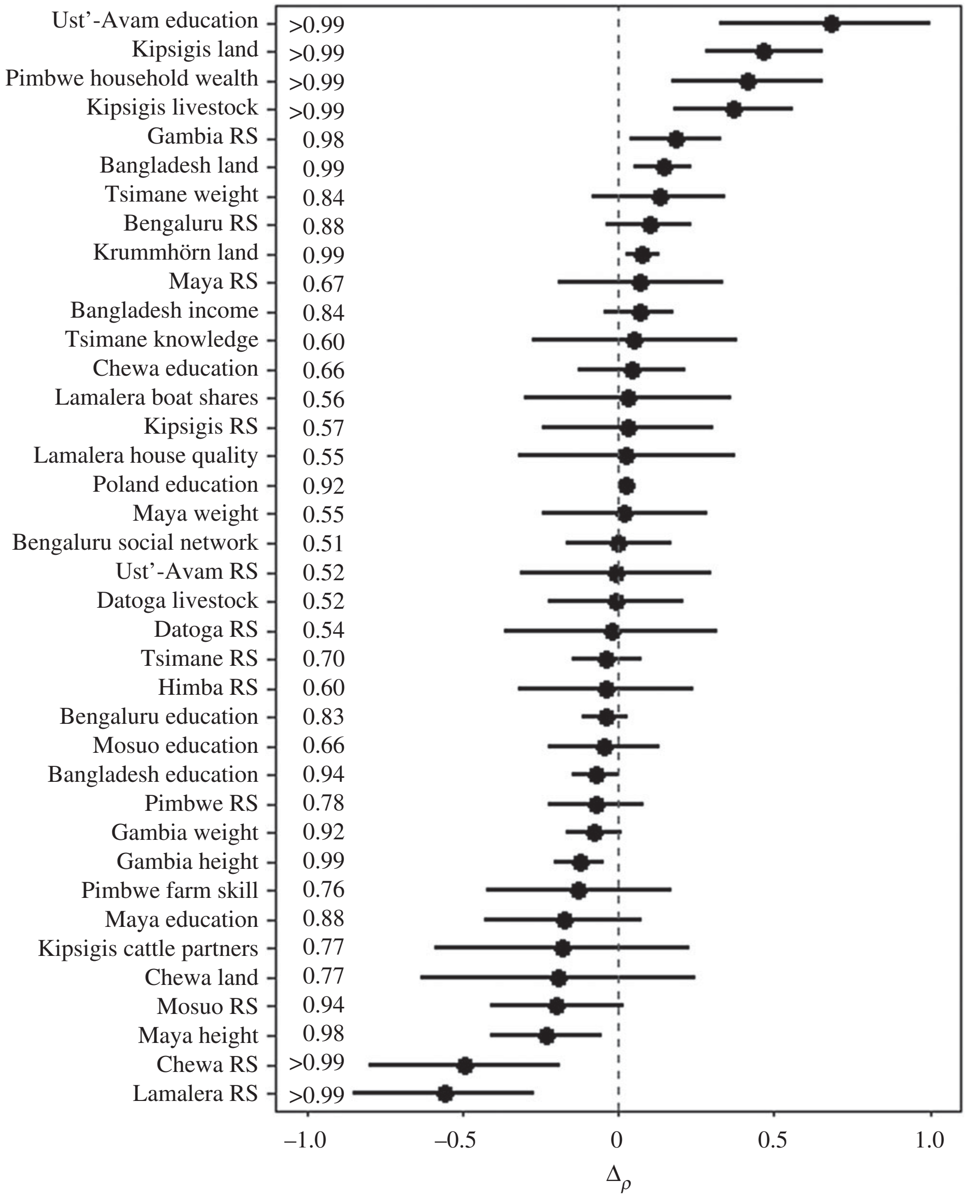

Figure 3. Difference between son and daughter correlations ($\rho_s - \rho_d = \Delta_\rho$), with 90% confidence intervals and datasets sorted by Δ_ρ. Numbers along the vertical axes for each wealth measure give the posterior probability that $|\Delta_\rho| > 0$.

Table 3. Estimated number of datasets that show little bias, son bias and daughter bias. (CI, confidence interval.)

	definition	*n*	90% CI
little bias	$\lvert\Delta_\rho\rvert < 0.1$	15	11–19
son bias	$\Delta_\rho > 0.1$	11	8–14
daughter bias	$\Delta_\rho < -0.1$	12	7–14

figure 3 and counting the amount that fall into each category. The choice of 0.1 as the cutoff is arbitrary.

Table 3 shows that roughly 15 datasets (39% of the total) are expected to have little sex-biased parental transmission, although we have confidently identified only two. The rest will have some notable bias, with about equal numbers daughter biased and son biased. Note that these calculations were done using a prior that assigned equal prior probability to every value of Δ_ρ in the interval (−1,1). If extreme values of Δ_ρ are *a priori* unlikely, then this would increase the number of datasets in the 'little bias' category.

5. Discussion

We have estimated mid-parent–offspring correlations for multiple wealth measures across a wide range of small-scale societies, examining whether these correlations vary between sons and daughters. We conclude that despite the imprecision of most estimates, there is substantial variation in correlations across populations. Moreover, some datasets show strong evidence for much higher parent–offspring correlation in one sex than the other. Other populations probably have very small differences, although we cannot securely identify most of them.

Our analysis does not support the hypothesis that son preference among parents is more predominant than daughter preference. This is perhaps surprising, given common perceptions, and given that some of our wealth variables are, following normative precepts, inherited only by sons (in contrast, we have no wealth measure that is inherited only by daughters). This does not mean that sons and daughters are everywhere treated equally; our data clearly refute that claim. Rather, we find that many populations appear to show no sex-biased parental investment and, among those that do, they are just as likely to favour daughters as sons despite social norms for gendered inheritance.

In this discussion, we address first the conditions under which parent–offspring correlations reveal patterns of sex-biased investment. We then interpret in more detail the patterning we find in our data before drawing conclusions about some aspects of female-biased kinship.

(a) Inferring preferences for sex-biased inheritance from parent–offspring correlations

As noted in the Introduction, the sex with the larger parent–offspring correlation in wealth will, all other things being equal, be the sex in which parents invest more heavily. But all other things are never equal, such that offspring wealth may correlate with parental wealth for many other reasons apart from direct parental investment, including genetic and cultural transmission of traits associated with wealth productivity [26]. To address this problem, we consider a model (detailed in the electronic supplementary material, S1) that includes two pathways of wealth inheritance: (i) direct parental investment and (ii) indirect transmission via the inheritance of genetic and cultural capability for wealth production. In short, our model of wealth transmission helps us derive the conditions under which offspring–parent correlations can be used to infer sex-biased investment. These conditions include that: (i) the ability to acquire wealth is equally heritable in males and females (whether through genetic or cultural inheritance), (ii) the effect of direct parental investment on offspring wealth is the same for sons and daughters relative to each sex's wealth standard deviation, and (iii) parent wealth is not correlated with a particular investment strategy (as hypothesized by Trivers & Willard [83]). Although we are unable to assess whether all three conditions hold in each of the datasets considered here, the model is useful in identifying circumstances that could unlink the parent–offspring correlation from the investment strategy, for instance, if wealthy parents invest more in sons than do poor parents (condition (iii)). We are not aware of any previous attempt to identify these conditions formally.

(b) Interpreting the pattern of sex-biased intergenerational correlations

Research of economists in the Philippines [23,84] and Ghana [73] corroborates our inferred conclusion that gender equality in parental investment may be a great deal more common than normative rules would imply. These studies show relatively egalitarian treatment of sons and daughters, as estimated from intergenerational correlations/elasticities for a variety of different kinds of capital, including health, education, land and productivity. It is important, however, to point out that apparent gender equality may be obscuring more nuanced dynamics. More specifically, different resource types may show different intergenerational transmission, and gender preferences may reverse as offspring grow older [53]. For example, material capital may be more effectively transmitted to sons, and human capital to daughters (as shown in the Philippines, [23]), and compensatory strategies may occur over the lifetime to make up for initial biases [22]. As such, global patterns are likely to be highly variable, and affected by which particular wealth types are measured and among offspring of what age. Once standardized data are available, meta-analyses of individual-level data will be needed to determine the effects of institutional norms, such as inheritance laws, political systems and religious values on not only parent–offspring correlations but the varying pathways entailed. Furthermore, only with a larger dataset across more strategically selected populations could we test more focused hypotheses, for example, that sons are favoured more in polygynous than monogamous populations. To date this hypothesis is supported quantitatively only with data based on normative (or institutional) codings for inheritance and marital customs (e.g. [45]); there is no evidence of such a pattern in the current dataset.

For the unbiased datasets, we re-emphasize that equal parent–offspring correlations do not imply that men and women have equal control of wealth. Systemic sexism can produce gender inequality even if parents invest in sons and daughters equally. Strictly speaking, our results show only that, for such populations, the daughters of rich families are just as likely to stay rich (relative to other women) in adulthood as are their brothers (and vice versa for the poor)—in other words 'silver spoon' effects exist equally for girls as they do for boys.

Some datasets do show evidence of strong sex-biased investment as inferred from our data. In some cases, we can readily hypothesize mechanisms underlying such inequality. For example, Kipsigis males, but not females, inherit land and livestock directly from their fathers; furthermore, those with large inheritances are more able to acquire more land and livestock over their lifetimes, thereby countering material wealth dilution effects. It is not surprising, then, that males more resemble their fathers than do females with respect to land and livestock. Inheritance systems do not, however, dictate such patterns. After all, patrilineal inheritance also characterizes the Datoga, for whom the estimated sex difference appears to be small. This probably reflects a pattern of assortative mating (see below). Clearly, then, *post hoc* explanations should be treated with skepticism. More population-specific information is needed to explain any particular statistic.

The observed tendency towards son bias for material wealth is consistent with adaptationist logic insofar as parents should invest more in the sex in which such investments more strongly augment fitness [85]. A common finding among human behavioural ecologists (e.g. [86–90]) is that material resources do indeed more strongly affect male than female RS, largely through the ability to acquire multiple mates. We would therefore expect the observed pattern of male bias in material wealth [45], but not necessarily in other wealth types. RS tends to show low intergenerational correlations. This observation weakly supports the prediction that selection should rapidly deplete heritable variation in fitness [91]. Increased competition for parental investment in larger families may also account for the low RS correlations. A weak tendency for daughters to show similar RS outcomes as their parents may be consistent with observations of heritable fertility among women under some conditions [92]. Alternatively, it may reflect the outcome of cooperation among maternally related kin (at least in the Chewa and Mosuo, both characterized as having matrilineal descent (table 1)). Speculation is problematic however, as Sear [21,93] has shown that Chewa children with maternal aunts and maternal grandmothers are actually less likely to survive than those without such maternal kin.

We note that the mechanisms whereby parents transmit resources to their children need not be the same for both sexes. For example, we have detected only a small son bias in

Krummhörn parental investment for land. The small effect size is, at first glance, surprising, because males are the sole inheritors of land. The discrepancy probably arises because of assortative mating: rich farmers marry their daughters off to rich farmers' sons [94]. The result is that the daughters of wealthy parents are only slightly less likely than their brothers to remain wealthy in adulthood. Similarly, Bevis & Barrett [23] found, using detailed data from the Philippines, that sons' incomes resemble parents' incomes mostly as a result of the bequests of land, whereas daughters inherit from their parents a more diffuse set of skills in income generation, probably mediated by education, culturally transmitted skills and values, nutrition, health and genetics (see also [95] for a similar decomposition of intergenerational effects). An understanding of such pathways, rather than simple statistical correlations, is key to designing appropriate policy interventions whether, for example, to allocate resources to reforming inheritance laws or making education freely available.

There are several potential problems with drawing inferences from our data. First, our parent–son and parent–daughter correlations in wealth correct only for age, and incorporate no information on family size and birth order. These covariates are often examined in site-specific analyses (e.g. [53,60,96,97]), providing insight into how parents allocate investment among their offspring. In Smith *et al.* [80], we address the implications of the number of inheritors, and specifically unigeniture, on our measure of intergenerational transmission. We conclude that although there are still many unanswered questions about how these variables might interact, specifically how intrafamilial inequalities might reinforce or dilute the transmission of privilege ([80], p. 91), the effects of factors like birth order and family size will be most detectable for material wealth—the most easily transmittable class of wealth ([75], table 1). More generally, we maintain that even in the absence of family size and birth order controls we can still identify the extent of sex-specific intergenerational wealth transmission.

A second possible inferential problem lies in the impact of offspring dispersal on estimating intergenerational wealth correlations. Some of our samples sizes are highly unbalanced, as in the Datoga where many daughters married outside of the study area or in the Chewa where sons typically move out of their community. This is only a problem if the probability of leaving the parental home is associated with parental wealth, for example, if only rich daughters marry out to find exceptionally wealthy husbands, or if sons only disperse if they envisage nothing to inherit at home [80,96,98]. We addressed this problem in our selection of field sites for the original study (Methods). Therein we also specified the various scenarios in which intergenerational transmission estimates may be biased upwards or downwards, finding that estimates of material wealth (assets that are most clearly 'rival' insofar as they cannot be shared by siblings (cf. [82])) are, as noted above, most susceptible [80]. The implications of differential dispersal for our intergenerational estimates point to the broader problems anthropologists face in making inferences from small-scale populations that are increasingly incorporated into more economically and culturally heterogeneous matrices—effectively nation states.

A third potential problem with our analysis is that each wealth measure is only correlated with the same wealth measure in the parents. For example, we only correlated offspring education with parent education. Suppose, however, that an offspring's education is determined largely by his/her parents' income, or some composite measure of wealth composed of multiple quantities? If so, then our single-variable analyses are inappropriate. Precisely identifying the complex pathways by which humans transmit wealth across generations will require more detailed data than that which we present here.

This is also important from an applied perspective. There are a diverse set of mechanisms posited to be responsible for intergeneration wealth transmission [99], and these vary both between populations and (most likely) at different wealth strata within populations [100]. Furthermore, the pathways may be complex and non-intuitive. For example, reforms to improve the inheritance rights of women in India have led to a significant increase in the education of women but an unanticipated decrease in the education attainment of their children, reflecting educated women's clearer perception of the opportunity costs associated with education, particularly of their sons [101]. As rates of inequality within developing nations escalate [102] better understanding of these pathways will be critical to resolving debates over how the vicious cycles whereby poverty breeds poverty might best be broken (as reviewed in [103]).

(c) Implications for female-biased kinship

The parent–offspring relationship is central to any kinship system. Father–son ties are key to patrilineal systems of descent and inheritance, whereas in matrilineal systems of descent and inheritance, emphasis is placed either on the parent (specifically mother)–daughter tie, or on the grandparent–maternal granddaughter tie (even though in the latter it is sons who invest in their sisters' children rather than daughters in their own children). Our convenience sample of populations is insufficiently variable with respect to inheritance rules to allow us to test systematically how parent–offspring wealth correlations might differ by inheritance norms. As our analyses of Δ_ρ show there are weak indications of a daughter bias in the only two populations with a matrilineal inheritance norm (Chewa and Mosuo), but there is, rather surprisingly, no clear signal of higher absolute correlations for daughters than for sons. The extent to which inheritance norms (both patrilineally and matrilineally biased) shape offspring outcomes is not straightforward. This may be because norms themselves do not appear to describe well the diverse mechanisms, whereby advantages or disadvantages are perpetuated across generations, or because norms allow for considerable flexibility (as shown for post-marital residence [52], ideologies of egalitarianism [78] and patterns of cooperation [104]).

Cultural practices associated with gender-biased kinship organization, such as inheritance rules, post-marital residence norms and marriage payments, have long been posited by anthropologists as influencing numerous social, including gender-biased, outcomes, with support from correlational cross-cultural data (e.g. [105]). Even prior to the start of systematic cross-cultural research Engels [2] proposed that gender inequality emerged with the intensification of agriculture, and the consequential establishment of private property (monopolized by men), leading to the supposed replacement of matrilineal with patrilineal descent. More regionally focused studies have linked female disadvantage to virilocality as a result of lower parental investment in the out-marrying sex (e.g. [13] for northern India) and the limited social support a woman enjoys once she has left her natal household (e.g. [106] for many parts of south and east Asia). This is intriguingly consistent with recent work in non-humans showing that sex differences in dominance may be related to social support networks rather than intrinsic features of sex *per se* [107]. Economists too are pursuing investigations into the specific consequences for women's well-being contingent on lineality (effectively whether they belong to their own or their husband's descent group), or at least features associated with lineality (S. Lowes 2018, unpublished manuscript). For example, contemporary women's advantageous political status has been linked to a history of no plough agriculture [108], and high juvenile female survival to favourable female earnings relative to males [109].

That said, direct positive outcomes associated with female-biased kinship institutions are not inevitable. A recent comparison of societies with matrilineal and patrilineal inheritance within both the Solomon Islands and the global Standard Cross-Cultural Sample finds very little evidence that matrilineal inheritance translates into real economic or political power in either sample [110]. In short, this body of literature, together with the results of the study reported here, suggests that a more careful understanding of the links between normative patterns (or institutions) and social outcomes is needed. This will require careful analyses of individual-level data, as presented here, to determine who exactly gains and who loses from institutional shifts such as from male to female-biased kinship.

In summary, with respect to sex-biased kinship systems, we find no support for the hypothesis that son preference among parents is more predominant than daughter preference, at least insofar as we can infer such preferences from our data. This suggests that despite the predominance of patrilineal inheritance and virilocality as norms in the ethnographic record, the parent–daughter relationship central to female-biased kinship organization bears much closer scrutiny, as indeed indicated in some specific ethnographic contexts within our sample. Maternal kin are critical to offspring survival in resource-stressed (as compared to wealthy) patrilineal Kipsigis households [111], and Himba women make frequent visits to their maternal kin despite virilocal residence [112]. More generally, a focus on the sex-specific ways in which economic well-being is transmitted across generations would appear to be a key step in determining both the adaptive value of varying parental strategies [25] and the persistence of inequality [26,27].

(d) Concluding remarks

We end with a methodological and a more general observation. First, an ideal study of sex-biased parental investment would investigate parents' actual behaviour, i.e. how many resources they devote to sons versus daughters over the period of dependence, and how this affects their offspring's subsequent wealth status (broadly defined as here). In the absence of such direct behavioural data, we follow economists in comparing the parent–offspring wealth correlations of each sex to explore sex differences in the 'silver spoon' effect. As our model shows, such correlations are affected by many things other than direct parental investment, issues that should be kept in consideration in all studies of parental investment that examine outcomes rather than actions.

Second, gender inequality is still pervasive. Differentials in income, education and autonomy persist globally [16,113,114]. Secondary sex ratios are still rising in some parts of India and China [115] prompting questions of why parents still appear to favour sons over daughters [116]. Furthermore, a recent study of the modern Chinese family in Taiwan shows higher wealth correlations among paternally than maternally related kin [74]. Anthropologists working in communities where such inequalities persist despite, or indeed because of, rapid social change need to document these dynamics. Examining the extent to which this inequality persists across generations, and the mechanisms entailed, is a key step in this pursuit.

Data accessibility. R code associated with each variable (including specific model form and posterior distribution algorithm) and anonymized population data are archived on github (https://github.com/babeheim/wealth-transmission-son-bias).

Authors' contributions. M.B.M., M.C.T. and R.B. wrote the paper; R.B. constructed the model and analysed the data, with contributions from B.A.B. and M.C.T.; M.B.M. (Kipsigis, Datoga, Pimbwe), H.C. (Poland), M.G. (Tsimane), K.L.K. (Maya), S.M.M. (Mosuo), D.A.N. (Lamalera), B.A.S. (Himba), R.S. (Chewa, Gambia), M.K.S. (Bengaluru), M.K.S. and M.C.T. (Bangladesh), E.V. (Krummhörn) and J.Z. (Ust'-Avam) contributed data to the population analyses and participated in development of the paper's intergenerational focus and methodological approach, in conjunction with the larger project together with B.A.B.

Competing interests. We declare we have no competing interests.

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References

1. Mill JS, Alexander E. 2001 *The subjection of women*, xxv, 216 p. New Brunswick, NJ: Transaction Publishers.
2. Engels F. 1902 *The origin of the family, private property and the state*. New York, NY: Charles H. Kerr.
3. Simmons LW. 1937 Statistical correlations in the science of society. In *Studies in the science of society* (ed. GP Murdock), pp. 493–517. New Haven, CT: Yale University Press.
4. Divale WT, Harris M. 1976 Population, warfare, and the male supremacist complex. *Am. Anthropol.* **78**, 521–538. (doi:10.1525/aa.1976.78.3.02a00020)
5. Sanday PR. 1973 Toward a theory on the status of Women. *Am. Anthropol.* **75**, 1682–1700.
6. Hrdy SB, Judge DS. 1993 Darwin and the puzzle of primogeniture: an essay on biases in parental investment after death. *Hum. Nat. Interdiscip. Biosoc. Persp.* **4**, 1–45. (doi:10.1007/bf02734088)
7. Paige K, Paige JM. 1981 *The politics of reproductive ritual*, xii, 380p. Berkeley, CA: University of California Press.
8. Shenk MK, Towner MC, Starkweather K, Atkisson CJ, Alam N. 2014 The evolutionary demography of sex ratios in rural Bangladesh. In *Applied evolutionary anthropology* (eds MA Gibson, DW Lawson), pp. 141–173. New York, NY: Springer.
9. Sen A. 1990 Gender and cooperative conflicts. In *Persistent inequalities* (ed. I Tinker), pp. 123–149. New York, NY: Oxford University Press.

10. Brooks R. 2012 Asia's missing women as a problem in applied evolutionary psychology. *Evol. Psychol.* **10**, 910–925. (doi:10.1177/147470491201000512)
11. Fortunato L. 2019 Lineal kinship organization in cross-specific perspective. *Phil. Trans. R. Soc. B* **374**, 20190005. (doi:10.1098/rstb.2019.0005)
12. Mattison SM. 2016 Matrilineal and matrilocal systems. In *The Wiley Blackwell encyclopedia of gender and sexuality studies* (eds N Naples, RC Hoogland, M Wickramasinghe, WCA Wong), pp. 1655–1660. Hoboken, NJ: John Wiley & Sons Ltd.
13. Dyson T, Moore M. 1983 On kinship structure, female autonomy, and demographic behavior in India. *Popul. Dev. Rev.* **9**, 35–60. (doi:10.2307/1972894)
14. Harrell S. 1997 *Human families*. New York, NY: Routledge.
15. Leonetti DL, Nath DC, Hemam NS. 2007 In-law conflict: women's reproductive lives and the roles of their mothers and husbands among the matrilineal Khasi. *Curr. Anthropol.* **48**, 861–890. (doi:10.1086/520976)
16. Jayachandran S. 2015 The roots of gender inequality in developing countries. *Annu. Rev. Econ.* **7**, 63–88. (doi:10.1146/annurev-economics-080614-115404)
17. Giuliano P. 2017 Gender: a historical perspective. In *The Oxford handbook of women and the economy* (eds S Averett, L Argys, S Hoffman). New York, NY: Oxford University Press.
18. Richards AI. 1950 Some types of family structure amongst the central Bantu. In *African systems of kinship and marriage* (eds AR Radcliffe-Brown, D Forde), pp. 207–251. London, UK: Oxford University Press.
19. Holden CJ, Sear R, Mace R. 2003 Matriliny as daughter-biased investment. *Evol. Hum. Behav.* **24**, 99–112. (doi:10.1016/S1090-5138(02)00122-8)
20. Davison J. 1997 *Gender, lineage, and ethnicity in Southern Africa*. Boulder, CO: Westview Press.
21. Sear R. 2008 Kin and child survival in rural Malawi: are matrilineal kin always beneficial in a matrilineal society? *Hum. Nat.* **19**, 277–293. (doi:10.1007/s12110-008-9042-4)
22. Levine D, Kevane M. 2003 Are investments in daughters lower when daughters move away? Evidence from Indonesia. *World Dev.* **31**, 1065–1084. (doi:10.1016/S0305-750X(03)00050-0)
23. Bevis LEM, Barrett CB. 2015 Decomposing intergenerational income elasticity: the gender-differentiated contribution of capital transmission in rural Philippines. *World Dev.* **74**, 233–252. (doi:10.1016/j.worlddev.2015.04.010)
24. Borgerhoff Mulder M *et al.* 2009 Intergenerational wealth transmission and the dynamics of inequality in small-scale societies. *Science* **326**, 682–688. (doi:10.1126/science.1178336)
25. Leimar O. 1996 Life-history analysis of the Trivers and Willard sex-ratio problem. *Behav. Ecol.* **7**, 316–325. (doi:10.1093/beheco/7.3.316)
26. Bowles S, Gintis H. 2002 The inheritance of inequality. *J. Econ. Persp.* **16**, 3–30. (doi:10.1257/089533002760278686)
27. Clark G. 2014 *The son also rises : surnames and the history of social mobility*. Princeton, NJ: Princeton University Press.
28. Dahl GB, Moretti E. 2008 The demand for sons. *Rev. Econ. Stud.* **75**, 1085–1120. (doi:10.1111/j.1467-937X.2008.00514.x)
29. Boserup E. 1993 *The conditions of agricultural growth: the economics of agrarian change under population pressure*. London, UK: Earthscan.
30. Burton ML, White DR. 1984 Sexual division of labor in agriculture. *Am. Anthropol.* **86**, 568–583. (doi:10.1525/aa.1984.86.3.02a00020)
31. Ember CR. 1983 The relative decline in women's contribution to agriculture with intensification. *Am. Anthropol.* **85**, 285–304. (doi:10.1525/aa.1983.85.2.02a00020)
32. Whiting BB, Whiting JWM. 1975 *Children of six cultures: a psycho-cultural analysis*. Cambridge, MA: Harvard University Press.
33. Wood W, Eagly AH. 2002 A cross-cultural analysis of the behavior of women and men: implications for the origins of sex differences. *Psychol. Bull.* **128**, 699–727. (doi:10.1037/0033-2909.128.5.699)
34. Fortunato L, Archetti M. 2010 Evolution of monogamous marriage by maximization of inclusive fitness. *J. Evol. Biol.* **23**, 149–156. (doi:10.1111/j.1420-9101.2009.01884.x)
35. Brightman R. 1996 The sexual division of foraging labor: biology, taboo, and gender politics. *Comp. Stud. Soc. Hist.* **38**, 687–729. (doi:10.1017/S0010417500020508)
36. Collier JF. 1988 *Marriage and inequality in classless societies*. Stanford, CA: Stanford University Press.
37. Talle A. 1988 *Women at a loss: changes in Maasai pastoralism and their effects on gender relations*. Stockholm, Sweden: Stockholm Studies in Social Anthropology.
38. Brown JK. 1970 A note on the division of labor by sex. *Am. Anthropol.* **72**, 1073–1078. (doi:10.1525/aa.1970.72.5.02a00070)
39. Kuhn SL, Stiner MC. 2006 What's a mother to do? The division of labor among Neandertals and modern humans in Eurasia. *Curr. Anthropol.* **47**, 953–980. (doi:10.1086/507197)
40. Gaulin SJC, Boster JS. 1990 Dowry as female competition. *Am. Anthropol.* **92**, 994–1005. (doi:10.1525/aa.1990.92.4.02a00080)
41. Clutton-Brock TH, Huchard E. 2013 Social competition and selection in males and females. *Phil. Trans. R. Soc. B* **368**, 20130074. (doi:10.1098/rstb.2013.0074)
42. Janicke T, Häderer IK, Lajeunesse MJ, Anthes N. 2016 Evolutionary biology: Darwinian sex roles confirmed across the animal kingdom. *Sci. Adv.* **2**, 1500983. (doi:10.1126/sciadv.1500983)
43. Schacht R, Rauch KL, Borgerhoff Mulder M. 2014 Too many men: the violence problem?. *Trends Ecol. Evol.* **29**, 214–222. (doi:10.1016/j.tree.2014.02.001)
44. McLennan JF. 1865 *Primitive marriage an inquiry into the origin of the form of capture in marriage ceremonies*. Edinburgh, UK: A. and C. Black.
45. Hartung J. 1982 Polygyny and the inheritance of wealth. *Curr. Anthropol.* **5**, 77–95.
46. Hartung J. 1985 Matrilineal inheritance: new theory and analysis. *Behav. Brain Sci.* **8**, 661–670. (doi:10.1017/S0140525X00045520)
47. Ember M, Ember CR. 1971 The conditions favoring matrilocal versus patrilocal residence. *Am. Anthropol.* **84**, 645–649. (doi:10.1525/aa.1982.84.3.02a00120)
48. Korotayev A. 2003 Form of marriage, sexual division of labor, and postmarital residence in cross-cultural perspective: a reconsideration. *J. Anthropol. Res.* **59**, 69–89. (doi:10.1086/jar.59.1.3631445)
49. Opie C, Shultz S, Atkinson QD, Currie T, Mace R. 2014 Phylogenetic reconstruction of Bantu kinship challenges Main Sequence Theory of human social evolution. *Proc. Natl Acad. Sci. USA* **111**, 17 414–17 419. (doi:10.1073/pnas.1415744111)
50. Moravec JC, Atkinson Q, Bowern C, Greenhill SJ, Jordan FM, Ross RM, Gray R, Marsland S, Cox MP. 2018 Post-marital residence patterns show lineage-specific evolution. *Evol. Hum. Behav.* **39**, 594–601. (doi:10.1016/j.evolhumbehav.2018.06.002)
51. Ly G *et al.* 2018 Residence rule flexibility and descent groups dynamics shape uniparental genetic diversities in South East Asia. *Am. J. Phys. Anthropol.* **165**, 480–491. (doi:10.1002/ajpa.23374)
52. Fortunato L. 2011 Reconstructing the history of marriage and residence strategies in indo-European-speaking societies. *Hum. Biol.* **83**, 129–135. (doi:10.3378/027.083.0108)
53. Borgerhoff Mulder M. 1998 Brothers and sisters: how sibling interactions affect optimal parental allocations. *Hum. Nat.* **9**, 119–162. (doi:10.1007/s12110-998-1001-6)
54. Cronk L. 1991 Preferential parental investment in daughters over sons. *Hum. Nat.* **2**, 387–417. (doi:10.1007/BF02692198)
55. Winterhalder B, Smith EA. 2000 Analyzing adaptive strategies: human behavioral ecology at twenty-five. *Evol. Anthropol.* **9**, 51–72. (doi:10.1002/(SICI)1520-6505(2000)9:2<51::AID-EVAN1>3.0.CO;2-7)
56. Godoy R, Reyes-García V, McDade T, Tanner S, Leonard WR, Huanca T, Vadez V, Patel K. 2006 Why do mothers favor girls and fathers, boys? A hypothesis and a test of investment disparity. *Hum. Nat.* **17**, 169–189. (doi:10.1007/s12110-006-1016-9)
57. Lawson DW, Mace R. 2009 Trade-offs in modern parenting: a longitudinal study of sibling competition for parental care. *Evol. Hum. Behav.* **30**, 170–183. (doi:10.1016/j.evolhumbehav.2008.12.001)
58. Ross CT, Borgerhoff Mulder M, Winterhalder B, Uehara R, Headland J, Headland T. 2016 Evidence for quantity–quality trade-offs, sex-specific parental investment, and variance compensation in colonized Agta foragers undergoing demographic transition. *Evol. Hum. Behav.* **37**, 350–365. (doi:10.1016/j.evolhumbehav.2016.02.005)
59. Neill DB. 2011 Urbanization and daughter-biased parental investment in Fiji. *Hum. Nat.* **22**, 139–155. (doi:10.1007/s12110-011-9110-z)

60. Judge DS, Hrdy SB. 1992 Allocation of accumulated resources among close kin: inheritance in Sacramento, California, 1890–1984. *Ethol. Sociobiol.* **13**, 495–522. (doi:10.1016/0162-3095(92)90014-U)
61. Rickard IJ. 2008 Offspring are lighter at birth and smaller in adulthood when born after a brother versus a sister in humans. *Evol. Hum. Behav.* **29**, 196–200. (doi:10.1016/j.evolhumbehav.2008.01.006)
62. Levine NE. 1987 Differential child care in three Tibetan communities: beyond son preference (Nepal). *Popul. Dev. Rev.* **13**, 281–304. (doi:10.2307/1973194)
63. Lazarus J. 2002 Human sex ratios: adaptations and mechanisms, problems and prospects. *Sex Ratios: Concepts Res. Methods* **1**, 287–311. (doi:10.1017/CBO9780511542053.015)
64. Piraino P. 2007 Comparable estimates of intergenerational income mobility in Italy. *BE J. Econ. Anal. Policy* **7**, Art 1. (doi:10.2202/1935-1682.1711)
65. Asadullah M. 2012 Intergenerational wealth mobility in rural Bangladesh. *J. Dev. Stud.* **48**, 1193–1208. (doi:10.1080/00220388.2011.646988)
66. Hertz T, Selcuk S, Jayasundera T, Smiths N, Piraino P, Verashchagina A. 2007 The inheritance of educational inequality: international comparisons and fifty-year trends. *BE J. Econ. Anal. Policy* **7**, Art 1. (doi:10.2202/1935-1682.1775)
67. Solon G. 2002 Cross-country differences in intergenerational earnings mobility. *J. Econ. Persp.* **16**, 59–66. (doi:10.1257/089533002760278712)
68. Corak M. 2006 Do poor children become poor adults? Lessons from a cross country comparison of generational earnings mobility. IZA Discussion Paper No 1993. See http://ssrncom/abstract=889034.
69. Chadwick L, Solon G. 2002 Intergenerational income mobility among daughters. *Am. Econ. Rev.* **92**, 335–344. (doi:10.1257/000282802760015766)
70. Cervini-Plá M. 2015 Intergenerational earnings and income mobility in Spain. *Rev. Income Wealth* **61**, 812–828. (doi:10.1111/roiw.12130)
71. Lefranc A, Ojima F, Yoshida T. 2014 Intergenerational earnings mobility in Japan among sons and daughters: levels and trends. *J. Popul. Econ.* **27**, 91–134. (doi:10.1007/s00148-012-0464-2)
72. Quisumbing AR. 1994 Intergenerational transfers in Philippine rice villages. Gender differences in traditional inheritance customs. *J. Dev. Econ.* **43**, 167–195. (doi:10.1016/0304-3878(94)90003-5)
73. Quisumbing AR, Payongayong EM, Otsuka K. 2004 Are wealth transfers biased against girls? Gender differences in land inheritance and schooling investment in Ghana's western region. IFPRI Food Consumption and Nutrition Division Discussion Paper 186, Washington, DC. See http://ebrary.ifpri.org/cdm/ref/collection/p15738coll2/id/47923.
74. Chu CYC, Kan K, Lin JC. 2019 Variations of wealth resemblance by family relationship types in modern Chinese families. *Proc. Natl Acad. Sci. USA* **116**, 6548. (doi:10.1073/pnas.1813136116)
75. Bowles S, Smith EA, Borgerhoff Mulder M. 2010 The emergence and persistence of inequality in premodern societies: introduction to the special section. *Curr. Anthropol.* **51**, 7–17. (doi:10.1086/649206)
76. Smith EA, Bowles S, Hertz T, Borgerhoff Mulder M, Shenk Mary K, Gurven M. 2010 Intergenerational wealth transmission and inequality in premodern societies: reply. *Curr. Anthropol.* **51**, 119–126. (doi:10.1086/650152)
77. Behrman JR. 1997 Intrahousehold distribution and the family. In *Handbook of population and family economics* (eds MR Rosenzweig, O Stark), pp. 125–188. Amsterdam, The Netherlands: North Holland.
78. Borgerhoff Mulder M, Fazzio I, Irons W, McElreath RL, Bowles S, Bell A, Hertz T, Hazzah L. 2010 Pastoralism and wealth inequality: revisiting an old question. *Curr. Anthropol.* **51**, 35–48. (doi:10.1086/648561)
79. Smith EA *et al.* 2010 Wealth transmission and inequality among hunter-gatherers. *Curr. Anthropol.* **51**, 19–34. (doi:10.1086/648530)
80. Smith EA, Borgerhoff Mulder M, Bowles S, Gurven M, Hertz T, Shenk MK. 2010 Production systems, inheritance, and inequality in premodern societies: conclusions. *Curr. Anthropol.* **51**, 85–94. (doi:10.1086/649029)
81. Boag PT, Grant PR. 1978 Heritability of external morphology in Darwin's finches. *Nature* **274**, 793–794. (doi:10.1038/274793a0)
82. Ross CT *et al.* 2018 Greater wealth inequality, less polygyny: rethinking the polygyny threshold model. *J. R. Soc. Interface* **15**, 20180035. (doi:10.1098/rsif.2018.0035)
83. Trivers RL, Willard DE. 1973 Natural selection of parental ability to vary the sex ratio of offspring. *Science* **179**, 90–92. (doi:10.1126/science.179.4068.90)
84. Estudillo JP, Quisumbing AR, Otosuka K. 2001 Gender differences in land inheritance, schooling and lifetime income: evidence from the rural Philippines. *J. Dev. Stud.* **37**, 23–48. (doi:10.1080/00220380412331322031)
85. Clutton-Brock TH. 1991 *The evolution of parental care*. Princeton, NJ: Princeton University Press.
86. Flinn MV, Low BS. 1986 Resource distribution, social competition, and mating patterns in human societies. In *Ecological aspects of social evolution: birds and mammals* (eds DI Rubenstein, RW Wrangham), pp. 217–243. Princeton, NJ: Princeton University Press.
87. Mace R. 1996 Biased parental investment and reproductive success in Gabbra pastoralists. *Behav. Ecol. Sociobiol.* **38**, 75–81. (doi:10.1007/s002650050219)
88. Borgerhoff Mulder M. 1988 Reproductive success in three Kipsigis cohorts. In *Reproductive success* (ed. TH Clutton-Brock), pp. 419–435. Chicago, IL: University of Chicago Press.
89. Hopcroft RL. 2006 Sex, status, and reproductive success in the contemporary United States. *Evol. Hum. Behav.* **27**, 104–120. (doi:10.1016/j.evolhumbehav.2005.07.004)
90. Stulp G, Sear R, Barrett L. 2016 The reproductive ecology of industrial societies, part i: why measuring fertility matters. *Hum. Nat.* **27**, 422–444. (doi:10.1007/s12110-016-9269-4)
91. Mousseau TA, Roff DA. 1987 Natural selection and the heritability of fitness components. *Heredity* **59**, 181–197. (doi:10.1038/hdy.1987.113)
92. Kohler H.-P, Rodgers JL, Christensen K. 1999 Is fertility behavior in our genes? Findings from a Danish twin study. *Popul. Dev. Rev.* **25**, 253–288. (doi:10.1111/j.1728-4457.1999.00253.x)
93. Sear R, Mace R. 2008 Who keeps children alive? A review of the effects of kin on child survival. *Evol. Hum. Behav.* **29**, 1–18. (doi:10.1016/j.evolhumbehav.2007.10.001)
94. Johow J, Willführ KP, Voland E. 2019 High consanguinity promotes intergenerational wealth concentration in socioeconomically privileged Krummhörn families of the 18th and 19th centuries. *Evol. Hum. Behav.* **40**, 204–213. (doi:10.1016/j.evolhumbehav.2018.11.005)
95. Kleinjans KJ. 2010 Family background and gender differences in educational expectations. *Econ. Lett.* **107**, 125–127. (doi:10.1016/j.econlet.2010.01.002)
96. Towner MC. 2001 Linking dispersal and resources in humans: life history data from Oakham, Massachusetts (1750–1850). *Hum. Nat. Interdiscip. Biosoc. Persp.* **12**, 321–349. (doi:10.1007/s12110-001-1002-1)
97. Lawson DW, Makoli A, Goodman A. 2013 Sibling configuration predicts individual and descendant socioeconomic success in a modern post-industrial society. *PLoS ONE* **8**, e0073698. (doi:10.1371/journal.pone.0073698)
98. Towner MC. 1999 A dynamic model of human dispersal in a land-based economy. *Behav. Ecol. Sociobiol.* **46**, 82–94. (doi:10.1007/s002650050596)
99. Roemer JE. 2004 Equal opportunity and intergenerational mobility: going beyond intergenerational income transition matrices. In *Generational income mobility in North America and Europe* (ed. M Corak), pp. 48–57. Cambridge, UK: Cambridge University Press.
100. Corak M. 2013 Income inequality, equality of opportunity, and intergenerational mobility. *J. Econ. Persp.* **27**, 79–102. (doi:10.1257/jep.27.3.79)
101. Bose N, Das S. 2017 Women's inheritance rights, household allocation, and gender bias. *Am. Econ. Rev.* **107**, 150–153. (doi:10.1257/aer.p20171128)
102. Hvistendahl M. 2014 While emerging economies boom, equality goes bust. *Science* **344**, 832. (doi:10.1126/science.344.6186.832)
103. Behrman JR, Schott W, Mani S, Crookston BT, Dearden K, Duc LT, Fernald LCH, Stein AD. 2017 Intergenerational transmission of poverty and inequality: parental resources and schooling attainment and children's human capital in Ethiopia, India, Peru, and Vietnam. *Econ. Dev. Cult. Change* **65**, 657–697. (doi:10.1086/691971)
104. Power EA, Ready E. 2019 Cooperation beyond consanguinity: post-marital residence, delineations of kin and social support among

South Indian Tamils. *Phil. Trans. R. Soc. B* **374**, 20180070. (doi:10.1098/rstb.2018.0070)

105. Naroll R. 1970 What have we learned from cross-cultural surveys? *Am. Anthropol.* **72**, 1227–1288. (doi:10.1525/aa.1970.72.6.02a00030)
106. Skinner GW. 1997 Family systems and demographic processes. In *Anthropological demography: toward a new synthesis* (eds DI Kertzer, T Fricke), pp. 53–95. Chicago, IL: The University of Chicago Press.
107. Vullioud C, Davidian E, Wachter B, Rousset F, Courtiol A, Höner OP. 2018 Social support drives female dominance in the spotted hyaena. *Nat. Ecol. Evol.* **3**, 71–76. (doi:10.1038/s41559-018-0718-9)
108. Alesina A, Giuliano P, Nunn N. 2013 On the origins of gender roles: women and the plough. *Quart. J. Econ.* **128**, 469–530. (doi:10.1093/qje/qjt005)
109. Qian N. 2008 Missing women and the price of tea in China: the effect of sex-specific earnings on sex imbalance. *Quart. J. Econ.* **123**, 1251–1285. (doi:10.1162/qjec.2008.123.3.1251)
110. BenYishay A, Grosjean P, Vecci J. 2017 The fish is the friend of matriliny: reef density and matrilineal inheritance. *J. Dev. Econ.* **127**, 234–249. (doi:10.1016/j.jdeveco.2017.03.005)
111. Borgerhoff Mulder M. 2007 Hamilton's rule and kin competition: the Kipsigis case. *Evol. Hum. Behav.* **28**, 299–312. (doi:10.1016/j.evolhumbehav.2007.05.009)
112. Scelza BA. 2011 Female mobility and postmarital kin access in a patrilocal society. *Hum. Nat. Interdiscip. Biosoc. Persp.* **22**, 377–393. (doi:10.1007/s12110-011-9125-5)
113. Seabright P. 2012 *The war of the sexes : how conflict and cooperation have shaped men and women from prehistory to the present*. Princeton, NJ: Princeton University Press.
114. Jerrim J, Macmillan L. 2015 Income inequality, intergenerational mobility, and the great gatsby curve: is education the key? *Soc. Forces* **94**, 505–533. (doi:10.1093/sf/sov075)
115. Hesketh T, Xing ZW. 2006 Abnormal sex ratios in human populations: causes and consequences. *Proc. Natl Acad. Sci. USA* **103**, 13 271–13 275. (doi:10.1073/pnas.0602203103)
116. Almond D, Edlund L, Milligan K. 2013 Son preference and the persistence of culture: evidence from South and East Asian immigrants to Canada. *Popul. Dev. Rev.* **39**, 75–95. (doi:10.1111/j.1728-4457.2013.00574.x)