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Differences between Sons and Daughters in the Intergenerational Transmission of Wealth

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Abstract

Persistent interest lies in gender inequality, especially with regard to the favoring 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 network 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. Rather we find wide variation in signatures of sex bias, with evidence of both son and daughter-biased investment. Further, we introduce a model that helps pinpoint the conditions under which simple 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.

Key Words: wealth transmission, parental investment, son bias

1. Introduction

Matriliny, often erroneously associated with notions of matriarchy (see Introduction to this Special Issue [see Introduction to Special Issue 1]), conjures up expectations of gender equality, or at least muted sex-biases [2-6], when compared to patriliney. In matrilineal societies women are key to the determination of descent and typically have greater support from their kin relative to women in patrilineal societies.

Furthermore, matrilineal 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., 7], grandparents investing in grandchildren born to their daughters [8], or parents bestowing inheritances directly on their daughters, as in many other southern African populations [9, see also 10].

In reality, normative patterns of intergenerational wealth transmission are unlikely to capture the full set of influences whereby privilege in one generation is passed to that of the next, even less so the implied gendered inequalities therein, insofar as the patterning, causality and implied mechanisms in son preference are highly variable globally [e.g., 5, 11, 12]. Wealth transmitted across generations can have strong effects on wellbeing of the offspring generation [13], a phenomenon popularly recognized as a child of the wealthy being born with a "silver spoon" in their mouth. Furthermore, such wealth transmission is implicated in complex dynamics of gender inequality [14]. Accordingly, we take a close look here at how parental wealth correlates with that of sons and daughters. To avoid some of the ambiguous metrics associated with the study of matriliney [1], we offer an empirical lens through which to analyze 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.

To place our work in the context of this Special Issue we stress that we are addressing neither descent (social identity based on filiation), nor post-marital residence, nor the collective ownership of property rights associated with descent groups. Rather we examine the intergenerational transmission of material, somatic, and network wealth from parents to their sons and daughters. This question aligns closely with the interest of evolutionary biologists in how parental quality is transmitted across generations to affect reproductive value [15] and the interest of economists in the persistence of inequality [16, 17].

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3 We present our argument as follows. First, we briefly review how gender differentials have been studied
4 by comparative social scientists, paying particular attention to intersections with gender-biased
5 intergenerational norms of matrilineal and patrilineal inheritance, and the importance of individual-level
6 data (2). We then turn to the methods (3) and results (4) of our study that examines how parental wealth
7 is associated with the wealth of their sons and daughters across a sample of 15 populations. In the
8 Discussion (5), we explore the generality of our results and consider the implications of our findings for
9 the understanding of matrilineal kinship. We also present a model (detailed in Electronic Supplementary
10 Material) that addresses the limitations of making inferences about sex-biased parental investment from
11 parent-offspring wealth correlations.
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21 **2. Sex differences, parental investment, norms and individual-level data**

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25 Male-biased differentials in wealth and power have long engaged socially-inclined philosophers [18],
26 political scientists [19], and comparative social scientists [20]. The phenomenon is widespread,
27 illustrated by the fact that post-marital residence [21, 22] and property inheritance [23] are
28 predominantly patrilocal and patrilineal. Such systems allow for men to form coalitions with their kin
29 rather than women with their kin [24]. South and Southeast Asia offer classic examples of male biased
30 sex ratios, son-biased inheritance norms and discrimination against daughters [25]. Such institutional
31 tendencies have led, for example, to an identification of the "missing women" across many parts of the
32 Middle East, North Africa, India, China and other parts of Asia [26, 27]. Gendered inequalities in rights,
33 employment, education, autonomy and access to resources are of course widely recognized across the
34 globe [e.g., 5], persist in (sometimes) subtle but clear patterns in industrialized contemporary
35 populations [e.g., in the USA, 28], and are shaped by a diverse set of ecological, historical,
36 institutional, evolutionary, and developmental influences [14]. These include the existence of private
37 property [19], differential contributions to subsistence [29-31], psycho-cultural factors reflecting
38 socialization [32, 33], marital strategizing [34], taboos and culturally transmitted proscriptions [35],
39 regional politics [2, 36], colonial policies [37], and both biological [38] and a broader range of ecological
40 constraints and opportunities [39]. Pursuing some of these ideas economists have in recent years begun
41 to study how gender-biased inheritance and postmarital residence patterns, specifically patriliney and
42 patri-virilocality, affect women's wellbeing [6, 40].
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3 An important mechanism contributing to gender inequality is sex-biased parental investment,
4 particularly in the form of intergenerational wealth transmission. There is a widespread and strongly-
5 supported claim that sons in many human societies are typically preferred as inheritors over daughters
6 [e.g., 41]. Indeed, given that the features of mammalian reproductive biology typically favor more
7 competition among males than females over access to mates [e.g., 42] it is generally expected that
8 parents will invest more heavily in their surviving sons than their surviving daughters. In humans, this has
9 been studied from both macro and micro perspectives.
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18 From the macro-perspective sociocultural anthropologists, as the natural historians of our species, have
19 for well over a century recognized the importance of sex-biased intergenerational transmission of
20 property [e.g., 43]. Quantitative support for such biases (and their patterning) relies mainly on analyses
21 that use cross-cultural codes capturing the norms and/or institutions that shape gender inequalities,
22 such as matrilineal versus patrilineal inheritance [44, 45] or matrilocal versus patrilocal post-marital
23 residence [46, 47], rather than actual patterns of behaviour or residence. Informative as such analyses
24 can be [see 48, and 49] normative descriptors of populations can obscure many of the choices and
25 strategies of individuals, as suggested by the unexpectedly poor fit of Y chromosome data with
26 normative residential patterns [50]. The persistent critique of studies based on normative codes is that it
27 is often unclear how far the coded variable state reflects a unique institutional solution and/or how
28 seriously it is followed. Ideally studies based on these codes should be supplemented by studies using
29 individual-level measures.
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42 At the micro-level evolutionary anthropologists have examined preferential parental investment by sex
43 using either individual investment behaviour or individual outcomes [51-59]. Strangely, empirical
44 evidence for sex differences in parent-offspring similarity, or the extent to which parents transmit their
45 traits to their offspring, is rarely the focus of investigation, or is simply assumed to be the consequence
46 of parental allocations. This is surprising, insofar as a fundamental assumption underlying tests for
47 adaptive variation in parental investment turns on how effective parents can be in transmitting their
48 traits to their offspring of each sex [15, 51, 60].
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56 Economists have addressed intergenerational wealth transmission using individual-level data [e.g., 16],
57 with the specific goal of revealing the transmission of inequality rather than the patterning parental
58 investment *per se*. They ask whether all children have an equal chance for a successful life, or whether
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3 children's fates are limited by the same opportunities (or constraints) as their parents. To answer such
4 questions individual-level data are used to estimate intergenerational elasticities (child's adult log
5 measures of human capital on parent's adult log measures of human capital). Such studies show, for
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7 example, how high parent-offspring similarities (elasticities) in education play a key role in contributing
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9 to income inequality in developed [61] and developing nations [62]. These studies nevertheless focus
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11 primarily on income and education differentials [e.g., 63], and mainly in (developed) nations with reliable
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13 panel data [64]. Furthermore, they typically look only at men [e.g., 65]. This is in part because women's
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15 labor force participation can be a poor indicator of her economic status (if only poor women work), and
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17 in part because often only few women are educated or earn incomes.
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21 Chadwick and Solon [66] broke the mold with a sophisticated analysis of income elasticities for sons and
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23 daughters, using panel data on income for the US. They found somewhat higher elasticities for sons
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25 (0.55) than daughters (0.35-0.49), and showed that much of the daughters' elasticity was attributable to
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27 assortative marriage—daughters of the rich marrying into rich families [see also 12]. More recent studies
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29 show smaller differences in gender-specific income elasticities – e.g., in Spain (0.39 versus 0.40 for
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31 income) [67] and Japan (0.39 versus 0.34 for income, for daughters and sons respectively) [68]. Perhaps
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33 unsurprisingly from an anthropological perspective, these more detailed quantitative surveys of sex
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35 differences in intergenerational transmission suggest that customary norms regarding property transfers
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37 are not the whole story: irrespective of the formal institutions of lineality, parents appear to strategize,
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39 bargain with one another, and make compensatory allocations that often run counter to expectations
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41 regarding son/daughter preferences based simply on inheritance or postmarital residential norms [11,
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43 69, 70, see also 71].
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45 Here we study a key set of relationships within any kinship system – between parents and sons and
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47 parents and daughters – to identify gender differences in the extent to which offspring resemble their
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49 parents with respect to different kinds of wealth. In so doing we move away from normative accounts of
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51 gender-biased inheritance systems. Rather we present individual-based data on parent-offspring wealth
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53 correlations for 38 wealth measures from 15 populations around the world, representing different
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55 modes of economic production. As in Borgerhoff Mulder et al. [13], we examine a range of
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57 wealth variables that capture holistic indicators of well-being, and include material assets, physical
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59 health, skills and social capital, greatly expanding the previous focus among economists on income and
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61 education.

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5 While we start from the assumption that sex-biased parental investment can be detected from parent-
6 offspring wealth correlations, we recognize that inferring parental discrimination *per se* from such data
7 can be problematic [51, 72]. Accordingly, we include a model in the Electronic Supplementary Materials
8 that identifies the condition under which this inference might be accurate, as reported in the Discussion.
9 The logic of our approach can be illustrated with the following example: suppose that parents of all
10 wealth levels invest most of their resources in daughters. The rich, having more wealth to invest, will
11 produce daughters who are much wealthier than the daughters of the poor. This creates a strong
12 correlation between a daughter's wealth and that of her parents. In contrast, because relatively little is
13 invested in sons, regardless of parent wealth, the sons of wealthy parents will tend to be only slightly
14 more wealthy than the sons of poor parents. Son's wealth will therefore be only weakly correlated with
15 parent wealth. The general result is that the sex in which parents invest more heavily will be the sex with
16 a larger parent-offspring correlation. This logic does assume that other mechanisms leading to parent-
17 offspring wealth correlations (e.g., genetic and cultural transmission for wealth productivity [16]) will not
18 upend the influence of direct parental investment, an assumption we return to in the Discussion in
19 connection with our model.
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34 We find that parent-offspring correlations show wide variation in parental investment behaviour across
35 different populations, thereby failing to support the common expectation that son preference is more
36 common than daughter preference. We estimate that roughly 40% of the datasets show little evidence
37 of sex-biased investment as indicated by parent-offspring wealth correlations. The remaining datasets
38 fall about equally into son-biased vs. daughter-biased categories, although material wealth measures are
39 more often son-biased in our sample.
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47 **3. Methods**

48 **(a) Data.**

49 The data represent a convenience sample of 15 populations assembled to test a model for the
50 relationship between inequality and intergenerational transmission [13, 73]. Two of our populations
51 are settled foragers (Lamalera, Ust Avam), four horticulturalists (Chewa, Gambia, Pimbwe, Tsimane), two
52 pastoralists (Datoga, Himba) and seven agriculturalists (Bangladesh, Bengaluru, Kipsigis, Krummhörn,
53 Maya, Mosuo, Poland). Only adults (age ≥ 18) were used. For somatic wealth, our measures include
54 education (in years), height, reproductive success (RS, measured as the number of offspring surviving to
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3 age 5), weight, and ethnographically appropriate measures of productive skill or knowledge. For
4 relational wealth, our measures are cattle partners and social network size. And for material wealth, our
5 measures include boat shares, household wealth, house quality, income, land, and livestock. These
6 variables (listed in Table 1) were chosen on the basis of availability in the original data set, with the data
7 collectors' endorsements that they are useful measures of well-being or success in the population. For
8 some material wealth variables (especially land and livestock), males are often the primary owners and
9 inheritors. In such cases, we assigned to women the wealth of their husbands. We recognize that this
10 assignment is somewhat artificial; for example, that a husband and wife live on the same amount of land
11 does not imply equal control over it.
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21 We use standardized wealth scores to compare an individual's wealth relative to others of his or her
22 same age and sex. This allows for comparisons across societies and also to examine the extent to which
23 the relative fates of sons and the relative fates of daughters are determined by that of their parents. In
24 other words, we are comparing not the wealth of males to females, but rather the extent to which the
25 relative fates of sons, and the relative fates of daughters, are determined by that of their parents.
26 Accordingly, whether our wealth measures have different practical meanings between the sexes is
27 irrelevant so long as the values assigned to women reflect some measure of advantage relative to other
28 women, and similarly men relative to other men.
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38 Table 1 includes the standardized difference between male and female mean wealth. A value of 1 implies
39 that males tend to have one standard deviation more wealth than females; -1 would imply the opposite.
40 This provides a rough measure of gender inequality with respect to the variable in question. Again, we
41 caution against a simple interpretation of these values because of the complex causes underlying them.
42 First, basic biological constraints may drive the differences, as is likely the case for weight; that sons are
43 larger than daughters is not necessarily evidence that sons are healthier or better nourished. Second,
44 even material wealth measures as shown do not necessarily reflect actual differential advantage in the
45 population. For example, although men and women had access to the same amount of land in
46 Krummhörn, men were the inheritors and had much more control over its use [74]. Third, in some
47 cases, the wealth variable is necessarily shared between the father and mother (e.g., some land or RS
48 datasets). If every chunk of wealth is owned jointly by one man and one woman, then a sex difference in
49 mean wealth can only be due to an unequal sex ratio (a point first recognized by Fisher [75] in his theory
50 of the evolution of sex ratios); the less common sex will necessarily have more wealth as measured here,
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3 regardless of its actual control of resources. Because of these problems, we do not further discuss mean
4 wealth differences.
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9 **(b) Statistical Inference.**

10 Our goal is to estimate the correlation between parent wealth and offspring wealth. Because our data
11 contain individuals of varying ages and because age often strongly predicts wealth, we compute
12 deviations from age-specific (and sex-specific) distributions. An individual i 's relative wealth deviation, D_i
13 , is his or her standardized deviation of wealth W_i relative to other individuals of the same age, a_i , and
14 sex, s_i :
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$$D_i = \frac{W_i - \mu(a_i, s_i)}{\sigma(a_i, s_i)} \quad [1]$$

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22 μ and σ are functions specifying the mean and standard deviation, respectively, for each age and sex.
23 Their functional forms for each population were chosen via Bayesian information criteria (BIC). We then
24 used Hamiltonian Monte Carlo (RStan) to infer posterior estimates of D for every individual. Further
25 statistical details can be found in the Electronic Supplementary Materials.
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35 The parent-offspring wealth correlation, ρ , is the correlation between offspring D on mid-parent D . The
36 mid-parent D , or D_{mp} , is the mean D of an individual's two parents; we use mid-parent wealth under the
37 assumption that both parents play a role in investment. We compute ρ separately for sons and
38 daughters, yielding ρ_s and ρ_d , respectively. We refer to the difference between son and daughter
39 correlations as $\Delta\rho$. That is
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$$\Delta\rho = \rho_s - \rho_d \quad [2]$$

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50 To understand the use of D , the wealth deviations, consider the following example: suppose men and
51 women tend to acquire more wealth (of unspecified kind) as they age. Comparing a young woman to an
52 old woman, we will likely find that the latter is more wealthy. But suppose the young woman
53 has acquired more wealth than is common for women of her age, while the old woman has less than
54 average. Then the young woman's wealth deviation, D , will be positive and larger than that of the older
55 woman's, whose D will be negative. The young woman will be counted as wealthier in this analysis.
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3 For all datasets, we checked whether the parent wealth distribution deviated from that of the offspring
4 distribution, even when controlling for age. For reproductive success (RS), this will clearly tend to be
5 true, because parents necessarily have at least one offspring, but their children may not. We
6 identified such cases by comparing models with and without a generation effect via BIC. For such cases,
7 each individual's deviation is taken with respect to his or her own generation rather than with respect to
8 the full sample from that population.
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16 For some datasets, only information for one parent is available, making the mid-parent D impossible to
17 calculate. For such datasets, we simply use the D of the one available parent. The ρ produced by this
18 method tends to differ from the ρ produced by the mid-parent method, but the precise effect
19 depends on the details of transmission. For example, under simple quantitative genetics, single-parent-
20 offspring correlations tend to be of smaller magnitude than those with both parents, but the effect is
21 moderated by assortative mating. Although we cannot calculate the expected error, we expect single-
22 parent correlations to be of the same sign as the true mid-parent correlation. We feel that these
23 datasets are therefore appropriate to include. We note these populations in the Electronic
24 Supplementary Materials, but do not separate them from other populations in our figures.
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34 **4. Results**

35 **(a) Parent-son and parent-daughter wealth correlations**

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38 Statistical estimates of the parent-offspring wealth correlations for sons (ρ_s) and daughters (ρ_d), and
39 their differences (Δ_ρ) are summarized in Table 2. The estimates of ρ_s and ρ_d are also plotted (along with
40 90% confidence intervals) in Figure 2, with populations sorted by mean correlation across both sexes.
41 The plots show that many of our estimates are not very precise; only about one half (39 of 74) have
42 standard errors less than 0.1. For most of the populations, then, we are moderately uncertain about
43 where ρ_s and ρ_d lie.
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53 Taking sons and daughters together, we can be 90% confident that wealth is positively transmittable (
54 $\rho > 0$) for just over half of the estimates (42 of 74). Weight shows consistent positive parent-offspring
55 correlation, probably due in large part to genetic transmission. Land, too, is consistently positive, and
56 education is also positive for most datasets.
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3 Few correlations show strong evidence of being negative. This is as expected, because a negative ρ
4 would imply that wealthy parents tend to have poor offspring. Only one is below 0 with 90% confidence:
5 Chewa male RS. Visual inspection of Figure 2 suggests that RS tends to be overrepresented among low
6 correlations (on the second panel). This observation weakly supports the common prediction that
7 selection should rapidly deplete heritable variation in fitness [76], leading to low parent-offspring
8 correlations in RS. Increased competition for parental investment in larger families may also account for
9 the low RS correlations.
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18 **(b) Estimates of sex differences in intergenerational transmission**

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21 Figure 3 shows plots of $\Delta\rho$, the difference between parent-son and parent-daughter wealth correlations,
22 with 90% confidence intervals. Because these estimates compound the uncertainty in both male and
23 female ρ , their errors are greater. We are therefore unable to precisely identify $\Delta\rho$ for most datasets. For
24 example, only twelve estimates, about a third of the total, have a standard error less than 0.1.
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31 Nonetheless, in some cases we can be quite certain that $\Delta\rho > 0$, and, for others, $\Delta\rho < 0$. We are 90%
32 confident that $\Delta\rho > 0$ for Ust Avam education, Kipsigis land and livestock, Pimbwe household wealth,
33 Krummhörn land, Bangladesh land, Gambia RS, and Poland education (Figure 3). We are 90% confident
34 that $\Delta\rho < 0$ for Lamalera RS, Chewa RS, Gambia height and weight, Maya height, Mosuo RS,
35 and Bangladesh education. The fact that a difference exists does not imply that the difference is very
36 large, however. For example, while we can be sure that parent-offspring education correlations are
37 greater for sons than daughters in Poland, the absolute difference in correlation is probably < 0.05 .
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46 Although most confidence intervals overlap zero, we caution against embracing the null hypothesis ($\Delta\rho$
47 = 0); most estimates that overlap zero also allow for the possibility of moderate to large $\Delta\rho$. Increased
48 precision would require larger samples. To demonstrate this, we ask the question: for which datasets can
49 we be confident that the difference is quite small say, $-0.1 < \Delta\rho < 0.1$ with 90% confidence? In fact,
50 there are only two: Poland education and Bengaluru education which, incidentally, are among our
51 largest samples. Our inability to identify populations with small $\Delta\rho$ is due to our wide confidence
52 intervals, not because the evidence points away from it, as we reveal below.
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Do particular wealth types or production systems show a tendency toward son or daughter bias? The

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3 data do suggest a few possibilities. First, five of the ten material wealth measures (land, livestock,
4 household wealth, income, and boat shares) are convincingly son-biased, while none are
5 clearly daughter-biased. Mechanistically, this may arise from male-biased norms of property
6 transmission; furthermore, this pattern would be expected evolutionarily if sons can use
7 inherited resources to enhance fitness more effectively than daughters (see discussion). Second, the
8 populations with matrilineal norms (Chewa and Mosuo) appear to show a slight tendency toward female
9 bias. These populations together account for only five wealth measures, however, so this pattern must
10 be viewed with caution. No pattern emerges with respect to marriage patterns: the most polygynous
11 populations (Chewa, Datoga, Gambia, and Kipsigis) show both son-biased and daughter-biased
12 correlations.
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22 23 **(c) Characterizing the Extent of Sex Bias**

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27 Although our estimates for each dataset are imprecise, we can nevertheless characterize the distribution
28 of Δ_ρ for the whole group of datasets using the computed posterior probabilities. We can ask, for
29 example, how many datasets are expected to be strongly son-biased, or how many show little bias in
30 either direction. Table 3 shows how many datasets are expected to show little sex bias ($-0.1 < \Delta_\rho < 0.1$
31), son bias ($\Delta_\rho > 0.1$), and daughter bias ($\Delta_\rho < -0.1$). These numbers are calculated by independently
32 drawing estimates from the distributions depicted in Figure 3 and counting the amount that fall into
33 each category. The choice of 0.1 as the cutoff is arbitrary.
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42 Table 3 shows that roughly 15 datasets (39% of the total) are expected to have little sex-biased parental
43 investment, although we have confidently identified only two. The rest will have some notable bias, with
44 about equal numbers daughter biased and male biased. Note that these calculations were done using a
45 prior that assigned equal prior probability to every value of Δ_ρ in the interval $(-1,1)$. If extreme values of
46 Δ_ρ are *a priori* unlikely, then this would increase the number of datasets in the “little bias” category.
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52 53 **5. Discussion**

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56 We have estimated sex differences in parent-offspring correlations for a wide range of small-scale
57 societies. Despite the imprecision of most estimates, we conclude that there is substantial variation in
58 correlations across populations, and, in many cases, across sex. Some datasets show strong evidence for
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3 much higher parent-offspring correlation in one sex than the other; other populations likely have very
4 small differences, although we cannot identify most of them.
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9 Our analysis does not support the hypothesis that son-preference among parents is more predominant
10 than daughter-preference. This is perhaps surprising, given common perceptions, and given that some of
11 our wealth variables are explicitly inherited only by sons (in contrast, we have no wealth measure that is
12 only inherited by daughters). This does not mean that sons and daughters are everywhere treated
13 equally; our data clearly refute that claim. Rather, we find that many populations appear to show no sex-
14 biased parental investment and, among those that do, they are just as likely to favor daughters as sons.
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21 In this discussion we address first the conditions under which parent-offspring correlations reveal
22 patterns of sex-biased investment. We then interpret in more detail the patterning we find in our data
23 before drawing conclusions about some aspects of female-biased kinship, and adding a few more
24 general conclusions.
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30 31 **(a) Inferring preferences for sex-biased inheritance from parent-offspring correlations**

32 As noted in the Introduction, the sex with the larger parent-offspring correlation in wealth will, all other
33 things being equal, be the sex in which parents invest more heavily. But all other things are never equal,
34 such that offspring wealth may correlate with parental wealth for many other reasons apart from direct
35 parental investment, including genetic and cultural transmission for wealth productivity [16]. To address
36 this problem, we consider a model (detailed in Electronic Supplementary Material) that includes two
37 pathways of wealth inheritance: (1) direct parental investment and (2) indirect transmission via the
38 inheritance of genetic and cultural capability for wealth production. In short our model of wealth
39 transmission helps us derive the conditions under which offspring-parent correlations can be used to
40 infer sex-biased investment. These conditions include that: (1) the ability to acquire wealth is
41 equally heritable in males and females (whether through genetic or cultural inheritance), (2) the effect of
42 direct parental investment on offspring wealth is the same for sons and daughters relative to each sex's
43 wealth standard deviation, and (3) parent wealth is not correlated with a particular investment strategy.
44 Although we are unable to assess whether all three conditions hold in each of the datasets considered
45 here, the model is useful in identifying circumstances that could unlink the parent-offspring correlation
46 from the investment strategy, for instance if wealthy parents invest more in sons than do poor parents
47 (Condition 3). We are not aware of any previous attempt to identify these conditions formally.
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(b) Interpreting the pattern of sex-biased parental behaviour

Research of economists in the Philippines [12, 77] and Ghana [70] corroborates our finding 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. For example, material capital may be more effectively transmitted to sons, and human capital to daughters [as shown in the Philippines, 12], and compensatory strategies may occur over the lifetime to make up for initial biases [11]. As such global patterns are likely to be highly variable, and meta-analyses of individual-level data are needed to determine the effects of institutional norms, such as inheritance laws, political systems, or religious values not only parent-offspring correlations but the varying pathways entailed. Furthermore, only with a larger data set and data collected specifically for the purpose, could we test more focused hypotheses, for example, that sons are favored 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., 44]; there is no evidence of such a pattern in the current data set.

For the unbiased datasets, we reemphasize 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. It is not surprising, then, that males more resemble their fathers than do females with respect to the land and livestock. Inheritance systems do not, however, dictate such patterns. After all, patriliney also characterizes the Datoga, for whom the correlation sex difference appears to be small. This likely reflects a pattern of assortative mating (see

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3 below). Clearly, then, *post hoc* explanations should be treated with skepticism. More population-specific
4 information is needed to explain any particular statistic.
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9 The observed tendency toward son bias for material wealth is consistent with adaptationist logic. Theory
10 predicts that parents will invest more in the sex in which such investments more strongly augment
11 fitness [78]. A common finding among human behavioural ecologists [e.g., 79, 80-83] is that material
12 resources do indeed more strongly affect male than female reproductive success, largely through the
13 ability to acquire mates. We would therefore expect the observed pattern of male bias in material
14 wealth [44], but not necessarily in other wealth types.
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21 We note that the form of parental investment need not be the same for both sexes. For example, we
22 have detected only a small son bias in Krummhörn parental investment for land. The small effect size is,
23 at first glance, surprising, because males are the sole inheritors of land. The discrepancy probably arises
24 because of assortative mating: rich farmers marry their daughters to rich farmers. The result is that the
25 daughters of wealthy parents are only slightly less likely than their brothers to remain wealthy in
26 adulthood. Similarly, Bevis and Barrett [12] found, using detailed data from the Philippines, that sons'
27 incomes resemble parents' incomes mostly as a result of the bequests of land, whereas daughters inherit
28 from their parents a more diffuse set of skills in income generation, probably mediated by education,
29 culturally transmitted skills and values, nutrition, health, and genetics (see also [84] for a similar
30 decomposition of intergenerational effects). An understanding of such pathways, rather than simple
31 statistical correlations, is key to designing appropriate policy interventions whether, for example, to
32 allocate resources to reforming inheritance laws or making education freely available.
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45 One potential problem with our analysis is that each wealth measure is only correlated with the same
46 wealth measure in the parents. For example, we only correlated offspring education with parent
47 education. Suppose, however, that an offspring's education is determined largely by his/her parents'
48 income, or some composite measure of wealth composed of multiple quantities? If so, then our single-
49 variable analyses are inappropriate. Precisely identifying the complex pathways by which humans
50 transmit wealth across generations will require more detailed data than that which we present here.
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58 This is also important from an applied perspective. There are a diverse set of mechanisms posited to be
59 responsible for intergeneration wealth transmission [85], and these vary both between populations and
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3 (most likely) at different wealth strata within populations [86]. Furthermore, the pathways may be
4 complex and non-intuitive. For example, reforms to improve the inheritance rights of women in India
5 have led to a significant increase in the education of women but an unanticipated decrease in the
6 education attainment of their children, reflecting educated women's clearer perception of the
7 opportunity costs associated with education, particularly for their sons [87]. As rates of inequality within
8 developing nations escalate [88] better understanding of these pathways will be critical to resolving
9 debates over how the vicious cycles whereby poverty breeds poverty might best be broken [as reviewed
10 in 89].
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20 **(c) Implications for female-biased kinship**

21 The parent-offspring relationship is central to any kinship system. This includes matrilineal systems, in so
22 far as emphasis is placed either on the parent-daughter tie, or on the grandparent-maternal
23 granddaughter tie (even though in the latter it is sons who invest in their sisters' children rather than
24 daughters in their own children). Our convenience sample of populations is insufficiently variable with
25 respect to inheritance rules to allow us to test systematically how parent-offspring wealth correlations
26 might differ by inheritance norms. As noted above there are weak indications of a daughter-bias in the
27 only two populations with a matrilineal inheritance norm (Chewa and Mosuo), but there is, rather
28 surprisingly, no clear signal of higher absolute correlations for daughters than for sons in these
29 matrilineal populations. The extent to which inheritance norms (both patrilineal and matrilineal) shape
30 offspring outcomes is not straightforward, and the norms themselves do not describe well the diverse
31 mechanisms whereby advantage or disadvantage are perpetuated across generations.
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44 Cultural practices associated with female-biased kinship organization, such as inheritance rules, post-
45 marital residence norms and marriage payments, have long been recognized by anthropologists as
46 influencing social outcomes, with support from correlational cross-cultural data [90]. Engels [19]
47 proposed that gender inequality emerged with the intensification of agriculture, and the consequential
48 establishment of private property (monopolized by men), leading to the replacement of matrilineal with
49 patrilineal descent. More regionally focused studies link gender inequality to virilocality as a result of
50 lower parental investment in the out-marrying sex (e.g., [2] for northern India) and the limited social
51 support a woman enjoys once she has left her natal household (e.g., [91] for many parts of south and
52 east Asia). This is intriguingly consistent with recent work in non-humans showing that sex differences in
53 dominance may be related to social support networks [92]. Economists too are pursuing this
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3 investigation into the specific consequences for women's wellbeing contingent on lineality, or at least
4 indicators associated with lineality [40]. For example, contemporary women's advantageous political
5 status is linked to a history of no plough agriculture [93], and high juvenile female survival to favourable
6 female earnings relative to males [94].
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12 That said, direct positive outcomes associated with female biased kinship are not inevitable. A recent
13 comparison of matrilineal and patrilineal societies within both the Solomon Islands and the global
14 Standard Cross Cultural Sample finds very little evidence that matrilineal inheritance translates into real
15 economic or political power in either sample [95]. In short, this body of literature, together with the
16 results of the study reported here, suggests that understanding the links between normative patterns (or
17 institutions) and social outcomes will require careful analysis of individual level data to determine who
18 exactly gains and loses from an institutional shift such as that from male to female-biased kinship.
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29 In summary, with respect to female-biased kinship systems, we find no support for the hypothesis that
30 son-preference among parents is more predominant than daughter-preference, at least insofar as we
31 can infer such preferences from our data. This suggests that despite the predominance of patriliney and
32 patrilocality as norms in the ethnographic record, the parent-daughter relationship central to female-
33 biased kinship organization bears much closer scrutiny, as indeed indicated in some specific
34 ethnographic contexts within our sample. Maternal kin are critical to offspring survival in resource-
35 stressed (as compared to wealthy) patrilineal Kipsigis households [96], and Himba women make frequent
36 visits to their maternal kin despite patrilocal residence [97]. More generally, a focus on the sex-specific
37 ways in which parental quality is transmitted across generations would appear to be a key step in
38 determining both the adaptive value of varying parental strategies [15] and the persistence of inequality
39 [16, 17].
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50 51 **(d) Concluding remarks**

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54 We end with a methodological and a more general coda. First an ideal study of sex-biased parental
55 investment would investigate parents' actual behaviour, i.e., how many resources they devote to sons
56 vs. daughters over the period of dependence, and how this affects their offspring's subsequent wealth
57 status (broadly defined as here). In the absence of such direct behavioural data, we follow economists in
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3 comparing the parent-offspring wealth correlations of each sex to explore sex differences in the “silver
4 spoon” effect. As our model shows, such correlations are affected by many things other than direct
5 parental investment, issues that should be kept in consideration in all studies of parental investment that
6 examine outcomes rather than actions.
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12 Second, gender inequality is still pervasive. Differentials in income, education and autonomy persist
13 globally [5, 98, 99]. Secondary sex ratios are still rising in some parts of India and China [100] prompting
14 questions of why parents appear to favor sons over daughters [101]. Anthropologists working in
15 communities where such inequalities persist despite or indeed because of rapid social change need to
16 document these dynamics. Examining the extent to which this inequality persists across generations is a
17 key first step in this pursuit.
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15 16 **Author contributions**

17 MBM and RB wrote the paper, with substantial contributions from MCT; RB constructed the model and
18 analysed the data; MBM, MCT, BAB, HC, MG, KKL, SLM, DAN, BS, RS, MKS, and EV contributed data to
19 the population analyses and participated in development of the paper's intergenerational focus and
20 methodological approach in conjunction with a larger project.
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Figure and Table Captions

Table 1: Summary of wealth datasets. “Stan. diff.” is the standardized difference: it is the difference between the son and daughter means, divided by the standard deviation. *Shared incomes and land holdings were recorded for Bangladesh married pairs; the sample means are therefore the same. **Krummhörn data are from historical records from which ages are unavailable.

Table 2: Estimates of parent-offspring correlations for each sex and the differences between them. SE is the standard error of the estimate.

Table 3: Estimated number of datasets that show little bias, son bias, and daughter bias.

Figure 1: Plots of ρ_s and ρ_d estimated for land ownership in Bangladesh. The steeper slope for sons (in blue) 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 the section “Statistical Inference” for an exact definition.

Figure 2: Parent-son and parent-daughter correlations, with 90% confidence intervals. The datasets are sorted according to the mean correlation across both sexes. “HH wealth” refers to household wealth; “Network” refers to a measure of social network wealth.

Figure 3: Difference between son and daughter correlations ($\Delta\rho$), with 90% CI. Numbers along vertical axes are the posterior probability that $\rho_s > \rho_d$ for (a) and $\rho_s < \rho_d$ for (b), for each dataset. “HH wealth” refers to household wealth; “Network” refers to a measure of social network wealth.

| Population | Wealth type | N sons | N daughters | Stan. diff. | Mean age |
|------------|------------------|--------|-------------|-------------|----------|
| Bangladesh | Education | 596 | 516 | 0.21 | 27.8 |
| | Income | 298 | 584 | 0* | 42.6 |
| | Land | 283 | 436 | 0* | 50.4 |
| Bengaluru | Education | 263 | 299 | 0.23 | 34.3 |
| | Network wealth | 162 | 183 | 0.22 | 33 |
| | RS | 291 | 355 | -0.12 | 33.9 |
| Chewa | Education | 147 | 98 | 0.35 | 23.5 |
| | Land | 33 | 118 | 0.04 | 30.7 |
| | RS | 35 | 132 | -0.58 | 30.7 |
| Datoga | Livestock | 95 | 40 | -0.22 | 30.9 |
| | RS | 95 | 40 | -0.43 | 30.9 |
| Gambia | Height | 390 | 427 | 1.24 | 24.1 |
| | RS | 87 | 220 | 0.34 | 32 |
| | Weight | 390 | 427 | 0.59 | 24.1 |
| Himba | RS | 54 | 92 | 0.21 | 39.4 |
| Kipsigis | Cattle partners | 61 | 41 | 0.3 | 44.3 |
| | Land | 161 | 109 | -0.44 | 42.3 |
| | Livestock | 161 | 109 | 0.27 | 42.3 |
| | RS | 160 | 108 | 0.46 | 42.4 |
| Krummhörn | Land | 708 | 744 | -0.01 | NA** |
| Lamalera | Boat shares | 64 | 55 | -0.14 | 36.7 |
| | House quality | 53 | 40 | -0.31 | 36.3 |
| | RS | 64 | 55 | -0.08 | 36.7 |
| Maya | Education | 106 | 103 | 0.6 | 32.1 |
| | Height | 63 | 78 | 1.57 | 33.8 |
| | RS | 99 | 88 | -0.14 | 32.4 |
| | Weight | 61 | 74 | 0.61 | 33.8 |
| Mosuo | Education | 141 | 156 | 0.11 | 28.1 |
| | RS | 134 | 146 | -0.32 | 28.3 |
| Pimbwe | Farm skill | 61 | 71 | -0.04 | 33.7 |
| | Household wealth | 77 | 92 | -0.03 | 32.7 |
| | RS | 226 | 215 | -0.26 | 29.7 |
| Poland | Education | 5781 | 7274 | -0.35 | 47.3 |
| Tsimane | Knowledge | 41 | 68 | -0.37 | 24.6 |
| | RS | 435 | 406 | -0.22 | 30.2 |
| | Weight | 110 | 107 | 0.86 | 26.6 |
| Ust Avam | Education | 55 | 45 | -0.5 | 22.6 |
| | RS | 77 | 54 | -0.44 | 25.1 |

Table 1: Summary of wealth datasets. “Stan. diff.” is the standardized difference: it is the difference between the son and daughter means, divided by the standard deviation. *Shared incomes and land holdings were recorded for Bangladesh married pairs; the sample means are therefore the same. **Krummhörn data are from historical records from which ages are unavailable.

| Population | Wealth type | ρ_s | SE | ρ_d | SE | $\Delta\rho$ | SE |
|------------|------------------|----------|------|----------|------|--------------|------|
| Bangladesh | Education | 0.47 | 0.03 | 0.54 | 0.03 | -0.07 | 0.05 |
| | Income | 0.29 | 0.05 | 0.22 | 0.04 | 0.07 | 0.07 |
| | Land | 0.52 | 0.04 | 0.37 | 0.04 | 0.14 | 0.06 |
| Bengaluru | Education | 0.67 | 0.03 | 0.71 | 0.03 | -0.04 | 0.04 |
| | Network wealth | 0.12 | 0.07 | 0.12 | 0.07 | 0 | 0.1 |
| | RS | 0.21 | 0.06 | 0.12 | 0.06 | 0.1 | 0.08 |
| Chewa | Education | 0.28 | 0.07 | 0.24 | 0.09 | 0.04 | 0.11 |
| | Land | -0.14 | 0.25 | 0.06 | 0.1 | -0.2 | 0.27 |
| | RS | -0.41 | 0.16 | 0.08 | 0.09 | -0.49 | 0.19 |
| Datoga | Livestock | 0.54 | 0.08 | 0.54 | 0.12 | -0.01 | 0.13 |
| | RS | 0.18 | 0.13 | 0.2 | 0.17 | -0.02 | 0.21 |
| Gambia | Height | 0.435 | 0.04 | 0.56 | 0.03 | -0.12 | 0.05 |
| | RS | 0.15 | 0.07 | -0.03 | 0.05 | 0.18 | 0.09 |
| | Weight | 0.37 | 0.04 | 0.44 | 0.04 | -0.08 | 0.06 |
| Himba | RS | 0.15 | 0.13 | 0.19 | 0.11 | -0.04 | 0.17 |
| Kipsigis | Cattle partners | -0.02 | 0.15 | 0.16 | 0.21 | -0.18 | 0.25 |
| | Land | 0.63 | 0.06 | 0.16 | 0.11 | 0.47 | 0.12 |
| | Livestock | 0.46 | 0.07 | 0.09 | 0.1 | 0.37 | 0.12 |
| | RS | 0.06 | 0.11 | 0.03 | 0.13 | 0.03 | 0.17 |
| Krummhorn | Land | 0.6 | 0.02 | 0.52 | 0.03 | 0.08 | 0.03 |
| Lamalera | Boat shares | 0.15 | 0.15 | 0.12 | 0.14 | 0.03 | 0.2 |
| | House quality | 0.14 | 0.14 | 0.12 | 0.16 | 0.03 | 0.21 |
| | RS | -0.14 | 0.13 | 0.42 | 0.11 | -0.56 | 0.18 |
| Maya | Education | 0.12 | 0.12 | 0.3 | 0.1 | -0.18 | 0.15 |
| | Height | 0.4 | 0.1 | 0.63 | 0.07 | -0.23 | 0.11 |
| | RS | 0.07 | 0.12 | -0.01 | 0.11 | 0.07 | 0.16 |
| | Weight | 0.25 | 0.13 | 0.23 | 0.11 | 0.02 | 0.16 |
| Mosuo | Education | 0.26 | 0.09 | 0.3 | 0.07 | -0.05 | 0.11 |
| | RS | -0.13 | 0.11 | 0.06 | 0.07 | -0.2 | 0.13 |
| Pimbwe | Farm skill | 0.08 | 0.14 | 0.21 | 0.12 | -0.13 | 0.18 |
| | Household wealth | 0.33 | 0.1 | -0.08 | 0.11 | 0.41 | 0.15 |
| | RS | -0.04 | 0.06 | 0.04 | 0.07 | -0.07 | 0.09 |
| Poland | Education | 0.3 | 0.01 | 0.28 | 0.01 | 0.02 | 0.02 |
| Tsimane | Knowledge | 0.03 | 0.15 | -0.02 | 0.14 | 0.05 | 0.2 |
| | RS | 0.05 | 0.05 | 0.09 | 0.05 | -0.04 | 0.07 |
| | Weight | 0.35 | 0.09 | 0.22 | 0.1 | 0.13 | 0.13 |
| Ust Avam | Education | 0.53 | 0.12 | -0.15 | 0.18 | 0.68 | 0.22 |
| | RS | -0.15 | 0.15 | -0.14 | 0.12 | -0.01 | 0.19 |

Table 2: Estimates of parent-offspring correlations for each sex and the differences between them. SE is the standard error of the estimate.

| | Definition | N | 90% CI |
|---------------|----------------------|----------|---------------|
| Little bias | $ \Delta\rho < 0.1$ | 15 | 11-19 |
| Son bias | $\Delta\rho > 0.1$ | 11 | 8-14 |
| Daughter bias | $\Delta\rho < -0.1$ | 11 | 7-14 |

Table 3: Estimated number of datasets that show little bias, son bias, and daughter bias.

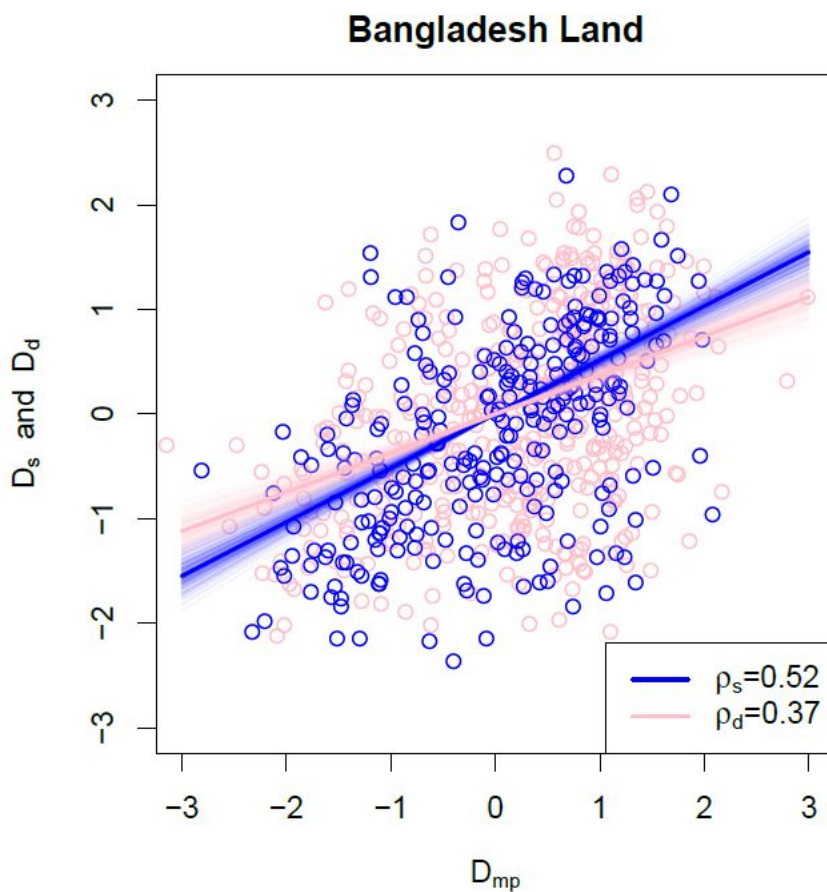


Figure 1: Plots of ρ_s and ρ_d estimated for land ownership in Bangladesh. The steeper slope for sons (in blue) is consistent with son-biased parental investment. D_s , D_d , and D_{mp} are standardized wealth deviations of sons, daughters, and midparents, respectively; see the section “Statistical Inference” for an exact definition.

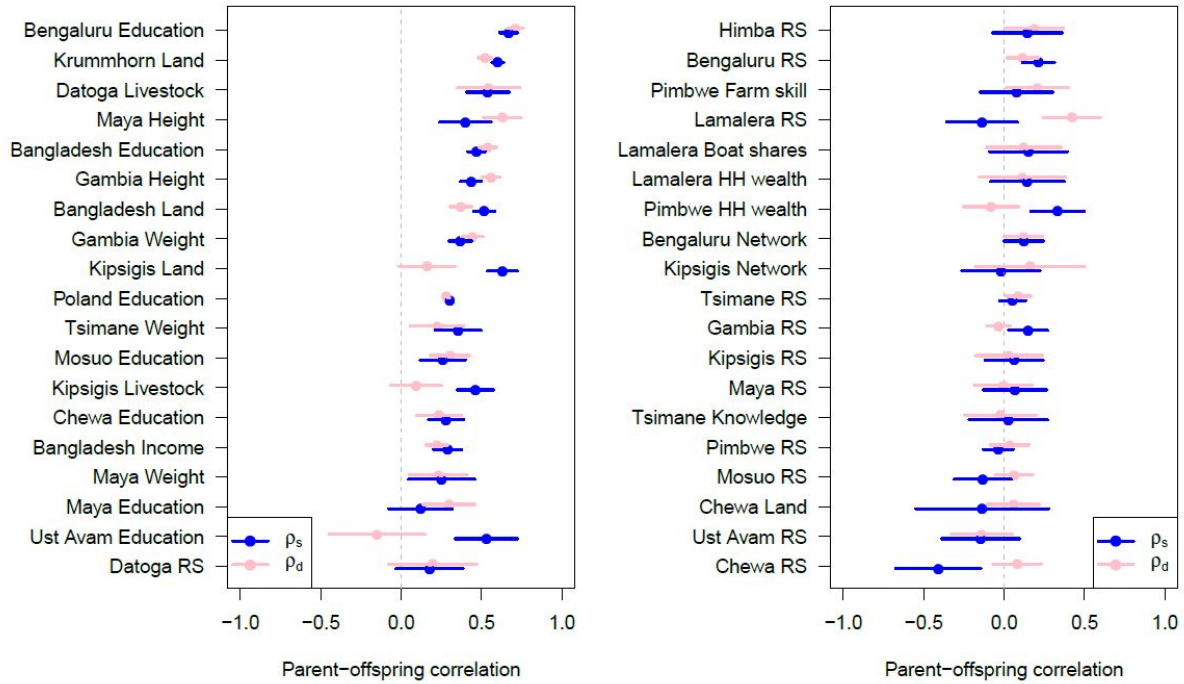


Figure 2: Parent-son and parent-daughter correlations, with 90% confidence intervals. The datasets are sorted according to the mean correlation across both sexes. “HH wealth” refers to household wealth; “Network” refers to a measure of social network wealth.

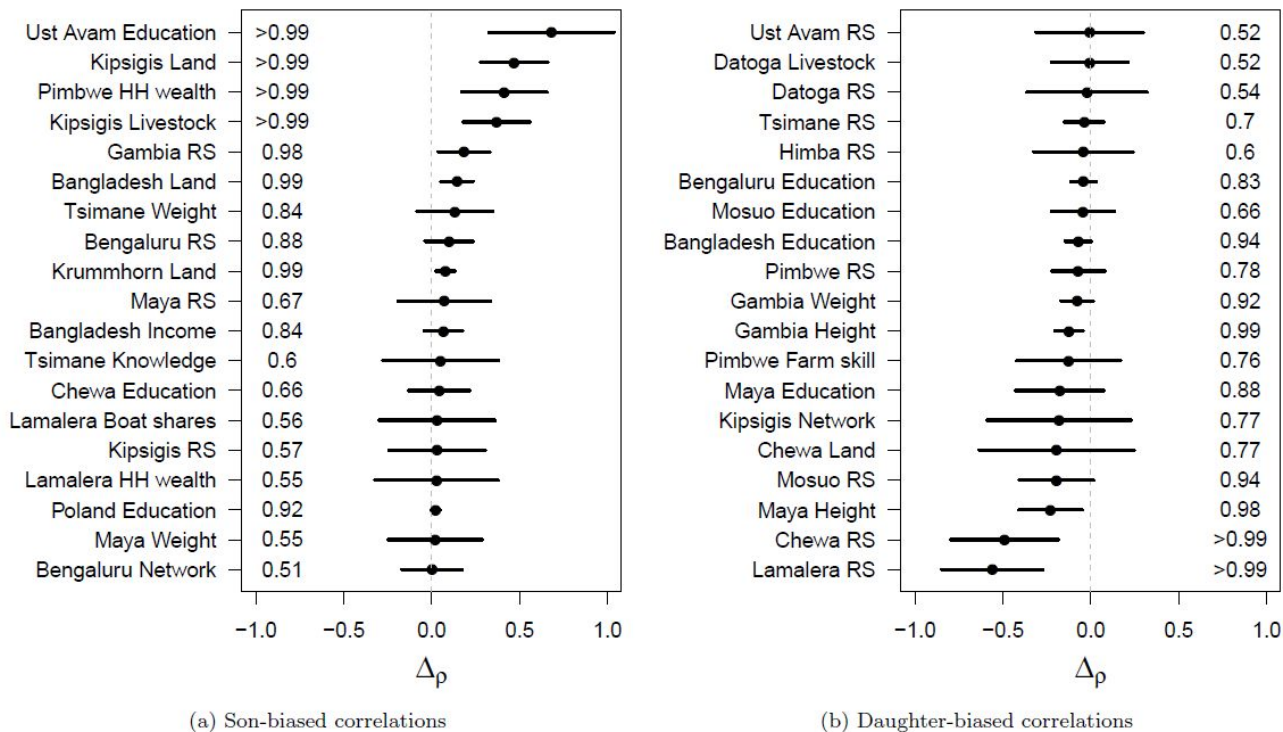


Figure 3: Difference between son and daughter correlations ($\Delta\rho$), with 90% CI. Numbers along vertical axes are the posterior probability that $\rho_s > \rho_d$ for (a) and $\rho_s < \rho_d$ for (b), for each dataset. “HH wealth” refers to household wealth; “Network” refers to a measure of social network wealth.