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Review

The puzzle of monogamous marriage

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The anthropological record indicates that approximately 85 per cent of human societies have permitted men to have more than one wife (polygynous marriage), and both empirical and evolutionary considerations suggest that large absolute differences in wealth should favour more polygynous marriages. Yet, monogamous marriage has spread across Europe, and more recently across the globe, even as absolute wealth differences have expanded. Here, we develop and explore the hypothesis that the norms and institutions that compose the modern package of monogamous marriage have been favoured by cultural evolution because of their group-beneficial effects—promoting success in inter-group competition. In suppressing intrasexual competition and reducing the size of the pool of unmarried men, normative monogamy reduces crime rates, including rape, murder, assault, robbery and fraud, as well as decreasing personal abuses. By assuaging the competition for younger brides, normative monogamy decreases (i) the spousal age gap, (ii) fertility, and (iii) gender inequality. By shifting male efforts from seeking wives to paternal investment, normative monogamy increases savings, child investment and economic productivity. By increasing the relatedness within households, normative monogamy reduces intra-household conflict, leading to lower rates of child neglect, abuse, accidental death and homicide. These predictions are tested using converging lines of evidence from across the human sciences.

Keywords: cultural group selection; monogamy; polygyny; marriage; norms; institutional evolution

1. INTRODUCTION

Approximately 85 per cent of societies in the anthropological record permit men to marry multiple wives [1]. Taking wives is always positively associated with status, wealth or nobility [2], even among highly egalitarian foraging societies [3]. After the origins of agriculture, as human societies grew in size, complexity and inequality, levels of polygynous marriage intensified, reaching extremes in the earliest empires whose rulers assembled immense harems [4,5]. Today, however, with absolute wealth gaps greater than any seen in human history, monogamous marriage is both normative and legally enforced in most of the world's highly developed countries. While the roots of the package of norms and institutions that constitute modern marriage can be traced back to classical Greece and Rome [6,7], the global spread of this peculiar marriage system [6] has occurred only in recent centuries, as other societies sought to emulate the West, with laws prohibiting polygyny arriving in 1880 in Japan, 1953 in China, 1955 in India and 1963 in Nepal. Given its historical rarity and apparent ill-fit with much of our evolved psychology, why has this marriage package spread so successfully? Historically, the emergence of monogamous marriage is particularly puzzling since the very men who most benefit from polygynous marriage—wealthy aristocrats—are often those most influential in setting norms and shaping laws. Yet, here we are.

This paper develops and tests the hypothesis that the modern package of norms and institutions that constitutes monogamous marriage has been shaped by cultural evolution driven by inter-group competition—a set of processes termed cultural group selection [8]. The idea is that competition among communities—such as nations, polities or religious organizations—favours those norms, values, beliefs, practices and institutions that most effectively harness, reinforce and shape our motivations and behaviour in ways that generate success in inter-group competition. Over centuries, these processes can lead to the spread of social norms and institutions (formal and informal) that create societal-level benefits and reduce aggregate societal costs, thereby giving an edge in inter-group competition. Inter-group competition need not result in violent conflict as such processes can produce a differential diffusion of beliefs, norms and institutions from more successful to less successful societies [8,9]. This aspect of cultural group selection may be particularly important for spread of normative monogamy.

Researchers from biology to history have long noted the puzzle of monogamous marriage, and suggested

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that such norms spread because of their group-beneficial effects [6,10]. While historians considering the puzzle have shown how the European historical record is at least consistent with a process driven by cultural group selection, little work has focused on developing and testing predictions regarding how normative monogamy impacts individual psychology, or how (if at all) those effects aggregate up to impact groups (though see Moorad *et al.* [11]). Thus, our effort here focuses in developing the broader theoretical and empirical issues, rather than in detailing historical cases.

We pursue this hypothesis as follows. First, we distinguish *mating strategies* from *marriage systems*, and clarify which aspects of our evolved psychology can be harnessed or reinforced by cultural group selection, and which aspects need to be suppressed. Second, we develop a set of testable hypotheses and their empirical implications. We predict that imposing monogamous marriage reduces male reproductive competition and suppresses intra-sexual competition, which shrinks the size of the pool of low-status, risk-oriented, unmarried men. These effects result in (i) lower rates of crime, personal abuse, intra-household conflict and fertility, and (ii) greater parental investment (especially male), economic productivity (gross domestic product (GDP) *per capita*) and female equality. We draw on both longitudinal and cross-sectional evidence from diverse disciplines. In some cases, we provide solid empirical tests of specific predictions or implications. In other cases, the available evidence provides only qualified support, basic consistency or prima-facie plausibility. As usual, future work may find the theory wanting and specific hypotheses wrong. In closing, we (i) contrast the conditions favourable to the spread of monogamous versus polygynous marriage, (ii) consider alternative hypotheses for the spread of monogamous marriage, and (iii) speculate on how marriage systems might be linked to the rise of democratic institutions and industrial economic growth.

2. BUILDING BLOCKS

It is crucial to recognize that marriage norms are not the same as our evolved mating psychology. Humans, like all primates, possess an evolved psychology that influences our choices regarding mates, mating, reproduction and parental investment. For established evolutionary reasons, male and female mating psychologies differ in important ways. As in other primates, these different mating strategies yield a mating system (or range of systems), as individuals cooperate and compete under different ecological and economic circumstances (see electronic supplementary material). Here, we first summarize key points about human mating strategies, and then discuss marriage systems. Our approach considers how specific marriage systems might be favoured by cultural group selection because of how they harness aspects of our evolved psychology.

(a) *Mating strategies*

There is much evidence that the mating strategies of men and women differ. Like many mammals, human females invest more heavily in their offspring than males. Humans also pair-bond [12,13]—both monogamously and polygamously—in collaborations that encourage more extensive male parental investment and a division of labour. This means that men generally have higher variance in fitness than women [14]. When competition for mates is fierce, less-attractive low-status men risk being shut-out entirely from mating. Since the fitness difference between having one long-term mate and zero mates is—on average—large, low-status males should often pursue risky, high-stakes, strategies that provide some chance of avoiding fitness oblivion [15]. This means that cues that indicate intensive intra-sexual selection should spark competitive motivations, steep temporal discounting and risk proneness. Low intra-sexual competition means that nearly all males can find at least one mate, and status gains do not lead to steep increases in reproductive success. Here, pursuing safe, long-term strategies like pair-bonding is favoured—that is, men will be more risk-averse and more patient. All fathers must decide whether to invest in their offspring or in seeking additional mates. This decision should depend on paternity certainty, and on the marginal payoffs to investing in offspring versus additional matings. When the rich high-status men cannot easily gain additional mates, they should invest more in offspring (see electronic supplementary material).

Women also possess flexible mating strategies. However, their direct fitness is limited to the number of children that they can bear and rear. For our purposes, when males vary substantially in status (based on skill, resources, power, etc.), women prefer higher status males as long-term pair-bonded partners, though they may also seek 'good genes' via extra-pair copulations when pair-bonded to a low-quality male. Polygynous pair-bonding is more acceptable to women than is polyandrous pair-bonding to men. Polyandrous men face paternity uncertainty—they are rather uncertain about which children are theirs—and must compete for their mate's limited reproductive capacities (gestation, lactation, etc.). Polygynously mated women face neither maternal uncertainty nor (usually) competition for their mate's essentially unlimited sperm. This implies that under conditions in which men vary substantially in status, polygynous pair-bonding is a likely outcome of both male and female mating choices. The electronic supplementary material further details and supports these points.

(b) *Marriage systems*

Marriage systems are distinct from mating strategies. Humans, unlike other species, are heavily reliant on cultural learning for acquiring all manner of behaviours and practices, including social behaviour. Because humans also acquire the standards by which they judge others as part of this process, cultural evolution gives rise to social norms. Failure to conform to norms results in reputational damage, loss of status and various forms of sanctioning [16].

Different societies have evolved diverse sets of norms that regulate pair-bonds. Such marriage norms influence people's long-term pair-bonds, and

thus their mating choices. Being married comes with economic, social and sexual expectations, prescriptions and prohibitions for both parties, who are accordingly evaluated—formally or informally—by their community. Marriage norms govern such areas as who (i) can marry whom (e.g. exogamy, incest taboos), (ii) pays for the marriage ritual, (iii) gets the children in the event of the groom's or bride's death, and (iv) is a 'legitimate' heir and can inherit property, titles, etc. Marriage norms also specify rules about partner number and arrangement (e.g. no group marriages). The key to understanding marriage versus pure pair-bonding is recognizing the role of a community in defining, sanctioning and enforcing marriage norms. This element of human social life is routinely missed in non-cultural approaches to monogamy [17,18].

Marriage norms are certainly not independent of our mating psychology, nor can they entirely subvert it. They can, however, influence behavioural patterns in two ways. First, humans readily internalize social norms, at least partially. This means norms become internalized such that norm adherence is intrinsically rewarding [16]. Work in neuroscience has shown how both adhering to local norms and punishing norm violators activates the brain's reward circuitry [19]. Second, the fact that people acquire and internalize norms means that norm violators can be condemned and sanctioned [20]. Sanctioning, independent of any internalization, results in norm violators suffering real costs. Thus, many marriage systems have culturally evolved to reinforce our evolved pair-bonding strategy, leading to more enduring male–female collaborations. This galvanizing effect of some marriage systems is thrown into stark relief by the existence of alternative systems like those possessed by (i) the Na in China, whose norms suppress long-term pair-bonding and operate without either marriage or paternal investment [21] or (ii) various South American societies, whose norms allow the spreading of perceived paternity, and paternal investment, across two or more fathers [22].

Of course, the prescriptions and prohibitions of marriage systems (sets of norms) and the actual mating patterns in human societies often do not match up—nor should we expect them to. Consider that some societies possess marriage norms specifying that each man and woman shall marry once in their lifetime. After marriage they shall never seek any sexual or romantic relationship with anyone else, ever, and all resources must be devoted to the good of the household. As with other norm violations like theft and lying, this never quite works out, as our evolved mating psychology gives rise to broad societal-level patterns of infidelity, divorce, prostitution, etc. But there is little doubt that particular marriage systems shape and influence the resultant mating patterns, as well as parental investment. In nineteenth century Europe, for example, non-marital fertility was so slight as to be demographically negligible despite substantial rates of late marriage and of adults who never married [23]. Thus, social norms are powerful enough to buttress our pair-bonding psychology, such that most people in a society have only one long-term mate, or to curtail almost all long-term pair-bonding, or to allow women to actively seek extra-pair copulations while repressing male jealously.

Marriage systems found throughout the anthropological record reflect and amplify aspects of our mating psychology. As noted, most human societies permit polygynous marriage in some form, including most foraging societies [3,24]. In polygynous societies, a man's social status, hunting skill, nobility and wealth lead to more wives [25].The autocratic leaders of chiefdoms, empires and early states ranging from Tonga to China consistently assembled immense harems with 100 or more women/girls [5]. Meanwhile, polyandrous marriage is relatively rare, often involves brothers marrying the same wife, and is frequently intermixed with polygynous marriages within the same population (see the electronic supplementary material).

The 15 per cent or so of societies in the anthropological record with monogamous marriage fall into two disparate categories: (i) small-scale societies inhabiting marginal environments with little status distinctions among males and (ii) some of history's largest and most successful ancient societies. Researchers have labelled these 'ecologically imposed' and 'socially imposed' forms of monogamous marriage [6,7,26]. Ecologically imposed monogamy occurs because the societies lack sufficiently large differences in male wealth or status to motivate women to become second wives. Socially imposed monogamy covers situations in which norms or laws regulate spousal number (along with inheritance and divorce rights), including circumstances in which a noble class forcibly imposes monogamous marriage on commoners while retaining polygyny for themselves (see the electronic supplementary material).

3. THEORY AND EVIDENCE

We hypothesize that as social inequalities expanded over human history and societies became increasingly complex, the group-level benefits of normative monogamous marriage increased. In relatively egalitarian societies, including most foragers, the social implications of polygynous marriages are minor. Few men in these societies achieve sufficient status to attract additional wives, and if they do, this is typically limited to one [27]. Among these foraging groups, very successful men might rarely obtain three or at most four wives [28]. For example, among tropical African foragers, the rates of polygyny range from 3 to 20 per cent [29]. Often, there are fewer older men than women due to male mortality in hunting accidents and violent conflicts, so polygynous marriages soak up any 'extra' women (for an exception see Marlowe [27]).

As the wealth and inequality of societies increased over the course of societal evolution, our evolved psychology operating through within-group cultural evolutionary processes increased the degree of polygynous marriage among the richest and most powerful men [4,28]. This increase in polygynous marriage would have led to predictable effects (see below). In the most complex societies (high-end states [30]), where a society's competitive success is influenced by its economic output, standing armies, innovation rates, trade, division of labour and offspring quality, higher rates of polygynous marriage reduce a society's competitive success. Under

these conditions, normative monogamy increases a society's competitiveness because of how it influences crime rates, male motivations, paternal investment, fertility and economic production. Lower crime rates favour more commerce, greater investment, more freely flowing information, greater economic production and a finer division of labour. Greater paternal investment and lower fertility favour higher quality offspring. Several of these factors favour greater innovation and more rapid economic growth.

(a) *Monogamous marriage reduces the intensity of intrasexual competition*

In this section, we present and empirically assess a series of inter-related hypotheses about how the extent and intensity of polygynous marriages negatively impact a group's success, stability or competitive ability, and clarify the effects created by normative monogamy. When we refer to 'normative monogamy' below, we mean to refer to the package of norms and laws governing modern marriage, not only to rules about spousal number. In particular, the customs and laws regulating divorce (e.g. division of assets) and inheritance are important. In referring to 'polygyny', we mean 'general' or 'non-sororal' polygyny [1], which does not limit men's spousal choices to the real or classificatory sisters of one's current wife (see electronic supplementary material).

Our approach predicts that increasing the extent and intensity of polygynous marriage increases male intrasexual competition. This implies that opportunities for sexual selection will be higher in more polygynous societies. Norms and institutions requiring monogamous marriage—or reducing polygyny—should reduce the strength of sexual selection. Here, we review two lines of evidence indicating that normative monogamy reduces intra-sexual competition. First, we present evidence indicating that the intensity of intra-sexual competition declined when monogamous marriage was gradually imposed on nineteenth century Mormon communities. Then, we show that the intensity of intrasexual competition is lower in normatively monogamous societies drawn from a sample of 18 societies with diverse marriage norms.

Data from Mormon communities between 1830 and 1890 show that intra-sexual competition declined dramatically as governmental forces suppressed polygynous marriage [11] through a series of civil, legal, legislative, financial and military manoeuvres that began in the 1840s and had mostly ended by 1890, when the Latter-day Saints church officially disavowed the practice of plural marriage. The estimated ratio of the opportunities for sexual selection on males (I_m) versus that on females (I_f) provides a key measure. In 1830, I_m/I_f was 2.4, which means that males faced nearly two-and-half times the selective intensity faced by females. By the latter part of the nineteenth century, this ratio had dropped and levelled off at 1.17, indicating that men faced only slightly more competition than women. The size of intrasexual competition had dropped by more than eight times during the period when monogamous marriage was imposed. Bateman gradients, which provide a different measure, tell the same story [11].

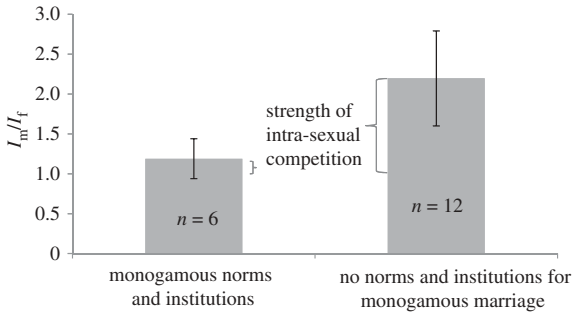

Figure 1. Comparison of the selective strength of intra sexual competition. Error bars are bootstrapped 95% CIs.

While this analysis is consistent with our hypothesis, it cannot causally isolate the effect of the imposition of monogamous marriage on intra-sexual competition because many other historical processes occurred over the same time period. However, further support emerges from comparing the I_m/I_f ratios from diverse societies [14], where the arrays of particular historical processes differ. The 1830 Mormon value of 2.4 for I_m/I_f is similar to that observed in other polygynous societies [14], such as the Yanomano of Venezuela (2.11), Arabs in Chad (2.28), or the Dogon (2.47) in Mali. The value of 1.17 among the late-nineteenth century American Mormons falls between the 1.25 of contemporary Americans and the 0.81 of historical Finland (1745–1900). Figure 1 contrasts the amount of sexual competition in societies with normative monogamy and those without it. When $I_m/I_f > 1$, males face more reproductive competition than females; the larger I_m/I_f, the fiercer is the competition. The mean values of I_m/I_f for these two subsamples indicate that opportunities for sexual selection (mate competition) are 6.4 times greater in societies lacking normative monogamy.

This combination of longitudinal and cross-sectional evidence converges to suggest that normative monogamy does indeed reduce intrasexual competition. Next, we examine whether this competitive suppression actually results in lower crime rates.

(i) *Implication: normative monogamy reduces crime*

One important implication of suppressed intrasexual competition should be reduced crime. By expanding the pool of unmarried men and elevating the degree of intrasexual competition, more polygynous marriages will increase men's discounting of the future and risk-taking, resulting in more socially undesirable behaviours. Faced with high levels of intra-sexual competition and little chance of obtaining even one long-term mate, unmarried, low-status men will heavily discount the future and more readily engage in risky status-elevating and sex-seeking behaviours. This will result in higher rates of murder, theft, rape, social disruption, kidnapping (especially of females), sexual slavery and prostitution. As a by-product, these men will probably engage in more substance abuse. Even among high-status males, competition can intensify if the fitness gradient remains steep. This can lead to risky bids for political power

motivated by the possibility of acquiring harems. By contrast, normative monogamy drains the pool of low-status unmarried men resulting in lower rates of social ills, including reduced rates of crime, social disruption and substance abuse.

To see why even a small increase in polygyny leads to a substantial increase in men without mates, imagine a society of 40 adults consisting of 20 males and 20 females. Suppose these 20 males vary from the unemployed high-school drop outs to CEOs. Let us assume that the 12 men with the highest status marry 12 of the 20 women in monogamous marriages. Then, the top five men (25% of the population) all take a second wife, and the top two (10%) take a third wife. Finally, the top guy takes a fourth wife. This means that of all marriages, 58 per cent are monogamous. Only men in the top 10 per cent of status married more than two women. The most wives that anyone has is four. While this degree of polygyny is not extreme in cross-cultural perspective [1,3], it creates a pool of 40 per cent of the male population who are shut out of the marriage market. To even enter the marriage market, a man has to be in the top 60 per cent of male status. Doubling one's number of long-term mates (to two) then requires entering the top 25 per cent of males. By contrast, normative monogamy means that no one is shut out, and increases in a man's relative status does not increase his number of long-term mates.

Several converging lines of evidence indicate that monogamous marriage reduces crime. First, we review evidence indicating that unmarried men gather in groups, engage in personally risky behaviour (gambling, illegal drugs, alcohol abuse) and commit more serious crimes than married men. Getting married substantially reduces a man's chances of committing a crime. Second, we review cross-national data showing that polygyny leads to a higher percentage of unmarried men, and that more unmarried men is associated with higher crime rates. Then, using within-country and historical data on sex ratio, we confirm that the more unmarried men or greater intrasexual competition are associated with higher crime rates. Finally, we discuss detailed anthropological cases that are consistent with this connection.

Cross-sectional data show that unmarried men are more likely than married men to commit murder [31], robbery and rape [32,33]. Moreover, unmarried men are more likely than married men to gamble and abuse drugs/alcohol [33]. These relationships hold controlling for socioeconomic status, age and ethnicity. Of course, these data do not prove that being unmarried causes criminal behaviour because individuals who are less likely to commit crimes, or abuse substances, might also be more marriageable or more likely to want to married.

Work using longitudinal datasets strengthens the case for a causal relationship. These data allow researchers to follow the same individuals over time to see how marriage impacts their behaviour *relative* to their own pre-marital behaviour. Sampson *et al.* [34] used longitudinal data that tracked boys once in a Massachusetts reform school from age 17 to 70. Most subjects were married multiple times, which allowed the researchers to compare their likelihood of committing a crime during married versus unmarried periods of their lives, using each individual as his own control. Across all crimes, marriage reduces a man's likelihood of committing a crime by 35 per cent. For property and violent crimes, being married cuts the probability of committing a crime by half. When men are divorced *or widowed*, their crime rates go up. Analyses also show that 'good marriages' are even more prophylactic than average marriages (though marrying a criminal wife has the opposite effect). This is consistent with prior work by Sampson & Laub [35].

Using data from Nebraska inmates, Horney *et al.* [36] examined the effects on criminal propensities of entering school, getting a job, moving in with a wife, moving in with a girlfriend and using drugs or alcohol. Controlling for all of these other factors, marriage reduces a man's probability of committing a crime by roughly half. This effect is strongest for assault and weakest for property crimes, but is significant for both of these as well as drug crimes. The size of this marriage effect is similar to entering school and much stronger than being on parole or probation. Interestingly, unmarried cohabitation does not reduce crime rates. Having a job had mixed effects, none of which were particularly large. The positive effect on crime of living with a wife is even larger than the negative effect of heavy drinking (for similar results from London see the study of Farrington & West [37]).

By far, the biggest factor in increasing an individual's criminal propensities was taking drugs [36]. This suggests that Horney *et al.*'s analysis may underestimate the total impact of marriage because marriage also reduces binge drinking and use of marijuana [38]. Thus, marriage probably has both direct effects on committing crimes, and indirect effects via a reduction in personal abuses. Cohabitation also reduces substance abuse, but less effectively than does marriage.

Researchers have explored several proximate mechanisms that explain how marriage reduces crime in men (electronic supplementary material). Though speculative, one interesting mechanism suggests that marriage in monogamous (but not polygynous) societies lowers men's testosterone levels. However, the selective forces generated by cultural group selection do not 'care' why marriage reduces criminal behaviour, only that it somehow does.

While marriage may reduce an individual's chances of committing a crime or personal abuse, two other important links are required to assess whether these individual effects aggregate up to impact whole societies: (i) does greater polygyny increase the size of the pool of unmarried men? and (ii) does this in turn increase crime rates? To examine this, we establish the first link using cross-national data to show that more polygyny is associated with a larger percentage of unmarried males in the population. Then, using the same dataset, we show that the higher the percentage of unmarried men in a country, the higher the rates of rape, murder, theft, robbery and fraud. Finally, to strengthen the case for a causal relationship, we then review within-country and historical analyses of the relationship between sex ratio and crime.

To establish the link between the degree of polygyny and the percentage of unmarried men, we use

national-level data obtained from Kanazawa & Still ([39]; 2009, unpublished data) who compiled crime statistics, demographic information and economic data from multiple sources together with a measure of the degree of polygyny for 157 countries. To create a measure of polygyny, Kanazawa and Still coded all of the cultures in the *Encyclopedia of World Cultures* on a four-point scale (from 0 = monogamy is the rule and is widespread, to 3 = polygyny is the rule and is widespread), and then developed a country-level value by aggregating all of the cultures within a country, multiplying the values for each culture by the fraction of the country's population represented by that culture. In the electronic supplementary material, we extend Kanazawa and Still's work by regressing the percentage of unmarried men (age 15 and over) in the national population on this measure of polygynous intensity with controls for economic development (GDP *per capita*), economic inequality (sectoral Gini coefficients), population density and degree of democracy in 1980, as well as dummy variables for Africa and Asia [39]. The results across six different model specifications show that the greater the degree of polygyny across nations, the higher the percentage of unmarried men. Going from a negligible degree of polygyny (polygyny = 0 nationwide) to widespread polygyny (polygyny = 3 everywhere) increases the size of this excess pool by between 13 and 27 per cent.

Making the second linkage, the electronic supplementary material also shows that the greater the percentage of unmarried men in the national population, the greater the rates of rape, murder, assault, theft and fraud, controlling for the same variables in the regression described above. The percentage of unmarried men is a highly significant predictor of all these crime rates, except assaults where it is only marginally significant. In fact, the percentage of unmarried men is the only predictor that is consistently important across all five felonies. For rape and murder, adding the percentage of unmarried men to a regression with all the other variables increases the variance explained from 33 to 45 per cent and from 12 to 24 per cent, respectively. For assault, theft and fraud, the variance explained increases by about 5 per cent when the percentage of unmarried men is added as a predictor.

While providing an important step, we should not place too much confidence in these findings because (i) the measure for the degree of polygyny is crude, (ii) the data on inequality is incomplete, and (iii) using aggregate cross-sectional data at the country level limits inferential power. More work is needed to extend this preliminary analysis. Nevertheless, these findings converge with the crime-reducing effects of marriage and with the suppression of intrasexual competition shown above. Further, given these other results, it is difficult to argue for reverse causality in these regressions, that a greater surplus of unmarried males causes more polygyny, or that more crime causes men to forgo marriage (independent of income, etc.).

Analyses done within countries allow us to further strengthen the case for a causal relationship between an excess of unmarried males and crime, while avoiding the pitfalls of cross-national analyses. Unequal sex ratios have arisen in a variety of circumstances, most notably in modern India and China, where parental preferences for sons have shifted the sex ratio in favour of males [40], and on frontiers, such as in the American West. The empirical patterns from all such diverse cases tell the same story [40,41]: unmarried low-status men, often in bachelor-bands, engage in higher levels of aggressive, violent and anti-social activities. India and China are particularly informative since the data quality permit econometric analyses aimed at assessing causal relationships.

In China, sex ratios (males to females) rose markedly from 1.053 to 1.095 between 1988 and 2004, nearly doubling the number of unmarried or 'surplus' men [42]. At the same time, crime rates nearly doubled—90 per cent of which were committed by men. An increase in sex ratio was created by the gradual implementation of China's one-child policy, as well as by the ongoing demographic transition. The fortuitous fact that different provinces implemented the policy at different times for reasons unrelated to crime rates creates an opportunity for statistical analyses of the impacts of the policy and the alterations in sex ratio it produced. The implementation date of the policy across provinces provides an exogenous variable that can be used to establish the direction of causality.

Regression analyses [42] show that a 0.01 increase in sex ratio is associated with a 3 per cent increase in property and violent crimes, controlling for a number of demographic and economic variables. These analyses also indicate that the effect arises from an increase in the number of unmarried men and not the overall number of men. Increases in inequality, unemployment and urbanization also have positive effects on crime rates, but the effect of sex ratio is independent of these. To preclude the possibility that measurement errors in sex ratio correlate with crime rates, Edlund *et al.* [42] use the implementation year of the one-child policy as an instrumental variable in a two-stage least-squares analysis. They use implementation year to predict sex ratio, and then use the predicted (unbiased) sex ratio data to predict crime. This indicates that a greater surplus of males *causes* crime rates to increase. For more details see the electronic supplementary material.

In India, Dreze & Khera [43] show that sex ratio differences across districts are strongly associated with murder rates, controlling for many other factors. The effect is large: going from a male to female ratio of 1.12 (in Uttar Pradesh) to 0.97 (in Kerala) cuts the murder rate by half. Moreover, controlling for many other factors, the authors show that males living in districts with more males relative to females are more likely to commit murders; that is, the average male gets more murderous (takes more risks) when the intrasexual competition is higher. This is important because otherwise the increase in murder rates could be attributed merely to an increase in the number of males.

Historical data also link disproportionately large shares of unmarried men to higher crime, violence and drug abuse. Drawing on a range of evidence, Courtwright [41] argues that the violent character of the American West arose principally from the large pool of unmarried men who migrated there. Variation in

crime rates in nineteenth century America corresponds to the spatial distribution of biased sex ratios. Over time, as sex ratios move towards unity in different regions, crime rates drop in those regions. Courtwright suggests that similar cases can be made for Australia's frontier in New South Wales and for the Argentinean Pampas.

Anthropological data provide an additional line of support for this view. In many non-industrialized societies, young unmarried men form groups of marauders who go on raids to steal wealth and wives, while raping and pillaging. Polygynous societies engage in more warfare [44], often with the goal of capturing women [1]. Cross-cultural analyses, though crude, indicate that polygynous societies also have more crime relative to more monogamous societies [45]. Ethnographic cases show why this is: among the Kuria in Tanzania, young males lacking sisters—who would bring substantial bridewealth—are much more likely to engage in cattle raiding, which they see as necessary to obtain sufficient resources to enter the polygynous marriage market [46]. The electronic supplementary material provides additional anthropological material.

This line of reasoning converges with three other areas of research. First, within economics, work on tournament theory predicts that when incentive gradients are steep (e.g. winner-take-all competitions), individuals should often prefer riskier strategies, especially when they are losing or perceive themselves as unlikely to win. These decision-theoretic models [47], which hinge on the same logic as our evolutionary approach [48], predict that even those who perceive themselves as winning or likely to win often need to pursue somewhat riskier strategy when incentive gradients (analogous to fitness gradients) are steeper, because they know that those who are currently losing will be pulling out all the stops. Empirically, field evidence from mutual funds, golf [49,50], auto-racing, distance running, basketball and poker shows that probable losers take more risks, and that both the size and spread of monetary prizes predict riskier choices by everyone [51]. Mutual fund managers [52,53], for example, who find their fund's performance behind other funds in the same category at mid-year, reallocate into riskier portfolios relative to those who did well in the first half of the year (a fund's ranking influences capital inflow, which influences managers' compensation). In auto-racing [54], races with larger spreads among the prizes have more accidents (accidents occur when drivers take risks that fail). Even in the laboratory, behavioural experiments show that players who are currently losing pursue the risky strategy more frequently (unless the outcomes of risky choices are highly correlated), and the choice of the risky strategy by the leading player depends on how big his lead is [55]. This work in economics supports earlier laboratory work by evolutionary psychologists showing similar effects [56].

Second, much empirical work from public health and psychology shows how increasing the steepness of the status/income hierarchies within societies influences outcomes in ways consistent with much evolutionary theorizing. Controlling for other variables, populations with steeper income gradients (more inequality) have worse social outcomes, based on evidence related to crime, violence, drug abuse, education and longevity [57]. Several of these patterns have been examined not only across nations but also among states within the US, and even among Chicago neighbourhoods [56,58].

Third, we posited that heightened intra-sexual competition influences crime rates and personal abuses—in part—by increasing individuals' risk tolerance and temporal discounting. While these specific proximate psychological mechanisms are not crucial to the larger theory, we note that existing experimental work provides preliminary support by showing that (i) prisoners are willing to risk greater financial penalties compared with students in identical behavioural experiments [59], (ii) inter-temporal choice experiments show that both drug addicts and smokers discount the future more steeply than control groups [60,61], and (iii) risk-preference experiments indicate that drug users are less risk-averse compared with non-users [62]. Thus, such preliminary evidence suggests that crimes and personal abuses tend to be committed more by those who are relatively more inclined towards risky choices and future discounting.

(ii) *Implication: monogamous marriage reduces the spousal age gap, gender inequality and fertility*

Polygynous marriage increases competition for wives, as married men remain on the marriage market. This increased competition drives down the age of first marriage for females and increases the spousal age gap. The reduced supply of unmarried women, who are absorbed into polygynous marriages, causes men of all ages to pursue younger and younger women. The competition also motivates men to use whatever connections, advantages or alliances they have in order to obtain wives, including striking financial and reciprocal bargains with the fathers and brothers of unmarried females (see electronic supplementary material for North American examples). Once adolescent girls and young women become wives, older husbands strive to 'protect' their young wives from other males (guarding the paternity of any offspring) and dominate household decision-making. More competition also motivates men to seek to control their female relatives (e.g. sisters), as demand for wives increases. This results in suppressing women's freedoms, increasing gender inequality and stimulating domestic violence. Women's loss of influence on household decision-making and their lower age of marriage results in higher fertility. By contrast, normative monogamy diffuses the pressure to bring younger brides into the marriage market, and thereby reduces the spousal age gap, male efforts to control ('protect') women, gender inequality and total fertility. We address below whether the effects on gender equality or the spousal age gap create—in themselves—any group-level benefits.

Table 1 compares (i) highly polygynous countries (HPCs) in which more than 10 per cent of married men have two or more wives, (ii) less-polygynous African countries (LPACs) in which less than 10 per cent of married men have two or more wives, (iii) comparable monogamous countries (CMCs) that lie between 20° North and South latitudes (developing countries), and

Table 1. Comparison of data from highly polygynous, less polygynous and comparable monogamous countries. In highly polygynous country, more than 10% married men have more than two wives. Adapted from Tertilt [63].

variables	highly polygynous countries	less polygynous African countries	comparative monogamous countries	North America/ Western Europe
no. of countries	28	20	58	24
female age at first marriage	19.9	22.7***	25.0***	29.6***
age gap (first wife only)	6.4	3.9***	2.8***	2.4***
total fertility	6.78	5.97**	4.62***	1.84***
child mortality rate, 1980 (%)	19.4	18.3	11.6**	1.4***
infant mortality rate, 1980 (%)	12.2	11.5	6.9**	1.2***
GDP *per capita*, 1985 (US$)	975	1574*	2798***	11 950***

*$p < 0.05$ (indicates comparison with highly polygynous countries).
**$p < 0.01$.
***$p < 0.001$.

(iv) North America and Western Europe, which provide a reference point. The HPCs are all African save for Bangladesh and Kuwait. The variables are mostly self-explanatory, though note that age gap gives the difference between the mean age of the husband or wife at their respective *first* marriages. In a polygynous society, the gap would further increase if the mean age for males included all subsequent wives [63,64].

HPCs have the lowest age of first marriage for females at 19.9 years, and the largest age gap between husbands and their first wife. The age of 19.9 years is significantly lower than in LPACs (at 22.7 years) and much lower than CMCs, where the mean age is 25. In HPCs, 36.7 per cent of women are married between the ages of 15 and 19. The age gap increases from 2.8 years in CMCs to 6.4 years in HPCs. In HPCs, the age gap goes as high as 9 years. Fertility drops from 6.78 in HPCs to 4.62 in CMCs. Similar patterns are obtained if one uses GDP *per capita* instead of latitude to create these categories [63].

These patterns are supported by other analyses. Using a country-level measure of the degree of polygyny, regression analyses also show that greater polygyny is associated with (i) lower ages at first marriage for females, (ii) larger spousal age gaps, and (iii) higher fertility rates, controlling for GDP [65]. The electronic supplementary material also reviews convergent findings derived from comparing monogamous and polygynous households within the same society.

(iii) *Implication: normative monogamy increases gross domestic product* per capita

Tertilt [63] constructed a decision model to investigate how marriage systems influence economic productivity and fertility. She assumes that men and women both care about having children and consuming other goods, but that men can continue to reproduce their entire lives, while women are limited to only a portion of their lives. She shows that this model produces polygynous mating patterns under a wide range of conditions, and that once calibrated, it generates predictions that qualitatively fit the empirical patterns of polygynous countries. Tertilt then uses the model calibrated to HPCs to investigate what would happen if monogamy were imposed on everyone. The model predicts that: (i) fertility rates go down, (ii) spousal age gaps shrink, (iii) saving rates increase, (iv) bride prices disappear, and (v) GDP *per capita* goes up substantially. The main cause of these effects is that men cannot invest in obtaining additional wives or selling daughters, so instead they have fewer children, invest in production, and both save and consume more. That is, the population looks less like a HPC and more like a CMC.

Interestingly, Tertilt [64] shows that imposing monogamy has a much bigger effect on GDP *per capita* than increasing the decision-making power of women. To explore this, Tertilt alters her model so that reproductive decisions are made by women instead of men, but permits polygyny. In this version of the model, the number of wives per husband declines a bit (monogamy does not emerge), as does fertility. GDP *per capita* increases and saving rates go up substantially, but the magnitudes of the effects are much smaller than the effects of imposing monogamy. This suggests that cultural group selection should act most directly on social norms that fortify monogamous marriage rather than directly on those that increase gender equality.

(b) *Normative monogamy reduces intra-household conflict*

Our reasoning predicts that increasing the extent and intensity of polygynous marriage will increase conflict within households because it (i) creates competition among co-wives, (ii) expands the spousal age gap, (iii) decreases the relatedness within households, and (iv) reduces paternity certainty (which increases male sexual jealousy). Allocations of household resources to another wife's children mean fewer resources for one's own children. Since co-wives are generally unrelated to each other and to each other's offspring, genetic relatedness does not provide the same degree of prophylaxis against intra-household violence as in monogamous households. Overall, lower mean

relatedness and more unrelated pairs in polygynous households mean a greater threat of abuse, violence and homicide. By contrast, normative monogamy (i) eliminates conflict between co-wives, (ii) decreases child abuse, neglect and homicide by increasing the mean relatedness in households and reducing the number of unrelated adult–child dyads, and (iii) reduces spousal homicide and domestic abuse by decreasing the spousal age gap, male mate competition and paternity uncertainty, and by increasing the age of women's first marriage.

Co-wife conflict is ubiquitous in polygynous households. From anthropology, a review of ethnographic data from 69 non-sororal polygynous societies from around the globe [66] reveals no case where co-wife relations could be described as harmonious, and no hint that women's access to the means of production had any mitigating impact on conflict. Consistent with this, an in-depth study of a fundamentalist Mormon community in the US [67] found substantial conflict among co-wives. The electronic supplementary material provides more background and reviews additional evidence. From health psychology, a comprehensive review of psychological studies [68] concludes that children from polygamous families experience higher incidences of marital conflict, household violence and family disruptions than do children of monogamous families. This work also suggests that the creation of step-parents is more common as men often leave their first wives to be with their newer wives, but they keep the children, which opens the door for abuse and neglect by unrelated mothers.

Polygynous marriages also create elevated risks of intra-household abuse, neglect and homicide because such households have lower average relatedness, and more unrelated dyads. Each additional wife is unrelated to the existing co-wives, and to all of these wives' children. The number of unrelated dyads in such a household, in fact, increases with the square of the number of wives (see electronic supplementary material). Much empirical work in monogamous societies indicates that higher degrees of relatedness among household members are associated with lower rates of abuse, neglect and homicide [69,70]. Living in the same household with genetically unrelated adults is the *single biggest risk factor* for abuse, neglect and homicide of children. Stepmothers are 2.4 times more likely to kill their stepchildren [71] than birth mothers, and children living with an unrelated parent are between 15 and 77 times more likely to die 'accidentally' [72].

Converging with these ideas is long-term research in the Caribbean, which shows how different household compositions impact cortisol levels (a stress hormone) in children. Children in nuclear families with only genetic parents showed the lowest cortisol levels. By contrast, children in households with distant relatives, stepfathers and half-siblings showed the highest cortisol levels of any household composite in the sample [73]. This suggests that the children of polygynous households will run higher cortisol levels owing to the presence of unrelated mothers and half-siblings.

The above-described effects of relatedness emerge from work in monogamous societies, so one could argue that they are somehow not applicable to polygynous households. However, research among fundamentalist Mormon communities reveals that the effects of relatedness are evident within polygynous households: full siblings show greater association, effect, solidarity and altruism when compared with half-siblings in the same household [74].

Finally, as explained above, normative monogamy may reduce spousal homicide, domestic violence and the use of physical coercion by decreasing the spousal age gap, gender inequality, paternal uncertainty and mate competition. Research indicates that both spousal age gaps and paternity uncertainty are important predictors of spousal homicides [75]. Meanwhile, cross-national regressions reveal that stronger monogamous marriage norms are associated with less (i) domestic violence, (ii) maternal mortality, (iii) female genital mutilation, and (iv) sex trafficking, even after controlling for GDP [65]. The electronic supplementary material expands these points.

Before proceeding, we emphasize that it is not entirely clear that reducing the spousal age gap, intra-household conflict or gender inequality will increase success in inter-group competition. However, here are three reasons to suspect that this might be the case. First, later marriage and less conflict means a greater fraction of children in a society will be reared by older, more skilled mothers who have had more time to acquire experience and education. These women will have more influence in household decisions and thus have fewer children. These factors can create group advantages in socioecologies in which greater parental investment improves cognitive abilities or skills, increases trust, or instantiates patience. Second, the lower childhood mortality and better health outcomes created by greater parental investment implies that resources are not 'wasted' on children who never become productive adults. Third, in addition to fully harnessing the economically productive talents of women, reducing gender inequality may suppress the tendency for polygynous societies to culturally evolve norms and institutions aimed at controlling women, such as arranged marriage, female circumcision, purdah (seclusion of women) and brideprice [76], many of which appear costly at the societal level. However, even if reduced gender inequality and household conflict spread merely as by-products of cultural group selection operating to reduce crime rates (to increase trade and reduce transaction costs), they still provide predictions to test the more general theory.

(i) *Monogamous marriage increases paternal investment and improves childhood outcomes*

Increasing polygynous marriages decreases overall male parental investment by (i) eliminating opportunities for low-status males to establish pair-bonds (and invest in offspring), (ii) diluting the per-child investment in larger families, and (iii) shifting investment by high-status males from offspring into obtaining more long-term mates. While allowing the resources of richer men to be distributed among more children, the net effect of polygyny on male parental investment will often be to reduce the average investment

per child. Normative monogamy provides increased opportunities for low-status males to marry, save and invest for the long term. The labour and talents of these would-be risk-taking criminals (and/or substance abusers) are instead channelled into long-term investments in family and child-rearing (reliable economic productivity). Their pair-bonding and paternal investment psychologies are tapped and harnessed relatively more than their risky, status-seeking mindsets. For married high-status males, normative monogamy raises the cost of seeking additional mates and thereby shifts efforts from mate-seeking to improving offspring quality.

We lack direct evidence for the effect of monogamous marriage on paternal investment, though ethnographic accounts suggest, for example, that highly polygynous fathers do not even know all of their children's names [77]. Nevertheless, both cross-cultural and historical evidence do indicate that the children of polygynous households have worse health outcomes compared with those in monogamous households, even after controlling for wealth, income and other demographic differences. We suspect that part of this difference results from the increased paternal investment in monogamous families, though it may also arise from the associations of monogamy with lower rates of household conflict, maternal mortality [65] or psycho-social stress (see the electronic supplementary material).

In Africa, diverse studies show that, relative to children from monogamous households, children from polygynous household risk diminished nutritional status, poorer health outcomes and elevated mortality. Table 1 shows that both infant and child mortality in HPCs are roughly twice that of CMCs. Much work supports this view [78–81]. Using data from 22 sub-Saharan African countries, Omariba & Boyle [80] found that children in polygynous families were 24.4 per cent more likely to die compared with children in monogamous families. Similarly, a study of six West African countries found that infants in polygynous families had a substantially greater risk of dying compared with children in monogamous households [82]. Community-level studies in Tanzania and Chad found that children in polygynous households had poorer nutrition than their counterparts in monogamous households from the same communities [83–85]. See electronic supplementary material for details.

Similar effects occur in North America. Using data from nineteenth century Mormons, Heath & Hadley [25] compare data from 90 households consisting of 45 headed by wealthy men (top 2% of wealth in that community) and 45 headed by poor married men (from the bottom 16%). These data show that wealthy males had on average 3.2 wives compared to 1.4 among the poor. All but five of the wealthy men had more than one wife. One rich man had 11 wives. Overall, the wealthy men controlled 120 women while the poor controlled 63. This means that 90 husbands had 183 wives, which implies roughly 93 missing men had no wives. While wealthy men had more total offspring and longer reproductive careers (33 years for wealthy men compared to 22 for poor men), the children of poor men had better survival rates for their children to age 15. For poor men, 6.9 of their offspring (per wife) survived on average to age 15, while for wealthy men only 5.5 of their offspring (per wife) survived to age 15. This is amazing, given that the poor men had less than 10 per cent of the wealth of the rich men, and the rich men had significantly more total offspring (including those that did not make it to 15). Perhaps, most telling is a comparison of rich with poor men, both with one or two wives: poor men's children out-survived rich men's 6.9 to 5.7 (mean number of offspring surviving to age 15 per wife). This supports the idea that poor men with insufficient resources for another wife tend to invest more in their existing offspring while rich men with the same number of wives invest less in offspring because they are expending resources seeking additional wives (see electronic supplementary material).

4. DISCUSSION

We propose that the unusual package of norms and institutions that constitute modern monogamous marriage systems spread across Europe, and then the globe, because of the package's impact on the competitive success of the polities, nations and religions that adopted this cultural package. Reducing the pool of unmarried men and levelling the reproductive playing field would have decreased crime, which would have spurred commerce, travel and the free flow of ideas and innovations. Greater security would have reduced transaction costs and both public and private security expenditures. Instead of engaging in risky status-seeking endeavours, low-status males would be more likely to marry, thus becoming risk-averse and future-oriented, and focus on providing for their offspring in the long run. Higher status males, instead of seeking to attract additional wives, would make long-term investments and attend to their offsprings' security. More personal security and less crime would have meant that many more individuals could shift to investing in long-term payoffs, including businesses, apprenticeships and education. Reduced demand for brides would have increased the age of first marriage for women and gender equality, which would have reduced total fertility. These expectations are broadly consistent with historical patterns in pre-modern England during the lead up to the industrial revolution [86].

The conditions in which inter-group competition favours normative monogamy are probably limited to situations involving competition among very complex human societies: those with substantial divisions of labour, well-developed commerce, inter-community trade, standing armies and highly skilled occupations. Competition among less complex societies need not favour normative monogamy. Some circumstances, such as those in which subsistence economies are dominated by female or child labour, would appear to favour greater polygynous marriage. When inter-group competition relies on large numbers of motivated young men to engage in continuous raiding and warfare to obtain resources, slaves, territory and concubines, groups with greater polygyny may generate larger and more motivated pools of males for these risky activities. If these larger pools of men more effectively expand their territories, populations and resources at the expense of

groups that constrain this pool, cultural group selection could favour greater polygyny. Supporting ethnographic cases are numerous [46,87], and cross-cultural analyses confirm several of the above proposed associations [44].

Religion may also be important in the spread of normative monogamy. The infusion of norms related to monogamous marriage into the supernaturally reinforced set of beliefs propounded by Christianity [88] may have been crucial to the long-term success of this marriage system and one element in the set of effects on religion created by cultural group selection [89]. The central challenge to monogamous marriage norms comes from wealthy and politically powerful men who have substantial fitness-related motivations and incentives to resist such practices. Imbuing monogamy with supernatural sanction, including the ability to create legitimate, divinely recognized, heirs in hereditary monarchies may have made all the difference in the pre-industrial world.

More generally, it is important to realize that the evolutionary processes we have highlighted should be thought of as favouring cultural practices that are 'polygyny-inhibiting', with prescriptive monogamy at the extreme. Islam, for example, contains polygyny-inhibiting elements [90] that attempt to constrain men's ability to accumulate wives by (i) placing an upper limit of four wives, (ii) requiring men to deal justly with all of their wives, and (iii) permitting a potential bride to contractually stipulate that her marriage becomes invalid if her husband marries again.

Other economic and evolutionary approaches posit that monogamous marriage arises from some form of fitness- [17] or utility-maximizing [18] decision. Such models are useful if they help us understand how cultural evolution could shape sets of inter-related social norms and institutions. There is little doubt that norms about spousal number, for example, coevolve with norms regarding inheritance, transfer payments and sexual fidelity. However, as the electronic supplementary material explains, such non-cultural approaches fail to account for (i) the normative nature of marriage systems (third-party condemnation of norm violators), (ii) the broad historical patterns in the expansion of monogamous marriage, (iii) the lack of polygynous marriage among wealthy North Americans, or (iv) the persistent challenges that nation states face in suppressing the spread of polygynous communities. Moreover, such accounts would have to assume that the empirical patterns we reviewed above are mere epiphenomena, which did not impact cultural evolution.

In closing, it is worth speculating that the spread of normative monogamy, which represents a form of egalitarianism, may have helped create the conditions for the emergence of democracy and political equality at all levels of government [7,91]. Within the anthropological record, there is a statistical linkage between democratic institutions and normative monogamy [92]. Pushing this point, these authors argue that dissipating the pool of unmarried males weakens despots, as it reduces their ability to find soldiers or henchman. Reduced crime would also weaken despots' claims to be all that stands between ordinary citizens and chaos. Historically, we know that universal monogamous marriage preceded the emergence of democratic institutions in Europe, and the rise of notions of equality between the sexes (see our historical sketch in the electronic supplementary material). In Ancient Greece, we do not know which came first but we do know that Athens, for example, had both elements of monogamous marriage and of democracy. In the modern world, analyses of cross-national data reveal positive statistical relationships between the strength of normative monogamy with both democratic rights and civil liberties [65]. In this sense, the peculiar institutions of monogamous marriage may help explain why democratic ideals and notions of equality and human rights first emerged in the West [6].

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ELECTRONIC SUPPLEMENTARY MATERIALS FOR

THE PUZZLE OF MONOGAMOUS MARRIAGE

CONTENTS

MATING STRATEGIES

Evolutionary approaches to human mating psychology, and in particular to the differences between male and female mating strategies, focus on the distinct selective pressures faced by males versus females. An essential difference in male and female mating psychology arises from two basic facts about primate (and mammalian) physiology: (1) females invest heavily in the egg compared to the paltry investment that males make in the sperm, and this asymmetric investment only increases as females subsequently must invest in gestation, lactation, and parenting if their offspring is to survive, and (2) females are limited in their lifetime reproductive output (their direct fitness) to the number of babies they themselves can carry to term and rear to adulthood. Meanwhile, males can potentially father thousands of offspring and invest nothing other than sperm. This difference spawns another pattern that will be relevant below: the variance in reproductive success is much lower for females compared to males. Women will have typically at most 18 offspring,[1] a number that was much lower for most of our evolutionary history. For men, offspring production can range from zero to thousands [2-4]. At the top end, some men (e.g., Genghis Khan) had so many reproductively successful offspring that their impact has been argued to be measurable in the human genome [5]. At the bottom end, low-status males have been routinely shut out from successful reproduction.

The same logic predicts a difference in "choosiness" with regard to mates (that is, differences in willingness to have sex). Because females can produce only a limited number of offspring, and each requires substantial investments of time and energy, female mating psychology favours selectively mating with high quality mates based on genetic quality and access to resources (for rearing the offspring). Any sexual encounter could result in two decades of intense investment. Males, who can potentially invest very little, should be less choosy, and focus mostly on the fertility and genetic quality of potential mates. This means, at the low end of reproductive success, almost any female can manage to get pregnant because some males are always willing to make the minimal investment necessary. In contrast, males that are both low-status and low genetic quality could easily end up leaving no offspring since females are choosy about with whom they mate. Empirical evidence from diverse societies broadly supports these differences in mating preferences [4, 6-8].[2] For our purposes, these data show specifically that women tend to prefer males with more resources and greater social status [10], while men tend to prefer younger, more attractive, women who are capable of successfully rearing healthy and robust offspring.

This approach suggests that males are the "risky" sex, and predicts both psychological and physiological responses to the steepness of the status hierarchy (the intensity of intra-sexual competition). For example, males who finds themselves without prospects for access to females should (1) heavily discount the future and invest achieving higher status now, and (2) be willing to

[1] There are a variety of aberrant cases that dramatically exceed this numerical guideline. The highest recorded number of children born to one woman is 69 (in Russia between 1725 and 1765). This involved 27 pregnancies resulting in 16 pairs of twins, 7 sets of triplets, and 4 sets of quadruplets. Some have questioned the veracity of this claim. The important point is that even this extreme case does not compare to a long list of despotic rulers from across the globe [1].

[2] There is much important cross-cultural variation in the relative strength of these preferences. Interestingly, consistent with evolutionary predictions, some of the variation in the importance of attractiveness (relative to other attributes) is predicted by the prevalence of pathogens and parasites in the environment. When pathogens and parasites are more dangerous, genetic quality (as indicated by attractiveness) is relatively more important because this predicts a resistance to pathogens and parasites [9].

take substantial risks aimed at increasing opportunities for status/sex (e.g., theft, murder, etc.), lest they get shut-out for certain. Ample empirical evidence indicates that males have a much greater propensity for taking risks of all kinds, especially when status is at stake [2, 3, 11, 12]. This means that social factors that flatten the outcomes of status differences or decrease reproductive competition will shift males away from high-discounting and risk-taking. These psychological and physiological shifts toward long-term investment in response to reduced competition may improve both health and educational outcomes for men.

However, central to understanding human mating and mating psychology is to recognize that humans, like some other primate species, form lasting pair-bonds. Gorillas, for example, form lasting pair-bonds in which males "mate guard" to both prevent other males from gaining sexual access to their partners, and protect their offspring—which they know are "theirs" if they have done a good job of mate guarding previously. However, unlike gorillas, human males in pair-bonds care—to varying degrees—for the offspring of their partners. This has been observed even in the smallest scale human societies, especially among foraging populations [13]. Human males, much more than all other primates, invest in at least some of their offspring for many years.[3]

Efforts to reconstruct the pre-cultural (pre-marriage norms) mating systems of human ancestors are necessarily speculative. A recent comprehensive effort [14] suggests that the common ancestor to chimpanzees and humans probably had a single-male mating system, like gorillas (who happen to share a common ancestor with humans and chimpanzees). In different ecological conditions males will be limited in the number of females that they can defend access to. If resources are widely scattered and scarce, single-male mating systems can turn into a mixture of groups, some involving monogamous pair-bonds and others involving one male and multiple females. Pair-bonding initially started out as mate guarding but as our lineage's brains began to expand, paternal contributions to subsistence and cultural transmission became increasingly crucial. This, and a variety of other evolutionary pathways, suggests that men possess psychological mechanisms for both mate guarding (to ensure paternity) and for regulating investment in offspring, while considering both their paternity certainty and the cost of additional mating opportunities [15, 16].

For men this creates two different kinds of reproductive strategies, one based on developing long-term pair-bonds and one based on seeking short-term (often, very short) mating opportunities (extra-pair copulations). The selection pressures for the two strategies are somewhat different. For short-term mating, males should focus principally on females showing cues of fertility (ovulation) and health. For selecting long-term mates, to mother the offspring that the male will invest in, males should desire females who are young, healthy, fertile, emotionally stable, motherly, hard-working, and of suitable and compatible personal characteristics. Since a male's desire to invest in offspring is strongly related to his beliefs about his paternity, males in long-term pair-bonds should always be concerned with the sexual fidelity of their mates—but they should be most concerned when intra-sexual competition is fierce and some males have limited or no reproductive opportunities. Both strategies can be operative at the same time, although the decision to invest in offspring and in pair-bonding necessarily shifts attention, resources, and affective commitments (including hormonal shifts) away from seeking short-term mates. Substantial evidence from psychological experiments support these predictions [3, 17-20].

[3] Note, the term "pair-bond" does not mean monogamy. One male gorilla can pair-bond with multiple females. Each of these is an independent durable relationship that facilitates the safe rearing of offspring.

Human female mating psychology also has two flexible strategies [14, 21], but they are different from males' strategies in crucial ways. Successful reproduction, at least in ancestral human societies, probably required pair-bonding with a male, establishing his beliefs about paternity, and obtaining as much of his investment in her and her offspring as possible.[4] In long-term mates, females look for a combination of the ability to invest in the form of resources and skills/abilities [10], some willingness to invest, physical size, and genetic quality. Extra-pair copulations do not improve a female's fitness in the same dramatic way they do a male's fitness. As noted, females have a limited number of times they can be pregnant in their lives, and they "want" (from a fitness perspective) to make each one count (get a high quality offspring). Once pair-bonded, it is more important for a female to appear chaste, since hints of sexual infidelity will reduce a male's paternity certainty and his investment in offspring.

Human females' other mating strategy comes into play when extra-pair copulations provide an opportunity to obtain higher quality genetic material (i.e., sperm), or other direct investment, while still retaining investment from their current partner. Much recent evidence supports this by showing how women's mate preferences shift during ovulation. Around the time of ovulation women's relative preferences for high genetic quality increases while their interest in resources decreases; they are also more interested in sex with men besides their long-term partner [23-25].

For males, the fitness maximizing situation is probably to have as many matings as possible, and have other males invest heavily in rearing their offspring (cuckold other males). However, since low-status males of low genetic quality will have limited mating prospects, they should shift toward long-term pair-bonding and parental investment assuming they can get at least one long-term mate. Higher-status males should shift the balance toward parental investment as their mating prospects diminish or become too costly. Social factors that (1) make mates available to low status males (who would otherwise not have them) and (2) increase the costs for higher status males of obtaining additional mates (either long or short-term mates) will increase overall parental investment by males. This suggests that suppressing intra-sexual competition should foster familial investment, savings, and security-seeking in males [2, 3, 12, 26].

PRIMATE MATING SYSTEMS

The interaction of different mating strategies by male and females in different ecologies yields diverse primate mating systems. Table 1 summarizes data on primate mating systems. Under the column "Mating System," males in "Multi-male polygyny" groups defend access to groups of females. Here there are no long-term mating-related associations between males and females (no pair-bonds). Within groups, males still compete for access to females when females become sexually receptive (that is, when they can get pregnant). Females typically signal their entry into this period with changes in colouration, or by presenting their hind quarters. Status competitions and consequent social rankings determine the frequency of mating with receptive females, although within-group males of lower rank are still given some access. A receptive female chimpanzee, for example, may end up mating at least once with most adult males in a group. Such multi-male groups contrasts with "Single-male polygyny," which means that some individual males successfully associate with, and limit access to, groups of females. Other males have no access to these females. Gorillas, for example, live scattered in small groups with one dominant male who defends (or guards) several adult females, and their offspring. Bands of subordinate "bachelors" also roam

[4] If males lack confidence in their paternity of offspring, they tend to invest less [11, 22].

these forests, occasionally challenging dominant males. Beginning with humans, the first column orders these categories according to their phylogenetic distance from humans. Humans are a type of Great Ape, and most closely related to chimpanzees, then gorillas and orangutans. Gibbons are a type of Lesser Ape, which share a common ancestor with all the Great Apes. All apes are equally distant from Old World Monkeys.

Table 1: Primate Mating Systems

#	Primate	Phylogenetic category	Mating system
0	Humans	Great Ape	see below
1	Common chimpanzee	Great Apes	Multi-male polygyny (no pair-bonds)
2	Gorilla	Great Apes	Single-male polygyny (pair-bonds)
3	Orangutan	Great Apes	Single-male polygyny (pair-bonds)
4	Gibbons	Lesser Apes	Monogamous (pair-bonds)
5	Colobines (from multiple genera)	Old World Monkeys	Single-male polygyny (pair-bonds)
5	Old world monkeys (from multiple genera)	Old World Monkeys	Multi-male (no pair-bonds)
5	Hamadryas and gelada baboons	Old World Monkeys	Single male polygyny (pair-bonds)
6	New world monkeys (from multiple genera)	New World Monkeys	Multi-male polygyny
6	New world monkeys	New World Monkeys	Monogamous (pair-bonds)
6	Marmoset/tamarin	Callitrichidae (New World Monkeys)	Monogamous and sometimes polyandrous (pair-bonds)

Putting the complicated question of humans aside, there are no Great Apes that mate monogamously or polyandrously [14, 27]. Gibbons, a Lesser Ape, do pair-bond monogamously, and together defend territories with their mates. Otherwise, only a few groups of New World Monkeys pair-bond monogamously. Saddleback tamarins are highly variable, and include groups that are monogamous and polyandrous, with some that are even multi-male. While active parental investment by males in offspring is extremely rare in primates, when it does occur it is always closely associated with monogamous mating systems. Monogamous male primate species invest in their offspring, unlike all other primates. Similar patterns hold in birds [28].

MARRIAGE SYSTEMS

Marriage systems are distinct from mating strategies. Humans, unlike other species, are heavily reliant on cultural learning for acquiring all manner of behaviors and practices, including social behavior. Because humans also acquire the standards by which we evaluate others as part of this process, cultural evolution gives rise to social norms [29-31]. Social norms are shared standards of behavior that emerge readily from a reliance on cultural transmission. Failure to meet minimal standards results in reputational damage, loss of status, and both formal and informal sanctions. Some norms also incentivize excess performance by providing reputational benefits for actions that

are above and beyond the normative standard [29]. In some societies having more wives is both a signal and a source of prestige [32] for males, see below. It is only in cases of marriage systems based on normative monogamy that adding wives is viewed negatively. Even in societies with substantial polyandrous marriages, people marrying polygynously are not viewed negatively.

Different societies have culturally evolved a wide range of social norms and institutions that regulate pair-bonds—these are marriage systems. Marriage systems influence peoples long-term pair-bonds based on locally shared behavioral standards that are enforced by the community. Being married comes with economic, social, and sexual expectations, prescriptions, and prohibitions (norms) for both parties (and their families), who are accordingly judged—formally or informally—by the community. Marriage may or may not be sanctioned by formal laws, and marriage certainly existed long before formal laws. Public rituals usually mark the commencement of a marriage. "Cohabitation," which is empirically distinguished from marriage in the main text (in terms of how marriage impacts crime), does not carry the set of shared expectations, prohibitions, and prescriptions, as judged by *a community*, that marriage does. The key to understanding marriage vs. merely pair-bonding is recognizing the role of a community in defining, sanctioning, and enforcing it. This element of human social life is routinely missed in non-cultural evolutionary and economic approaches to monogamy

Marriage systems represent collections of social norms that harness and extend our evolved psychology for forming long-term pair-bonds. Marriage norms, for example, govern such areas as who (1) a person can marry (e.g., exogamy, incest taboos), (2) pays for the marriage ritual, (3) pays for which spouse (dowry or brideprice[5]), (4) gets the children in the event of the groom's (or bride's) death, and (6) is a "legitimate" heir of the couple. For our purposes, marriage norms also specify rules about partner number, and arrangement of partners (e.g., no group marriages). A *marriage system* is the package of marriage-related norms in a society.

Marriage norms are certainly not independent of our mating psychology, nor can they entirely replace or subvert it. They can, however, strongly influence behavioral patterns in two ways. First, humans readily internalize social norms, at least partially. This means that norm adherence is intrinsically rewarding [31]: work in neuroscience has shown how both adhering to local norms and punishing norm violators activates the brain's reward circuitry [34]. Second, the fact that people acquire and internalize norms means that any norm-violator may be condemned and sanctioned in some way [35]. Thus, independent of any internalization, norms impose real costs on norm violators. Of course, some cultural evolutionary trajectories have generated sets of norms and institutions that suppress our pair-bonding instincts and dramatically reduce or eliminate paternal investment [36], or manage risk by distributing beliefs about paternity among multiple fathers [37].

Table 2. Marriage Systems in Cross-cultural Perspective

Type	**Ethnographic Atlas N = 1231 societies [33]**
Monogamous	15% (186)
Occasional polygyny	37% (453)
Frequent polygyny	48% (588)
Polyandry	0.3% (4)

[5] A dowry is a payment from the bride's family to the groom and/or his family. A brideprice is a payment from the groom's family to the bride's family. Payments can be in the form of cash, jewellery, animals (e.g., cows, chickens), or other items that have value within the culture.

NATURE AND VARIATION IN NORMS REGARDING SPOUSAL NUMBER

To examine the nature and variation in patterns of human mating, and particularly in marriage patterns, we examine the anthropological record of extant and historically known societies. The most extensive database of such information across diverse human societies is the *Ethnographic Atlas*[6], which currently includes information on marriage for 1231 societies. These data, summarized in Table 2, show that exclusive monogamy occurs in about 15.1% of the sample, polygyny in 84.6% of these societies, and polyandry in less than 1%.

The problem with using all these data straight from the *Ethnographic Atlas* is that the data points are non-independent. That is, many of these societies are probably historically related and have splintered off over centuries from older societies. This leads to the worry that certain traits might be common because certain societies happened to spread. To mitigate this problem, cross-cultural researchers use the Standard Cross-Cultural Sample [40]. This is a sample of 186 preindustrial societies from across the globe that have been selected both to avoid historical connections (which create non-independence) and because of the rich quality of material available for them. Table 3 shows that using this sub-sample we find monogamy is also limited to about 15% of societies.

Table 3. Marriage Systems in the Standard Cross Cultural Sample[7]	**Count (%) N = 176**
Polyandry	2 (1.1%)
Monogamy	27 (15%)
Monogamy with occasional polygyny	33 (19%)
Polygyny preferred (but <20% of male engage)	54 (31%)
Polygyny preferred (> 20% of males engage)	60 (34%)

For our purposes, one problem with these data is that they represent mostly ethnographic observations about how marriage systems actually operate on the ground. For monogamy, they do not separate *normative or imposed monogamy* from *ecological monogamy* [42-44]. By normative or imposed monogamy we mean groups that possess marriage norms that prescribe monogamous marriage and punish violations in some fashion. For some societies with socially-imposed monogamous marriage, there remain debates about whether they should be categorized as "monogamous" [44] since (1) the nobility often retained the right to marry polygynously, such as in Egypt and Babylon (monogamous marriage was imposed on the commoners), and (2) slave concubines were still permitted for those with the means (inheritance rights for offspring varied).

Ecological monogamy describes situations in which there are no prohibitions against having different marital arrangements, but that the economic or ecological circumstances are such that males are not sufficiently different from one another to attract more than a single wife. Some small-scale societies have strong sharing norms that demand the equitable division of economic surpluses across the group. Such levelling will sometimes reduce polygyny to just monogamy, at least during periods of scarcity.

[6] The *Ethnographic Atlas* was first published by Yale anthropologist George Peter Murdock in a series of installments beginning in 1962 and ending in 1980 (published as the *Atlas of World Cultures* in 1980). It represents the single largest coded anthropological database of world cultures. The codes were derived from collections of ethnographic and historical materials. In 1998, Gray [33] produced an updated and corrected version. The *Standard Cross Cultural Sample*, developed by both Doug White and Murdock, is a subsample of the best known cultures, selected so as to maximize historical independence.

[7] Data is drawn from White [38]. This work cross-checks and verifies earlier coding efforts [39-41].

In a detailed study of polygyny, White [38] tried to distinguish the cultural rules of a society from their practices by re-coding the Standard Cross-Cultural Sample looking to distinguish cultural norms from the what happened on the ground. Drawing from White, Table 4 distinguished cases of (1) norm-prescribed monogamy, (2) monogamy preferred but some polygyny, and (3) various degrees of polygyny. The coding for prescribed monogamy is strict in the sense of focusing on the existence of penalties for extra-marital offspring. Monogamy is prescribed in 15% of these societies, and preferred in another 17%. Where monogamy is only "preferred", polygyny inevitably creeps in. Of the 186 societies in the Standard Cross-Cultural Sample, White was able to find normative statements from ethnographers for 183. Meanwhile, direct behavioral observations of those in Table 3 were only available for 176 societies. Regarding the coding used to generate Table 4, White warns that while descriptions appear normative, it's not completely clear they are always prescriptive (p. 534). Thus, Table 4 probably sets an upper bound on the amount of prescriptive monogamy.

Polygynous marriage systems are composed of many parts and much variation exists within the category. White's comprehensive statistical analysis empirically distinguishes two major kinds, or clusters, and one minor category. The major clusters distinguish *sororal polygyny* from *general polygyny*. In sororal polygyny there is substantial normative pressure for a male to marry real or classificatory sisters (who are typically some kind of cousin). This partially solves a major problem with polygynous households: conflict among co-wives over access to the husband and his resources. When co-wives are relatives they can more easily cooperate (humans have an evolved psychology for helping blood relatives), and tend to live in the same house. See Table 5.

Table 4. Cultural Norms	**Count (%) N = 183**
Monogamy prescribed (offspring of non-wives do not inherit)	27 (15%)
Monogamy preferred but some polygyny	32 (17%)
Polygyny for exceptional males (leadership, skills)	45 (25%)
Polygyny for men of wealth, nobility, etc.	33 (18%)
Polygyny preferred for most men. Most older men should have 2+ wives.	46 (25%)

Under general polygyny (meaning non-sororal polygyny), the other major type, wives are rarely sisters and may be quite different in age. Because of conflict among co-wives, each wife often maintains a separate household, or at least a separate hearth. It is under general polygyny that differences in the numbers of wives for each man can get extreme. Globally, sororal polygyny tends to occur in the New World (the Americas) while general polygyny tends to occur in the Old World, and remains common in Africa.

Table 5: Household Arrangements	
Marriage Arrangements	**Ethnographic Atlas % (N = 1267)**
Independent nuclear, monogamous	14.6% (186)
Independent nuclear, polygyny	35.7% (453)
Preferentially sororal, cowives in same dwelling	5.4% (69)
Preferentially sororal, cowives in separate dwellings	1.4% (18)
Non-sororal, cowives in separate dwellings	27% (344)
Non-sororal, cowives in same dwellings	12.4% (157)
Independent polyandrous families	0.32% (4)
Missing data	2.8% (36)

The minor cluster involves societies with sharp social stratification (classes or castes) in which only members of the high class can marry polygynously (monogamy is enforced in the lower classes by the upper classes). Realize also that ascription or assignment to the nobility or high caste is often by birth and blood, not by wealth. This means that rich traders who are of low birth status are limited to one official wife.

As is clear from these data, polyandrous marriages are quite rare. However, four other patterns are important: polyandry is (1) usually fraternal polyandry, meaning brothers marry the same woman, (2) typically found intermixed with other marriage types in the same society, including both monogamy and polygyny, (3) considered to be somewhat unstable with the youngest husbands leaving the marriage, or taking additional wives themselves (giving rise to polygynandry), and (4) principally confined to the Himalayan and, to a lesser degree, Indian regions of Eurasia, though it has been observed elsewhere, including in the Americas [45]. Many researchers have argued that polyandry emerges when sustaining a household requires the input of multiple males [45]. For example, in some places economic circumstances make it necessary for a man to travel long distances from the household while the presence of bandits requires a man to guard his family—solution: brothers team up.

Besides the broad categories outlined above one sees reports of other forms of marriage in humans, such as group marriage. Many of these reports are of dubious quality. Sometimes they track to the observations of single travelers who noted a particular family arrangement (that is, one family), often with insufficient detail to judge just how well the observer had investigated. Or, non-anthropological observers have confused marriage with the custom of wife sharing or loaning, which was common in both aboriginal North America and Australia. In these societies, which were numerous (and usually polygynous), husbands controlled sexual access to their wives, and it was considered polite and honourable for them to give their wives' "services" to close friends or honoured guests for a night or some period of time. Since these other men were often married as well, it might have appeared to a casual observer as if some kind of complicated marital arrangement existed.

Nevertheless, there may be a few societies that have some degree of group marriage, alongside polyandry [46]. The case of the Todas in India was extensively documented by the psychologist and anthropologist W.H.R Rivers [47]. Here, two brothers (usually) would marry a single woman. When the family's economic prospects improved, a second woman is brought into the marriage, often a sister of the first wife. This suggests that some cases of group marriage exist, but nowhere do they form a stable societal pattern prescribed by social norms. After reviewing the evidence, Murdock [39: 24] claims that group marriage has never been normative in any human society.

One feature of marriage norms is worth highlighting. As noted, marriage norms prescribe and prohibit roles and responsibilities related to economics, subsistence, child rearing, sex, and inheritance. Still, only 23.3% of societies in the Standard Cross-Cultural Sample (including monogamous and polygynous ones) have marriage norms that strongly condemn extra-marital sexual activity by males [48]. Meanwhile 89% of societies condemn all extra-marital sex by wives, though there are interesting exceptions in societies that believe in partible paternity [37].

SUPPLEMENTAL THEORY AND EVIDENCE

With regards to how polygynous marriage creates a pool of low-status unmarried men, two additional points should be mentioned. First, it is possible to avoid creating a pool of unmarried males if population growth rates are particularly high and men marry much younger females. Of course, high population rates are not sustainable. Second, if divorce is permitted, high status males will engage in serial monogamy. Serial monogamy is what otherwise polygynously marrying men are forced into under normative monogamy. Serial monogamy, however, does not expand the pool of unmarried men since men are required to give up one wife before taking another (the size of the pool of single women is unaffected). And, if divorce is costly, more paternal investment can still be extracted. Modern divorce, for example, obliges men to support the divorced wife and their children.

MECHANISMS THOUGH WHICH MARRIAGE INFLUENCE MALE BEHAVIOR

There are several sociological hypotheses about what the causal relationship is between marriage and crime, which we sketch here for the interested reader. These hypotheses are not mutually exclusive and the strength of evidence varies substantially between them.

1. Marriage changes routine activities, especially with regard to deviant peer groups. Unstructured activities with peers increase the frequency of deviant behaviors among those ages 18 to 26. The same person, when married, will spend less time with same-sex peers than when not married (or before marriage). There is supporting empirical evidence for this hypothesis in the finding that the transition to marriage is followed by a decline in time spent with friends and exposure to delinquent peer groups, controlling for age [49]. This idea is related to Waite and Gallagher's [50: 24] argument that marriage restrains people from certain kinds of behavior (i.e., staying up all night drinking beer) that do not pay off in the long run (in health, happiness, or income).
2. Parenting responsibilities can lead to changes in routine activities because more time is spent in family-centred activities than in unstructured time with peers.
3. A change in criminal behavior may occur in response to the attachment or social bond that forms as a result of marriage. Social bonding: the social ties of marriage create

interdependent systems of obligation, mutual support, and restraint that impose significant costs for translating criminal propensities into action [51].

4. For some, getting married connotes "getting serious"; in other words, becoming an adult. Marriage means having someone to care for and having someone to take care of you, and these perceived responsibilities and obligations strengthen when children enter the family. Marriage norms mean being married changes expectations of one's proper behavior [52].

TESTOSTERONE AS ONE PROXIMATE MECHANISM

Though speculative, testosterone may provide one important proximate mechanism that contributes to regulating male psychology in the manner predicted. Lower testosterone is associated with reduced risk-taking and sex-seeking [53] as well as greater sensitivity to infant cries [54]. Some evidence from normatively monogamous societies suggests that testosterone drops in men both when they marry (in a monogamous society) and again when they become fathers [55-58]. However, marriage and fatherhood do not appear to reduce men's testosterone in polygynous societies [59], because, of course, married men are still on the mating market— still openly and actively seeking additional long-term mates [though see 60]. This suggests that marrying in a polygynous society, especially if a male is higher status, may not have the same effects on criminal behavior and personal abuses as it does in normatively monogamous societies. Thus, normative monogamy may provide a kind of societal-level testosterone suppression program [61].

CROSS-NATIONAL REGRESSIONS LINKING POLYGNY AND CRIME

These analyses extend analyses already performed by Kanazawa and Still [62, 63]. Kanazawa provided the dataset. More information about this dataset is available in their papers.

To show that increasing polygyny is associated with a higher percentage of unmarried men, we use national-level data from Kanazawa and Still [62, 63], who compiled crime statistics, demographic information and economic data together with a measure degree of polygyny for 157 countries. To create a measure of polygyny, Kanazawa and Still coded all of the cultures in the *Encyclopedia of World Cultures* on a four point scale (from 0 = monogamy is the rule and is widespread, to 3 = polygyny is the rule and is widespread), and then developed a country-level value by aggregating all of the cultures within a country, multiplying the values for each culture by the fraction of the country's population represented by that culture.

First, we regress the percentage of unmarried men (age 15 and over) in the national population on this measure of polygynous intensity with controls for Economic Development (GDP per capita), Economic Inequality (sectoral Gini coefficients), Population Density, and degree of Democracy in 1980, as well as dummy variables for Africa and Asia [62]. The complete model in Table 6 (Model 6) provides estimates for the coefficients in this regression equation:

$$\% \text{ of unmarried men} = \text{constant} + \beta_1 * \text{Deg. of Polygyny} + \beta_2 * \text{GDP per capita} + \beta_3 * \text{Pop. Density} + \beta_4 * \text{Index of Democracy} + \beta_5 * \text{Gini sectoral} + \beta_6 * \text{Africa dummy} + \beta_7 * \text{Asia dummy}$$

Models 1 to 5 in Table 6 perform this estimation with various terms on the right-hand side dropped from the equation. The coefficients are estimated using standard linear regression techniques (least squares) and are accompanied by robust standard errors (Huber/White sandwich). This was accomplished using Stata IC 10.1.

Table 6. Regressing the percentage of unmarried men on the degree of polygyny						
	Model 1	**Model 2**	**Model 3**	**Model 4**	**Model 5**	**Model 6**
Deg. Polygyny	**3.030*** **	**3.542*** **	**3.489*** **	**2.980*** **	**1.740**	**1.740***
	(0.952)	(1.059)	(1.072)	(0.765)	(1.183)	(1.028)
GDP per capita		0.000218*	0.000167	-0.000391**	-0.000362*	-0.000295*
		(0.000114)	(0.000121)	(0.000153)	(0.000185)	(0.000160)
Pop. Density			0.000533*	0.000617	0.000536*	0.000495*
			(0.000317)	(0.000398)	(0.000270)	(0.000276)
Index of Demo.				0.165***	0.0944**	0.0985***
				(0.0307)	(0.0378)	(0.0364)
Gini sectoral					-0.0623	-0.150**
					(0.0633)	(0.0690)
AFRICA						6.925**
(1= African)						(2.992)
ASIA						-0.0340
(1= Asian)						(2.128)
Constant	37.21***	35.38***	35.60***	31.20***	37.98***	37.65***
	(0.939)	(1.621)	(1.698)	(1.547)	(3.166)	(3.537)
Observations	128	126	119	116	86	86
R-squared	0.081	0.092	0.099	0.346	0.151	0.243
*p < 0.1 **p< 0.05 ***p<0.01; Robust errors (Huber/White) are in parentheses below the unstandardized coefficients.						

Variable descriptions:

- % of unmarried men = the percentage of men (over age 15) who were unmarried in each country in 1990.
- Deg. of Polygyny = the degree of polygyny within a country based on data between 1991 and 1995. This varies from 0 (no polygyny) to 3 (widespread polygyny). Because the Degree of Polygyny variable was constructed based on information gathered between 1991 and 1995, most of the other control variables were collected from this period as well. The precise year used depended on the availability of information.
- GDP per capita = Gross Domestic Product Per Capita for a country.
- Pop. Density = persons per square mile in the country.
- Index of Democracy in 1980 = an index for the strength of democracy in a country. This index varies from 0 (completely authoritarian) to 100 (most democratic). It comes from Bollen's [64] detailed analysis and comparison of such measures.
- Gini sectoral = the sectoral gini coefficient for a country. One concern with this sectoral gini data is that it comes from 1980. Sectoral Gini is used in lieu of standard Gini coefficients because it is available for a larger number of societies. Note that it is possible to find Gini coefficients for many of the countries listed as "missing" in the K&S dataset, and Kanazawa and Still [62] use four measures of inequality in their analyses. The problem with regular Gini coefficients from the early 1990s is that they are derived from different sources. Sometimes those sources (1) use male income only, (2) calculate the inequality of households instead of persons, (3) involve only people in urban areas, and (4) use gross taxable income instead of other definitions of income or consumption. K&S drew their Gini coefficients from a single source to deal with this problem, but this limits the available data.

- Africa dummy = 1 when the country is in Africa and 0 otherwise.
- Asia dummy = 1 when the country is in Asia and 0 otherwise.

Across the six models in Table 6, the higher the Degree of Polygyny, the higher the percentage of unmarried men in a country. While the coefficient on the Degree of Polygyny in Model 5 misses conventional significance (p = 0.15), the size of the coefficient is identical to that in Model 6. Going from a negligible degree of polygyny (polygyny =0 nationwide) to widespread polygyny (polygyny = 3 everywhere) increases the size of the pool of unmarried men by between 13% and 27%. A comparison of AIC for each model shows that Model 6 is the best.

Countries drop out of the regressions when additional predictor variables are added because of a lack of data on those variables. This occurs most seriously when the sectoral Gini coefficients are added. We suspected that including sectoral Gini might bias results toward less polygynous societies. This, however, is not the case. Removing the societies without sectoral Gini data does not appreciably alter the distribution of our Degree of Polygynous variable.

Making the second link, Table 7 shows that the greater the percentage of unmarried men in the national population the greater the rates of rape, murder, assault, theft and fraud, controlling for the same variables as above. To deal with the highly skewed distributions of crime rates we've taken the natural logarithms of these rates. The percentage of unmarried men is a highly significant predictor of all these crime rates, except assaults where it is only marginally significant. The regression equations estimated in Table 7 is:

$$\text{Ln(Crime Rate)} = \text{constant} + \beta_1 * \%\text{ of unmarried men} + \beta_2 * \text{GDP per capita} + \beta_3 * \text{Pop. Density} + \beta_4 * \text{Index of Democracy} + \beta_5 * \text{Gini sectoral} + \beta_6 * \text{Africa dummy} + \beta_7 * \text{Asia dummy}$$

The dependent variable Ln(Crime Rate) is natural logarithm of five different crime rates: rape, murder, assault, theft and fraud (see columns of Table 7). These are measured in incidences per 100,000. These data were also gathered from the early 1990s.

The percentage of unmarried men is the only predictor that is consistently important across all five felonies. For rape and murder, adding the percentage of unmarried men to a regression with all the other variables increases the variance explained from 33% to 45% and from 12% to 24% respectively. For Assault, Theft, and Fraud, the variance explained increases by about 5% when our theoretical variable is added.

Table 7. Regressing Crime Rates on the Percentage of Unmarried Men

Natural logs of→	Rape	Murder	Assault	Theft	Fraud
% unmarried men	**0.0510*** **	**0.0225*** **	**0.0337***	**0.0324****	**0.0500*** **
(age 15+)	(0.0128)	(0.00815)	(0.0196)	(0.0153)	(0.0136)
GDP per capita	2.89e-05	-4.53e-05**	6.84e-05**	0.000140***	0.000142***
	(2.00e-05)	(1.80e-05)	(2.97e-05)	(2.20e-05)	(2.20e-05)
Pop. Density	-7.54e-05*	-2.91e-05	-6.96e-05	3.16e-06	-9.16e-05
	(3.94e-05)	(3.19e-05)	(8.24e-05)	(6.54e-05)	(6.04e-05)
Index of Demo.	0.0108**	0.0111***	0.00841	0.0173***	0.00251
	(0.00467)	(0.00309)	(0.00653)	(0.00494)	(0.00528)
Gini sector	0.00815	0.000776	0.00453	0.00465	-0.00279

	(0.00723)	(0.00711)	(0.0128)	(0.0113)	(0.0106)
AFRICA	-0.0389	0.0286	0.338	-0.184	-0.401
	(0.339)	(0.226)	(0.422)	(0.384)	(0.311)
ASIA	-0.241	0.0106	-0.0961	-1.120***	-0.515
	(0.371)	(0.394)	(0.625)	(0.262)	(0.620)
Constant	-1.400***	0.336	1.025	2.676***	0.550
	(0.527)	(0.465)	(1.000)	(0.804)	(0.718)
Observations	75	86	84	86	83
R-squared	0.449	0.240	0.220	0.682	0.559
*p < 0.1 **p< 0.05 ***p<0.01; Robust errors (Huber/White) are in parentheses below the unstandardized coefficients predicting the natural logarithm of each crime rate.					

CRIME AND SEX RATIO

In China, as presented in the main text, sex ratios (males to females) rose markedly from 1.053 to 1.095 between 1988 and 2004, nearly doubling the unmarried or "surplus" men [65]. At the same time, crime rates nearly doubled—90% of which were committed by men. The increase in sex ratio was created by the gradual implementation of China's one-child policy. Different provinces implemented the policy at different times for reasons unrelated to crime rates providing an opportunity for analyses of the impacts of the policy and the alterations in sex ratio it created. The date of implementation provides an exogenous variable that can be used to establish directions of causality.

The authors of the study argue that this setup is also ideal for examining how the surplus males affect crime rates for two reasons. First, limiting child number through potent family planning strengthened preferences for male children. Highly valued male children will benefit from heavier parental investment, and should—if anything—be less likely to commit crimes than the boys of previous generations. Second, limiting family size causes the population to shrink, which opens up opportunities in the labour market and ought to decrease people's likelihood of committing crimes (there are lots of jobs). So it is significant that, despite these pressures, crime actually went up over this period. While not entirely persuasive, these arguments provide an important point of departure.

To challenge the hypothesis that the increase in crime was driven by an increase in the surplus of low-status, unmarried men, the authors also examine crimes usually committed by white-collar (high status) criminals. Since high status men are still marriageable they are insulated from the hypothesized effect (they wouldn't be as insulated in a polygynous society, since additional wives could be added). These analyses show that sex ratio does not impact white-collar crime. Thus, the increase in crime driven by a surplus of unmarried men is only found in property (larceny) and violent crimes.

It is also worth noting (contrary to expectations) that increases in rape do not appear to be an important component of this increase in violent crimes, although rates of rape may have been offset by a dramatic increase in prostitution during the same period (from 25,000 to between four and six million prostitutes). Analyses from several studies support the linkage between higher prostitution

rates and a greater excess of males. Below, we review a longitudinal study of rape that shows how it's influenced by fluctuations in brideprice (the cost of obtaining a wife).

In India's case, besides showing that sex ratio differences across districts are strongly associated with murder rates, Dreze and Khera [66] broke the sex ratio down into effects created by differences in sex ratio at birth and the effects created by migration of males in, or out. Both had significant effects, as expected. Their analyses also indicate that literacy is an important independent negative predictor of murder rates across districts, though poverty and urbanization are not. The authors used murder rates because they worried about under- or biased reporting of other crimes—but deaths are hard to avoid reporting.

There is one cross-national study [67] showing that sex ratio is *negatively* (not positively) related to crime (murder, rapes, and assaults). Overall, there are two reasons not to worry about conclusions drawn by this study. First, these are cross-national analyses, which mean many different factors vary across nations (unlike the within-country analyses above) that might be causing these effects. That is, truly causal variables not included in the analyses may correlate with the few variables included in the analyses to create these effects. Normally, econometricians would include many control variables to address this (see main text), but Barber's study controlled only for infant mortality. Second, the sex ratios in many of these nations are very far from 1.05 (the birth value), which means that most of the sex ratio differences are driven by migration, or death of males due to organized violence. What these findings might be telling us is that males leave unstable and violent countries with more crime to move to peaceful and stable countries with less crime. Or, societies with more crime may tend also to have more war and organized violence, which disproportionately remove males (they get killed). This could be sorted out with the analysis of longitudinal (time series) data, such as was used for China above, but this analysis has not been done. As an interesting aside, note that this study does find that *polygyny* is associated with more assaults and murders, independent of sex ratio.

POLYGYNY, SEX RATIO, RAPE AND SEXUAL EXPLOITATION

Within a society, evidence for a positive relationship between degree of polygyny in a society and rape rates comes from the Gusii of Kenya [68]. This polygynous society has a bride price that is paid from the groom's father to the bride's father in the form of cattle. Historically, the size of the brideprice continually escalated until the government periodically intervened and forced the price to be lowered. The lowered rates held temporarily and then the escalations began again. The size of the brideprice impacted how many males were able to get wives because many males were unable to afford the brideprice, especially if they did not have a sister who had gotten married (because the cattle the family receives for the sister can be used to pay the brideprice for her brother). Many fathers tried to arrange marriages for their daughters with older, wealthy men to get brideprices, so more males were excluded from marriage. In 1936-1937, brideprices were at their highest levels in nearly 50 years and many young men who could not afford brides turned to cattle raiding and rape. As brideprice increased rape rates also increased. In one reported incident, a group of young men captured a group of females at the market and raped them, precipitating a decrease in brideprice. The lower rates held until 1950, during which time rape rates were lower. When brideprices began to escalate again in 1950, outbreaks of rape and the existence of rape gangs again occurred.

The evidence from the Gusii suggests that men rape when they are unable to access females in socially legitimate ways and refrain from rape when women are available to them. Consequently,

polygynous societies may face an increased risk of rape as access to females is denied to a subset of males in the population.

As noted above, in addition to rape, the sexual needs of an increasing pool of unmarried men are met by expanding sex industries. In San Francisco's Chinatown in the mid-1800s, a time and place with a low female to male ratio, the 1850 census indicates that 71% of the area's females were prostitutes [69] and when Australia was populated by male European convicts but few European women, prostitution was widespread [70]. Other times and places include the American frontier, urban Africa, and medieval Europe [71, 72]. Using cross-national data, McDermott [73] reports a positive relationship between polygyny and sex trafficking, controlling for GDP.

MONOGAMOUS MARRIAGE, ECONOMIC PRODUCTION, AND FERTILITY

With regard to Table 1 in the main text, Tertilt [74] asserts that you obtain the same pattern if you create your comparable sample of monogamous countries by matching on GDP instead of latitude. She did not do this because, as we discuss in the main text, her model shows that when males cannot invest in obtaining more wives (because of imposed monogamy) they invest and save in ways that generate both reduced population growth and more rapid economic expansion (increasing GDP per capita). Thus, she suggests that the nearly threefold increase in GPD per capita between Comparable Monogamous Countries and Highly Polygynous Countries is partially caused by legally imposed monogamy.

MICRO-LEVEL CASE STUDIES OF AGE OF FIRST MARRIAGE AND AGE GAP

It is important to realize that our theoretical approach is focused principally on how polygyny will create differences *among societies* in factors like the age gap between husbands and wives and the power of women in society. However, if men recognize early in their reproductive careers that they are likely to be either monogamously married (at best) or polygynous, we may be able to detect individual-level differences (as opposed to societal-level differences) based on the strategies men deploy going into marriage. Men who are either highly polygynous or on the road to high levels of polygyny might prefer very young wives, perhaps because they are easier to control. The higher status of polygynous men, or of men likely to be polygynous in the future, should permit them to more effectively get what they want. Yet, in societies in which men are more equal or upwardly mobile, strategic shifts in preferences for younger wives might not emerge early enough to create observable within society differences. Thus, it will be impressive if we find any differences in the predicted directions.

This case material suggests two findings. First, a future-polygamous man will marry a younger first wife than a future-monogamous man (although the difference in age is not always statistically significant, it is always in the predicted direction). Second, the age difference between husbands and first wives is greater in polygynous marriages than in monogamous marriages. To illustrate these patterns, we provide data from four disparate societies in Africa, the Middle East, and Australia.

A study of Bedouin Arab women living in Israel's Negev [75] found that the average age of marriage for polygynous women and monogamous women was 19.2 and 19.5 respectively. These are not statistically significantly different, but do go in the predicted direction. Polygynous men tend to be

older at marriage than their monogamous counterparts (27 vs. 23, respectively; $p < 0.001$). This difference in men's age at marriage creates a greater age gap between husbands and wives in polygynous marriages (7.83 years) compared to monogamous marriages (3.49 years). See Table 8. All of the Bedouins are Muslim and 50% live in villages recognized by the state of Israel and the other 50% live in unrecognized villages. Culturally, they are characterized by their shared attributes of patriarchy, collectivism, and authoritarianism [75].

Table 8. Age at first marriage among Bedouin Arabs

	Women		Men	
Variable	**Monogamous**	**Polygynous**	**Monogamous**	**Polygynous**
Avg. age at 1st marriage	19.46	19.16	22.95	26.99*
Avg. # of years younger than husband	3.49	7.83*	--	--

* $p < 0.001$

Polygyny is illegal in Turkey. Nonetheless, polygyny is common in rural villages in south-eastern Turkey and it is estimated that 2% of all marriages in Turkey are polygynous. Senior wives are the first women to whom a man married. A junior wife is the most recent wife joining the marriage. Senior wives are higher status than junior wives, and junior wives have no legal rights on the husband's heritable wealth. Prior to 2004, children of junior wives were registered as belonging to senior wives; this practice changed when laws were passed to recognize the legitimacy of children born in extramarital affairs [76]. The percentage of girls marrying under age 15 is significantly different across marriage types—see Table 9. Thirty percent of polygynous senior wives marry under age 15 versus only 10% of monogamous wives [76]. The average age of first marriage for senior polygynous wives is 15, compared to 17 years of age for monogamously married wives. This difference is not statistically significant, though it does go in the predicted direction.

Table 9. Age at first marriage in a municipality in south eastern Turkey

	Monogamous wives	**Polygynous-senior wives**	**Polygynous-junior wives**	**Statistical significance**
Avg. age at 1st marriage	17	15	18	Not significantly different
% of married women under age 15	10	30	13	$p < 0.01$

The Arsi Oromo of southern Ethiopia are agro-pastoralists. A third of women are in polygynous marriages, and approximately 29% of men have two wives and 11% have three or more wives. It often takes many years for a man to accrue enough wealth to take an additional wife and the average number of years between marriages is 12.6. Among the Arsi Oromo, the average age of marriage for senior wives in polygynous marriages is 15.3 compared to 17.3 for wives in monogamous marriages. Average age at first marriage for junior wives is older than that of monogamous wives. The difference in age of first marriage is statistically significant between each group of women [77]. See Table 10.

Table 10. Age at first marriage among the Arsi Oromo of Ethiopia				
		Polygynous wives*		
	Monogamous wives*	**Senior wives**	**Second wives**	**Third and higher wives**
Avg. age at first marriage	17.25	15.32	18.73	20.1
*All ages are statistically significantly ($p < 0.05$) different from each other				

The Aboriginal community in south-east Arnhem Land, Australia was traditionally polygynous foragers. In the 1950s, the community was established as a mission settlement and polygyny was prohibited. Although polygynous marriages continued over the next 30 years, the number of new polygynous marriages declined and by the late 1980s they were almost entirely eliminated. However, women who had previously been married in polygynous unions continued to live in the community. As of 1981, 65% of the women in the community were currently, or at some point had been, in a polygynous marriage. Based on record reviews, census data, and interviews, a reproductive history of women from the community was created [78]. The findings reveal that there was a large age difference between husbands and wives in polygynous marriages; a gap that was much greater than that in monogamous marriages (see Table 11). Women in polygynous marriages were younger at the birth of their first child than monogamously married women, although this difference is not statistically significant. Reflecting the age difference between spouses, men in polygynous marriages were significantly older at the birth of their first child compared to men in monogamous marriages.

Table 11. Ages at first birth and age difference between spouses among Aboriginals in Arnhem Land, Australia			
Variables	**Monogamous marriages**	**Polygynous marriages**	**Statistical significance**
Avg. age difference between husbands and wives	7	17.1	$p < 0.001$
Avg. mother's age at 1st birth	19.32	19.19	$p > 0.05$
Avg. father's age at 1st birth	28.71	36.27	$p = 0.004$

Overall, the findings from these case studies converge with the cross-country evidence reviewed in the main text. These intracultural studies on marriage age also are interesting because they *suggest* that, in addition to driving down marriage age for females across the board (that is, in both monogamous and polygamous unions), there is a further effect specific to polygynous marriages: that is, polygynously marrying men seem to select younger girls as wives (even as first wives) compared to monogamists, both in absolute but especially in relative terms. One plausible explanation for this is that selection of a younger (and especially a relatively younger) bride increases a man's ability to exert control over her. An alternative evolutionary hypothesis, that men are selecting adolescent females because of higher fertility, does not hold since fertility declines as one moves down in age below around 17.

POLYGYNOUS MARRIAGE AND FEMALE EQUALITY

The available cross-country evidence also supports the idea that permitting polygyny increases males' motivations to control women, an effect created by competition among males for access to women. Table 12 partitions the Highly Polygynous Countries (HPC) from the Comparable Monogamous Countries (CMC). The UNDP's Gender Empowerment Measure aggregates a variety of measures of female empowerment into a single index (ranging from 0 to 1). It includes male-female income ratios and female representation in high status jobs. In 2009, Canada was ranked 4th in the world on this, with a score of 0.83 (Norway is currently 1st at 0.91). The HPC mean is 0.22, while CMC score at 0.50. The ratio of adult female to male literacy tells the same story [79].

Cross-national regressions converge with Table 12. Using her own five categories of polygynous intensity across nations, McDermott [73] shows positive statistical relationships between the degree of polygyny and (1) rates of primary and secondary education of female children, (2) domestic violence, (3) maternal mortality, (4) sex trafficking, (5) female genital mutilation, and (6) inequality of females (vs. males) before the law. These results all hold controlling for GDP. However, while broadly supportive of our theoretical proposal, more analysis is needed, such as including additional control variables (economic inequality, population density, continental dummy variables, and democracy) and replacing GDP with GDP per capita.

Table 12: Female Equity Comparison

Variable	HPCs	CMCs
Gender Empowerment Measure (GEM), 2003	0.22	0.50
Ratio of adult female to male literacy rates, 2005	0.66	0.95

SEX RATIO AS A PROXY FOR THE EFFECTS OF POLYGYNY ON WOMEN

While highly polygynous marriage systems are confined primarily to Africa, sex ratios vary much more widely across the globe. Here we assume that sex ratios favouring males will create effects that mirror those of polygynous marriage by increasing the competition among men for access to women. If true, sex ratio ought to have the same effects on female power and well-being that greater polygyny has, *for the same reasons*. Men will tighten their control over wives, sisters and daughters. This may appear counterintuitive, as one might expect women to gain power given that they are the "limiting resource." However, empirical evidence indicates that this is not the case. As women become scarce they tend to be viewed as commodities and, along with the greater control exerted over them, fertility rates increase and divorce rates decline [80].[8]

To examine the relationship between sex ratio, age of first marriage, and female inequity, South and Trent [80] performed a battery of cross-national analyses using data from 117 countries. Their sample included countries from across the full spectrum of development, but with a bias towards more developed countries (as the lesser developed countries were less likely to have the requisite data available). The sex ratios for each country were based on data available for the number of

[8] Both fertility rates and divorce rates are considered reliable proxies of women's empowerment by those who study human development [80]. When women have more power in the household and more education they have fewer children and divorce more frequently. Additional children are generally a greater cost for women compared to men. Each additional child costs women in terms of labour, health, and ability to attract additional mates. For divorce rates, suppose that 10% of the time only the husband wants a divorce, 10% of the time only the wife wants a divorce, and 10% of the time both want a divorce. If women have no power, the divorce rate is 20%. If women have power, it's 30%.

males and females between the ages of 15 and 49 from any year between 1973 and 1982. Variability in the sex ratio could be due to differences in the sex ratio at birth, migration, or mortality. The authors speculate that in countries with high mortality rates, such as in East Africa, mortality accounts for most of the skewing of the sex ratio (with mortality impacting males between ages 15-49 more than females). Differential mortality by sex could also skew the sex ratio. Analyses controlled for the reliability of the sex ratio data for each country, as well as the socioeconomic development of each country (an indicator composed of variables including GDP, infant mortality, percentage of population living in urban areas, and life expectancy).

South and Trent found that in countries with a high ratio of males to females, females married younger, controlling for the aforementioned factors. This converges with other evidence. Currently, the declining sex ratio in China has caused rich families to acquire infant girls to guarantee their sons have wives [61]. Similarly, in some regions of India (the world's largest democracy) more than half of females in some regions are married before age 15 [81]. As well, in the American frontier where females were in short supply, brides were reported as young as 12 and 13 [71]. This converges with findings reported in the main text, indicating that competition for scarce females drives the age of first marriage down.

These analyses also show that higher sex ratios (i.e., more males than females) predict lower participation of women in the labour force, lower illegitimacy rates, and lower divorce rates (all illustrating male control). In more developed countries, they found that the sex ratio had a *greater* effect on indicators of women's roles than in less developed countries, with the exception of participation in the labour force. In more developed countries, higher sex ratios predict a lower age at first marriage (for females), higher fertility rates, and lower literacy rates.[9]

Some of South and Trent's analyses suggest that living in a society with a highly skewed sex ratio may contribute to diminished well-being for women, as evinced by the high female suicide rate relative to that of males in countries with a high sex ratio. However, data on female and male suicide rates were only available for 51 countries and were not considered highly reliable. These findings, while weak on their own, are consistent with suicide rates in China [World Health Organization (WHO)82], which has the world's highest female suicide rate (14.8 per 100,000). As a point of comparison, Canada's female suicide rate is 5.1 per 100,000. China does not have a high suicide rate for males (13 per 100,000 compared to Canada's male suicide rate of 19.5 per 100,000) (WHO, 2003), indicating that the high female suicide rate is not a reflection of a generalized sense of diminished well-being in China but rather a problem specifically affecting females. The trend of increased female suicide rates in low sex ratio countries suggests that something about being a woman in a country with a relative scarcity of females creates an environment that is deleterious to the well-being of women.[10]

Overall, while it's possible that the causal pathways for some of these effects are different from, and specific only to sex ratio, the convergence with both our macro-level comparisons of countries with

[9] These cross-national analyses could suffer problems similar to those discussed for Barber (2000) above. However, two reasons suggest these issues might be less pertinent in this case. First, South and Trent used an accepted measure of socioeconomic development as a control (instead of only infant mortality), a larger sample, and also included a control for data quality (which Barber did not). The use of the socioeconomic index of development as a control is crucial for their findings. Second, it is more difficult in this case to see how biased migration patterns could have skewed these results.

[10] However, a country's socioeconomic development has a greater effect on the female suicide rate than the sex ratio [80].

differing degrees of polygyny and our micro-level case studies of monogamous and polygynous marriages in the same societies is striking. Increased competition for females, whether due to polygyny or to unbalanced sex ratios, seems to depress the age of marriage for females, increase the spousal age gap, and increase male efforts to control females. This appears to apply in developed societies as well as underdeveloped and developing societies.

NORMATIVE MONOGAMY, PATERNAL INVESTMENT, AND INTRA-HOUSEHOLD CONFLICT

As background, it is important to realize just how discriminating people are regarding kin-relatedness. For example, evolutionary theory predicts that people ought to behave more altruistically—as if they were more closely related—to those who are related through a matriline (e.g., mother's sister's son) compared to those related through a patriline (e.g., father's, brother's son). This is because every linkage through a male brings some paternity uncertainty (was he really the genitor?). Several empirical studies in different countries now demonstrate that people make this subtle distinction in the predicted manner [3]. This is important in the case of polygynous families because many of the siblings are actually (or supposed to be) genetic half siblings through the paternal line. Because it is through the paternal line, theory predicts more conflict than with equivalent half siblings related through the mother.

MORE ON CONFLICT AMONG CO-WIVES

Here we provide some additional material on conflict among cowives in polygynous households.

Unrelated women within a polygynous household compete directly for household resources. The outcome of these conflicts may directly impact the future welfare of their genetic progeny. This is a zero-sum game among non-relatives without common genetic interests (that is, no common offspring). In a typical monogamous nuclear family all pairs of individuals are close genetic relatives, or share a common genetic interest (spouses are unrelated but linked genetically through shared offspring). Under such circumstances, our approach predicts that serious conflicts will likely arise among the unrelated women in the household.

In-depth ethnographic work in polygynous communities supports this view. Straussman [83] highlights the conflict among both cowives and half-sibling sons. Mothers both reported and widely feared that their cowives would try to poison their sons—so the poisoner's son could inherit the father's land instead. Straussman also shows that children of polygynous marriage have a statistically increased chance of dying (relative to monogamous marriages), and she argues that this increases the stress experienced by children. This converges with both ethnographic accounts in which competing cowives suspect and accuse each other of engaging in witchcraft, and with an econometric analysis of data from the Ivory Coast showing that the children of first wives in polygynous marriages receive extra education, probably because of the relative power of the first wife [84].

MORE ON VIOLENCE AMONG UNRELATED FAMILY MEMBERS

Genetic relatedness between individuals within households impacts the chances of violence, including homicide and child abuse. While much violence occurs among household members, most

of this violence occurs among the non-relatives within households [11, 85]. This suggests that—*ceteris paribus*—lower relatedness and more unrelated dyads will increase violence and homicide within households.

Even before considering "blended families" arising as a consequence of divorce and remarriage, non-sororal polygynous households have—by definition—more unrelated members. Husbands are unrelated to all their wives. The wives are typically unrelated or only distantly related to each other, and thus unrelated or even less related to the children of all the other wives. For comparison, contrast a monogamous nuclear family with two parents and four children. In this household there is one unrelated pairing (assuming no marital infidelity): the spouses. Now consider a polygynous household with two wives, each with two children. This quite small polygynous family has 7 unrelated pairings (3 adult pairs + 4 wives-to-others'-children). That is, for similarly-sized families with four children each, the polygynous household has *seven times* the number of unrelated pairs. The ratio of the number of unrelated pairs for polygynous to monogamous households increases with square of the number of wives in the polygynous household.[11]

When the implications of divorce and remarriage are considered, the effect is further exacerbated. Divorce and remarriage under polygyny not only puts children in a household with an unrelated adult male (just as with monogamous re-marriages), but it adds to the mix one or more stepmothers. To see this, suppose an aspiring polygynous man's first wife has two children and he marries a second wife who already also has two children. This places the incoming children in a household with two unrelated adults, and places the husband's genetic children in a household with one unrelated adult (the new wife).

Of course, it might be argued that this effect would be offset if divorce and remarriage were less common in polygynous households than monogamous ones. It is sometimes argued, for instance, that polygyny may be preferable alternative to "serial monogamy", in the sense that it is better to keep a man's families together than to encourage him to leave one to start the next. However, the available information indicates that divorce in polygynous marriages is at least as prevalent as in monogamous marriages.[12]

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[11] Assume that w = the number of wives, and that k is the number of children each wife has (for simplicity assume each wife has the same number of children). The number of unrelated pairs is $N_p = w(1+(w-1)(0.5+k))$. Assume the number of wives in a monogamous family is always 1, the number of children is irrelevant, and $N_{pm}= 1$. Thus, the ratio of unrelated pair in polygynous vs. monogamous is merely N_p. If $w = 3$, $N_p = 18$.

[12] Due to the underground nature of polygynous marriages in North America we know little about divorce rates in North American polygynous communities, though Jankowiak (2008) reports that more than 40% of the women in the FLDS polygynous communities of Colorado City and Centennial Park will divorce during their lives. The comparable statistic for the U.S. in general is 34%, and the number for other religious groups who condemn divorce such as Catholics is much lower (it's also much lower for atheists). More systematic and controlled analyses from polygynous societies generally show higher divorce rates for polygynous vs. monogamous marriages in the same society [86, 87]. Even these analyses, however, are not entirely persuasive, due to small, localized, samples and sometimes a lack of statistical controls. A more detailed investigation from Nigeria, which controlled for differences in religion, education, urban living, childlessness, and several other variables, shows that while polygynous marriages with 3 or more wives are highly unstable, polygynous marriages with *only* two wives were more stable than monogamous marriages. Relative to monogamous families, polygynous families with more than two wives are five times more likely to divorce. Meanwhile, 2-wife polygynous families divorce half as often as monogamous households. This applies to both Christian and Muslim marriages. Using the numbers from this study we calculated that permitting polygyny

An important concern with the analysis of genetic relatedness above, which suggests that violence and abuse may be higher polygynous households, is that much of the existing research has focused on men as the perpetrators of the additional abuse and filicide. If stepfathers are the only concern, maybe there will be no difference between the polygamous and monogamous households (since they include no stepfathers). That is to say, if stepfathers are the problem, then the children of three women are no worse off sharing one father than having one husband per mother.

In their analysis of an FBI database, Weekes-Shackelford and Shackelford [85] were able to calculate and compare the rates of filicide by stepfathers and stepmothers, as compared to their genetically related counterparts. In this data, while a stepfather is 8.5 times more likely to kill his child (stepchild) compared to genetic fathers, stepmothers are still 2.4 times more likely to commit filicide. Comparing stepfathers and stepmothers, stepmothers have a rate that is roughly 1/3 that of stepfathers. Three unrelated mothers equal one unrelated father in terms of mortal danger to the child.

Beyond homicide per se, the data also demonstrates that a lack of genetic relatedness puts children at higher comparative levels of risk. Studies show, for instance, that investments of money, time and effort by mothers are generally lower for step or adopted children *when* those children compete with the mother's own genetic children [88, 89].[13] For example, adopted and stepchildren do not wear seatbelts or go to the dentist as often as genetic children. Data from Australia indicates that children living with genetically unrelated parents are much more likely to be "accidentally" killed, compared to both children living with two genetic parents *and even* children living with a single genetic parent. While children living with a single genetic parent are only 1.29 times more likely to die accidentally, children living with an unrelated parent are between 15 and 77 times more likely to die accidentally (children living with no biological parents are between 37 and 102 times more likely).

Besides conflict among unrelated cowives and between cowives and their unrelated children, there is also potential for conflict among brothers and sisters, since many of these individuals are actually only half-sibs and may be dramatically different in age. Even siblings have conflict, since they compete for the same resources from the parents. This sibling rivalry is mitigated by the altruism that comes with being closely related. Half-siblings, however, are only half as related as full siblings and face at least as much competition, and this matters, as noted above [90]. Some evidence also indicates that polygynous households are sensitive to degrees of relatedness, just as are monogamous households. Jankowiak and Diderich [90] compared the solidarity, affect, association and altruism between full and half siblings in polygynous Mormon families. The data reveal much greater association, affect, solidarity, and altruism toward full siblings compared to half-siblings. This finding is interesting because it runs directly contrary to official ideological preaching in this community. Norms may have real effects, but that does not mean that they can completely over-ride ancient evolved impulses.

THE ROLE OF SEXUAL JEALOUSY, AGE DISPARITY, AND SPOUSAL CONFLICT

will increase the divorce rate unless the number of 2-wife marriages is at least triple the number of all other polygynous families combined. Note that this study has some shortcomings in that it was not able to control directly for income (using education as a proxy), or the ages of the husband and wife at first marriage.

[13] Adopted children, however, do just as well as genetic children as long as they are not directly competing with a sibling who is the genetic progeny of the parents.

Violence driven by sexual jealousy within pair-bonds may be at least as high, and probably higher, in polygynous societies as compared to monogamous societies. There are three reasons why it should be worse (more violent) in polygynous societies, and this applies to first wives as well as to (in more extreme fashion) subsequent wives. First, the larger age gap is a risk factor for spousal violence and homicide. Testing the evolutionary idea that sexual jealousy should increase as the age gap between husband and wives increases, Breitman and Shackelford [91] show that in Chicago, controlling for a wide range of other factors, the age gap between husbands and wives is strongly related to homicide rates. The larger the age gap, the more likely it is that a husband will kill his wife, and vice-versa (the young wife murders her husband). Notably, however, the effect is highly non-linear: in moving from spouses being the same age to husbands being between 13 and 15 years older, the rate increases from 5 per 100,000 to 8 per 100,000. After that, it spikes to almost five times the same-age rate. This suggests that polygyny is relatively (potentially) much more dangerous than monogamous relations because age gaps of 16 years are not uncommon when accumulating young wives (Jankowiak 2008).

A second application of these ideas to polygynous households involves paternity uncertainty. If a man has multiple wives he may have an increasingly difficult time keeping track of where they all are at any one time ("mate-guarding" is more costly), especially since they often maintain separate residences to manage co-wife conflict. Since polygynous husbands typically circulate among their wives residences or rooms on different nights, there may be many nights in which the husband has little idea about what his other wives were doing. This may lead to greater paternity uncertainty and potentially to more use of violence as a form of coercive control.

Finally, polygyny creates greater competition in the mating and marriage markets because all married men are still "on the market" (to add wives) and must compete with the pool of unmarried men created by polygyny. This will elevate competition for women and cause men to use more violent and suppressive measures to sustain paternity certainty, and retain their wives. As shown above, greater polygyny is associated with less gender empowerment and lower rates of female literacy.

POLYGYNOUS MARRIAGE AND CHILDHOOD OUTCOMES

Here we expand on the material covered in the main text.

Using data from 22 sub-Saharan African countries, Omariba and Boyle [92] found that children in polygynous families were 24.4% more likely to die compared to children in monogamous families. The degree to which polygyny elevated mortality risk varied by the GDP of the child's country, with polygyny posing a smaller risk to mortality in wealthier countries. Family characteristics (maternal education, socioeconomic status, and urban versus rural residency) also reduced the effect of polygyny on child mortality by approximately a third. Similarly, a study of six West African countries found that infants in polygynous families had a 50% greater risk of dying compared to children in monogamous families [93]. Note, however, that while qualitatively convergent with much other work, we have less confidence in the details of this particular analysis because of a lack of controls for wealth and no effects in the purely bivariate analysis.

Detailed ethnographic studies in Tanzania and Chad found that children in polygynous households had poorer nutritional status than their counterparts in monogamous households, as indicated by the children's height and weight measurements [94-96]. In Hadley's [95] Tanzanian study, the

women had freedom of mate choice and a general abundance of food with little seasonal food insecurity. Despite these favourable conditions, the children of polygynously married mothers were more likely to be underweight, and were relatively shorter and gained less weight and height during the duration of the study than children of monogamously married mothers. These differences are more pronounced during periods of scarcity. The study started in the dry season, when food is more abundant, and at that time no significant differences in weight were detected between children in monogamous and polygynous households. At the second measurement period, during the wet season when food is scarcer, 24% of children in polygynous households were underweight compared to 8% in monogamous households. No differences were detected in wealth scores between monogamously and polygynously married women and yet monogamously married mothers reported running out of food early during the wet season more often than polygynously married mothers. Wealth differentials do not appear to explain the difference in nutritional status. The analyses controlled for children's age and sex, and household wealth.

In Sellen's [96] Tanzanian study, children of polygynous mothers had lower weight for age scores and height for age scores than children of monogamous mothers. Children's growth and fatness were correlated with both mothers' marital status and household wealth, with wealth having a greater effect than marital status. There was no significant interaction between marital status and household wealth. The analyses controlled for wealth and child and maternal characteristics. Similar findings are numerous [e.g., see 83, 97].

Finally, in looking at the 19th century Mormon data from Health and Hadley reported in the main text, realize that both rich and poor men could be behaving in a manner consistent with maximizing their reproductive success. Rich men produced many more total surviving offspring (past age 15) than poor men; it is merely that their survival rates were lower. Having additional wives more than compensated, reproductively speaking, for the lower survival rates. Poor men could not add wives without decreasing the survival rates of their children: adding wives for poor men decreased child survival, but for rich men this had no impact.

INTERPERSONAL AND PSYCHO-SOCIAL IMPACTS ON WIVES IN POLYGYNOUS MARRIAGES

Women in polygynous marriages may experience both benefits and costs associated with their marital arrangement. The identified benefits stem from the relationship with co-wives, who may provide assistance in household work, childcare, and companionship. Women in polygynous marriages may experience greater autonomy than women in monogamous marriages because the assistance from co-wives makes time available to pursue other endeavours [98]. Moreover, as is the case in households of Bedouin-Arabs, when relationships among co-wives improve, the benefits ripple through the family to improve other relationships, including those among siblings, between wives and husbands, and between children and fathers [99].

Despite the potential advantages stemming from harmonious or helpful co-wife relationships, there are studies indicating detrimental consequences associated with being a woman in a polygynous marriage *in some societies* (but not all, see below). Studies among Arabs in Israel [75] and Turkey [76] found significantly higher rates of psychological distress and disorders among polygynously married women compared to their monogamously married counterparts. Among the disorders/distress experienced at significantly elevated rates by polygynously married women in the Arabic sample are depression, obsession-compulsion, hostility, anxiety, phobia, psychoticism, and paranoid ideation [75]. Women in polygynous marriages also reported significantly more

problems in family functioning and marital relationships and less satisfaction in life than monogamously married women in their societies [75]. In the sample from Turkey, the increased likelihood of having a psychological disorder among senior wives compared to monogamous wives was 1.6 times for conversion disorder and 2.4 times for somatization disorder. The other disorders were not significantly different in prevalence between monogamous and polygamous wives.

The rates of the aforementioned problems vary with the women's co-wife ranking (based on when they married in). However, the impact of wife-order differs cross-culturally. In some societies, senior wives experience higher rates of emotional and psychological distress, presumably because the wives perceive that they are being supplanted by younger wives, or because they believe they have failed to meet the standards of a "good wife" [75]--thus leading their husbands to add another wife. In other societies, the junior wives experience greater rates of emotional and psychological distress because they are subordinate to the senior wives, and/or their husbands favour the senior wife.

Contrary to the findings on emotional and psychological well-being among the Arabs and Turks, a study among East Africans did not find any difference in rates of anxiety or depression between women in polygynous versus monogamous marriages [100]. However, the authors suggest that this may be due to the fact that the study was conducted during the dry season when food is generally abundant and workloads are low. Emotional distress may be more likely to manifest itself during 'hunger seasons.' Alternatively, the authors raise the possibility that the psychological measures were culturally inappropriate. Of course, it may also be that negative consequences associated with polygyny do not emerge in all cultural contexts (such as that in East Africa), or that there may also be benefits that offset the costs—thus, women do not experience a net decrease in emotional/psychological well-being from polygynous marriages. Since women in East Africa are economically productive, households with multiple wives could be generally wealthier than monogamous households, which could offset the downsides of polygyny. Although Patil and Hadley did not control for wealth, they did control for food insecurity in the three months preceding the study (which could be a proxy for wealth) and found this to be a consistent correlate of psychological distress. This suggests that there could be an offsetting wealth effect occurring.

HISTORICAL SKETCH OF THE EMERGENCE OF MODERN MONOGAMY

Historians and anthropologists trace the origins of modern monogamy,[14] which spread across the world with the global expansion of Europe after 1500, back through Rome to the Greek city states (e.g., Athens and Sparta), and possibly back to the root of the Indo-European expansion [43, 44, 101, 102]. Under European, and at times specifically Christian missionary influence, monogamy spread throughout the Americas, Australia, and Oceania, and eventually into Asia. Legal monogamy was adopted rather recently in many places: 1880 in Japan, 1955 in India (partially), 1963 in Nepal, and1953 in China [44].

Greek city states first legally instituted monogamy as part of many different reforms, including elements of democratic governance, which were meant to build egalitarian social solidarity among

[14] Here we use "modern monogamy" to refer specifically to the cultural evolutionary trajectory that produced the Western notion of monogamy that all readers will be familiar with.

their citizenries. Prior to this, all accounts suggest polygyny was common, at least among the nobility, and monogamy was a strange "Greek idea" (instituted legally in the early sixth century BCE in Athens). While Greek monogamy limited each male citizen to a single wife, it was considered acceptable to import sex slaves, which wealthy men did. This approach is interesting because it addresses one of the fundamental social dilemmas posed by polygynous marriage systems: it keeps local women available to poor men for marriage (avoiding the problems created by poor unmarried males), while at the same time allowing rich men broad sexual access to "imported" women.

It is not entirely clear, but the Romans likely inherited and further developed the monogamy of the Greeks (as they did with many Greek ideas), though Etruscan marriage norms. Relative sexual equality likely had some influence as well. Rome outlawed polygamy and regulated this with laws about sexual behavior, birth legitimacy, and inheritance. Bigamists could be prosecuted for adultery, and married women had to be accompanied in public [43, 103].

Later, Augustus felt Roman morality was declining and weakening his empire, so he instituted a series of reforms in an effort to get every man from age 25 to 60 to be married. Augustus evidently believed that making sure most men were monogamously married would strengthen Rome. Legal changes included: (a) restricting married men from having extra-marital sexual relationships with women who were not registered prostitutes, (b) limiting the size of the inheritance that unmarried men could receive, (c) making divorce a formal legal process (to discourage serial monogamy), and (d) eliminating concubinage for married men and making the offspring of concubines unable to inherit wealth. A series of Roman emperors after Augustus, including Tiberius, Claudius, Hadrian and Severii, continued to reinforce these legal principles and adapt the law.[15] The evolution of this aspect of the Roman legal system is intimately intertwined with the emergence of greater sexual equality under the law [44, 101, 103].

Early Christian ideas about monogamy and sexual purity are a combination of the evolving Roman ideals and notions drawn from Greek stoicism. Christian ideals solidified and eventually spread throughout Europe, which was highly polygynous in the pre-Christian era and during the early days of Christianity. These ideas do not come unambiguously from Judaism (which permitted polygynous marriage until at least the 11th century), nor from the Christian Gospels. At best, the New Testament offers some vague recommendations for monogamy among church leaders in the Pastoral Letters [44]. In the Old Testament, the prophets and kings are all polygynous. There are, however, references to husband and wife being of "one flesh", which may imply monogamy as an ideal.

European aristocracies, which derived from clan-based tribal societies, were highly polygynous in the 5th century. However, all sought alliances with the Catholic Church, which worked vigorously to impose monogamous marriage on the aristocracy. As European kings gradually converted to Christianity, sometimes out of true belief and sometimes for political expediency, the Church increasingly controlled their marriages, and thus their legitimate heirs (that is, they controlled who had rights to political power). Since the lower strata of these societies, who were rapidly adopting Christianity, were economically limited to monogamous marriage anyway, the main line of resistance came from the nobility. Once the nobility began to accept monogamous marriage (without the harems of their peers elsewhere in the world), general monogamy and associated laws

[15] While supporting laws strengthening monogamous marriage (believing it was for the good of the Empire), most Roman Emperors (not all) voraciously pursued immense sexual variety in their personal lives [104]. They were monogamously married, but mated polygynously in extravagant fashion.

followed [43]. The medieval Church continued to adjust and spread the doctrines that reinforced monogamous marriage.

Historians have argued that this was one of the great social achievements of the Middle Ages [103], to put the peasants and the nobility on the same footing with regard to marriage, and it may have been a key step in the development of modern notions of equality—both of the equality among men, and of male-female equality. Realize that norms prescribing monogamous marriage temporally preceded all of the West's eventual development of democracy, equality, human rights, women's liberation, etc.

As noted above, modern monogamy likely spread out from Europe because these societies were so successful, militarily, economically, and politically [43, 44, 101, 103]. Monogamy has even now been made law in some Islamic countries [44], including Turkey (1926) and Tunisia (1956). The possibility that normative (often imposed) monogamous marriage was causal in the successful global expansion of European (and European-descent) societies is something that becomes increasingly plausible when we examine the societal-level effects of monogamy.

ALTERNATIVE HYPOTHESES

Other economic and evolutionary approaches to the spread of monogamous marriage posit that it arises from some form of fitness [105] or utility maximizing decision under particular circumstances [106]. Such models are useful if they help us understand how cultural evolution, driven by cultural group selection, could shape sets of interrelated social norms and formal institutions in such a way as to generate success in inter-group competition. There's little doubt that social norms about spousal number coevolve with norms regarding inheritance, transfer payments, and female sexual fidelity. Both of these approaches suggest how certain social or economic conditions might reduce the incentives for males to marry additional wives.

However, such approaches miss important aspects of marriage and culture. First, they fail to grasp that marriage is not merely pair-bonding, or a contract among those in the marriage. There is a community in which this pair-bonding occurs, and members of these communities often have strong opinions regarding what constitutes proper behavior for married persons. Failure to meet these shared expectations has downstream implications for a person's reputation and those of their children [29, 31]. In other words, most societies have one or a few normative marriage contracts, rather than leaving the matter up to private negotiation. Decision-makers, be they inclusive fitness or utility maximizers, have to consider how their behaviors will be judged by others. That is, norms exist, shape behavior, and influence both cultural and genetic evolution [30, 107].

Second, these approaches fail to address the expansion of monogamous marriage across Europe, and then across the globe. This spread began long before the industrial revolution (so it cannot be caused by modern economic development, as Gould et. al. suggest), and diffused into places with immensely different inheritance practices, norms of sexual fidelity, and marriage transfer payments (see historical sketch above).

Moreover, immigrants from polygynous to monogamous countries (or vice-versa) do not recalculate their inclusive fitness or utility upon arrival in their new home, as such approaches suggest. Unlike North America, French laws had permitted polygynously marrying African immigrants to settle in France. This led to a massive explosion of polygynous households there

(200,000), and to the predictable array of social problems. France subsequently changed its law in 1993 to halt such immigration. If people were fitness maximizers as Fortunato and Archetti [105] argue, immigrants should switch to prefer monogamous marriage upon arrival in France (no need for laws or "crack-downs"). They don't. In fact, press accounts suggest immigrant men use their relative wealth advantage—compared to their home country—to obtain even more wives [108]. Also see http://www.dw-world.de/dw/article/0,,1664241,00.html.

Fourth, none of these models explain why the richest men in the world do not marry polygynously. In Gould et. al.'s model, men trade additional wives off against obtaining a high quality wife in order to raise high quality offspring. Wealthy men could still marry polygynously by hiring a team of experts to compensate any shortcomings in their wives. In Fortunato and Archetti's model, men trade polygyny (and a divided inheritance) for a wife's willingness to increase his paternity certainty. The model doesn't deal with male inequality, however. Billionaires could trade hundreds of millions of dollars in an offspring's inheritance to each of several wives in exchange for increased paternity certainty (or hire a paternity certainty security force, as emperors did). By any inclusive fitness accounting, being the third or fourth wife of a billionaire will beat the monogamous deals offered by other men.

Fifth, putting aside immigrants, monogamously marrying countries have to continually suppress the outbreak and spread of polygynous communities—which is hard to explain if people are marrying monogamously based on fitness or utility calculations (they should "want" monogamy). Not only did high status Mormon males start marrying polygynously long before arriving in Utah (while living among monogamously marrying Americans), but the U.S. government spent decades working to suppress polygyny, using immense civil, military, and financial resources. Even in the modern world, estimates suggest that nearly 100,000 Americans currently live in polygynous households—despite facing the same environment in terms of human capital, inheritance laws, and marriage transfer customs as other non-polygynous Americans. Polygynous marriage is also spreading in the Islamic communities of Africans and African Americans in Philadelphia and New York. See NPR pieces on this: http://www.npr.org/templates/story/story.php?storyId=90886407 and http://www.npr.org/templates/story/story.php?storyId=90857818.

Finally, non-cultural theories cannot address why marriage prescriptions and prohibitions are so tied up with certain religions, and the desires of supernatural agents. From our perspective, religions with incentivizing supernatural agents are a form of cultural technology favoured by cultural group selection to galvanize group-beneficial social norms [109, 110]. Using supernatural sanction to sustain monogamous marriage may be a particularly instructive case since monogamous marriage runs directly counter to the interests of the most powerful men in any society. Without appealing to a higher power, and making monogamous marriages sacred, persuading kings and aristocrats to give up polygynous marriage may have been impossible.

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