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Conventions and moral codes: A Bayesian model of the spread and maintenance of social norms

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Publication Date

2023

Peer reviewed|Thesis/dissertation

UNIVERSITY OF CALIFORNIA

Los Angeles

Conventions and moral codes:

A Bayesian model of the spread and maintenance of social norms

A dissertation submitted in partial satisfaction

of the requirements for the degree

Doctor of Philosophy in Anthropology

by

Renée Vera Hagen

2023

ABSTRACT OF THE DISSERTATION

Conventions and moral codes:

A Bayesian model of the spread and maintenance of social norms

by

Renée Vera Hagen

Doctor of Philosophy in Anthropology

University of California, Los Angeles, 2023

Professor Brooke Anne Scelza, Chair

How do social norms spread in a population? Which processes affect whether a social norm persists over time or disappears quickly? These are the questions that guide this dissertation. In modeling the spread and maintenance of social norms, I employ and integrate two theoretical frameworks: cultural evolution theory, an anthropological framework that aims to model how culture changes over time and space and understands cultural change as somewhat analogous to Darwinian evolution; and sexual conflict theory, a theoretical perspective from evolutionary biology that investigates how conflicts of interests between the sexes are played out over evolutionary time. Throughout this work, I apply Bayesian statistical inference to empirically test hypotheses on norm change.

The term 'social norm' as used colloquially can have various meanings. *Descriptive* social norms refer to what most people in a population do; they describe common behaviors or conventions of a group. On the other hand, *prescriptive* social norms say something about what is morally right, about how the world ought to be, and how people should behave. I argue that this distinction is crucial for pinpointing the processes affecting the dynamics of

social norms, as descriptive and prescriptive norms are likely subject to some shared as well as distinct selective pressures and processes of change.

In Chapter 1, I apply the framework of cultural evolution theory to examine how a set of descriptive norms introduced by a cultural outgroup spreads in a population. Here the norms under study are perinatal care practices as recommended by the WHO and locally promoted by the Red Cross and government health workers among Himba women in the Kunene region of Namibia. Access to formal medical care is on the rise in this region, and medical workers regularly visit communities to promote WHO-recommended perinatal care practices. Based on interviews with 100 Himba mothers, I use Bayesian multilevel logistical regression models to examine how perceptions of group preferences, prestige ascribed to outgroup conformers, interaction with the outgroup, and access to resources affect women's uptake of medical recommendations concerning perinatal care. I find that women who perceive medical recommendations as common in their group prefer, plan and practice these recommendations more often themselves, and my analyses show that an observed shift towards medical recommendations regarding hospital birth and use of contraceptives is in line with predictions of conformity-biased social learning. Concluding this chapter, I argue that norm changes and the cultural evolutionary processes that can lead to them are not uniform, either in process or pace. Empirical studies like this one provide important examples of how these changes reflect local culture and circumstance. They are critical for better understanding the models that currently predominate in cultural evolution work, and can help bridge the gap between anthropology and public health by demonstrating where norm change campaigns might be most effective.

Chapter 2 takes as point of departure the somewhat paradoxical observation that many women support social norms that seem - from the perspective of western feminism - against their own self-interest. Women around the world support and promote patriarchal gender norms that justify men's dominance over women, assign men more rights than women, or that otherwise favor men over women. In this chapter, I employ sexual conflict theory to consider

whether women's attitudes towards patriarchal gender norms reflect their anticipated fitness costs and benefits. Using Bayesian multilevel cumulative probit models, I test whether these hypothesized fitness payoffs are consistent with self-reported attitudes of people in China, Japan, South Korea and Taiwan ($n = 18{,}317$). I find that as expected, women's gender norms are more egalitarian than men's but that older age is associated with increasing support for patriarchal gender norms. This age-effect is stronger for women, and this gender difference suggests the effect cannot be explained by a generational shifts in norms alone, but is in line with predicted changes in fitness interests. Unlike predicted under the 'gendered fitness hypothesis', I find little evidence that having more sons leads to more patriarchal gender norms. An association between the two seems largely driven by a preference for sons, and the gender of women's children is mostly unrelated to other gender norms. Lastly, in most populations higher social status correlates with egalitarian attitudes more so for women than for men. I conclude that part of the variation in women's attitudes towards gender norms may be explained through their varying interests in such norms depending on their age and marital status. Women's increased interests in patriarchy may in some cases result from a real decrease in the costs they experience, but can also reflect higher costs of social deviance from the culturally dominant gender ideology. Social status may be protective against the costs of contesting culturally dominant norms, and future work may investigate how social status and other factors may mitigate the price of going against the grain.

Lastly, in Chapter 3 I bring the two theoretical perspectives, cultural evolution and sexual conflict theory, together and argue that an underappreciation of the complex relationship between gender norms and sex ratios has hampered a successful understanding of sexual conflict in humans. This complexity may explain why some classic findings regarding sex ratios and bargaining power from the non-human animal literature are not always replicated in human populations. I review and expand upon existing theory to increase its applicability to humans, where gender norms regulate sex ratio-effects on sexual conflict and bargaining. Importantly, gender norms are in part a product of women's and men's sometimes conflicting

reproductive interests, but these norms are also subject to other evolutionary processes, and their flexibility is constrained. Gender norms shape sex ratio effects by constraining who is on the marriage market, how they are valued, and by affecting people's reproductive decision-making power. Norms about the value and status of women and men also directly affect sex ratios in many of the world's populations, and I hypothesize that they structure how individuals respond to market value gained or lost through biased sex ratios. In conclusion, an integration of sexual conflict theory and cultural evolutionary theory is required to address these complexities and vital to a full understanding of sexual conflict in humans.

The dissertation of Renée Vera Hagen is approved.

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2023

"One is not born, but becomes a women."

– Simone de Beauvoir, The Second Sex

"All happy families are alike; each unhappy family is unhappy in its own way."

– Leo Tolstoy, Anna Karenina

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ACKNOWLEDGMENTS

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PUBLICATIONS AND PRESENTATIONS

R.V. Hagen, 2023. Common behaviors and Moral Codes: Modeling the temporal dynamics of social norms. *Invited talk at the UCLA Behavior, Evolution and Culture Speaker Series* in Los Angeles, CA.

R.V. Hagen, H.C. Barrett, and B.A. Scelza, 2023. Understanding women's support for patriarchal gender norms in four East Asian countries. *In prep.*

R.V. Hagen, and B.A. Scelza, 2023. Sex ratios, gender norms, and why you need both to understand sexual conflict in humans. *In prep.*

R.V. Hagen, D.A. Knorr, S. Li, A. Mensing, and B.A. Scelza, 2022. Staying alive enhances both women's and men's fitness. *Behavioral and Brain Sciences 45.*

R.V. Hagen, B.A. Scelza, and H.C. Barrett, 2022. Understanding women's support for unequal gender norms in four East Asian countries. *Oral presentation at the annual meeting of the European Human Behaviour and Evolution Society* in Aarhus, Denmark.

S. Lew-Levy, ... **R.V. Hagen**, ... and H.E. Davis, 2022. Socioecology shapes child and adolescent time allocation in twelve hunter-gatherer and mixed-subsistence forager societies. *Scientific Reports 12*: 8054.

R.V. Hagen, 2022. Genetic diversity between human 'races' cannot be compared to dog breeds (Dutch title: De analogie met honden gaat niet op). *Opinion article in Volkskrant.*

R.V. Hagen, and B.A. Scelza, 2021. Adoption of outgroup norms provides evidence for social transmission in perinatal care practices among rural Namibian women. *Invited plenary talk at the Annual Meeting of the International Society for Evolution, Medicine and Public Health 2021, online.*

R.V. Hagen, and B.A. Scelza, 2020. Adoption of outgroup norms provides evidence for social transmission in perinatal care practices among rural Namibian women. *Evolution, Medicine and Public Health 1*: 161-173.

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CHAPTER 1

Adoption of out-group norms provides evidence for social transmission in perinatal care practices among rural Namibian women

1.1 Introduction

In its seminal 1996 report, *Care in Natural Birth: A Practical Guide*, the WHO states that the aim of care during a normal delivery is, "to achieve a healthy mother and child with the least possible level of intervention that is compatible with safety" (WHO, 1996). While the report notes that such care can come either inside or outside of the formal medical system, birth attendants should be properly trained, able to detect and diagnose problems and perform minor interventions. At the same time, they state uncomplicated births should take place, "...as close to home and her own culture as possible," and that the laboring woman should be, "...accompanied by people she trusts and feels comfortable with" (WHO, 1996). In the postnatal period, while acknowledging home births and continuing to emphasize the role of kin and other support partners, there is again substantial focus on continued contact with medical professionals and promoting "best practices" including exclusive breastfeeding and, when needed, treatment of mother and infant with antibiotics and antiseptics (WHO, 2005). In many parts of the world, these recommendations, and the myriad policy and health interventions that stem from them, require women to straddle two normative contexts during the perinatal period: those of their home community, and those of the biomedical setting they come into contact with. Understanding how this dual context affects women's decision-

making, and their propensity to adopt new norms and practices is critical to public health. Here we use cultural evolution theory to make predictions about what shapes women's preferences, plans and practice related to perinatal care, set alongside predictions that are drawn from more traditional theory and practice within public health. This dual perspective allows us to parse out how an evolutionary perspective is useful to thinking about behaviors and norm change in the context of perinatal care, as well as where it falls short.

Cultural evolution theory has been shown to have significant explanatory power in predicting the emergence and spread of social norms (Boyd & Richerson, 1985; Axelrod, 1986). At the core of this theory is the idea that culture is made up of information that is learned and transmitted socially, with some cultural traits more likely to be passed on than others (Boyd & Richerson, 1985; Richerson & Boyd, 2005). Thus, cultural evolution theory can inform policy interventions aimed to promote behavioral change, but applied studies are rare (Efferson *et al.*, 2019; Muthukrishna, 2019). This study provides much-needed empirical data on the effect of social learning biases on norm change by examining the adoption of perinatal care norms among Himba women living in the Kunene region of northwest Namibia, where 55 out of 1000 live births do not survive beyond the first month (MoHSS & ICF, 2014, p. 88). Himba communities are currently transitioning from having very little access to formal medical care to a setting of increased access, acceptance and use.

Computer simulations and experiments have shown that learning behavior socially is often more advantageous than individual learning (Henrich & Boyd, 1998; Kameda & Nakanishi, 2002; Mesoudi & O'Brien, 2008; Rendell *et al.*, 2010; Perreault *et al.*, 2012). When individuals follow a social learning strategy, they do not copy cultural traits at random but are often biased towards particular types of information or individuals to learn from (Henrich, 2001). Social learning becomes particularly dynamic when groups interact, as this opens up the potential for new ideas to enter a population and spread (Henrich, 2001; Jordan & Shennan, 2003; Su *et al.*, 2010; Lycett, 2014; Maliepaard & Alba, 2016). These interactions are becoming increasingly common as urbanization and exposure to markets and communication

technology increases. Public health is a rich arena to study these changes because, aside from schools, health care is often one of the first forums for interaction between majority and minority cultures in rural areas. Even where access to formal clinics and hospitals is limited, health workers often travel to remote areas, bringing with them recommendations, new technologies (e.g. birth control, vaccinations), and information about how to further utilize the biomedical system. As interactions with the outgroup (in this case the medical community) increase and exposure to new ideas about perinatal practice begins to penetrate a community, interesting questions emerge about how that information spreads, and whether and to what extent it supplants existing beliefs and practices. Within this arena, studying norm change in relation to perinatal care is particularly interesting from an evolutionary perspective because of its substantial impact on fitness (Kohler *et al.*, 2001; Munshi & Myaux, 2006; Howard & Gibson, 2017).

1.1.1 Theories of norm change

Norms and behaviors can serve as markers of group identity and facilitate interaction between group members (Barth, 1969; Anderson, 1983; McElreath *et al.*, 2003). Self-identification with a social group provides individuals with prescriptive norms and guidelines for appropriate behavior in a particular setting (Hogg, 2000), and perceptions of the norms and behaviors of the members of one's 'ingroup' have been shown to affect behavior in a variety of settings (Eisenberg *et al.*, 2005; Rimal & Real, 2005; Nolan *et al.*, 2008; Kapadia *et al.*, 2012). For example, Dynes et al. (2012) found that Kenyan men and women's use of contraceptives is influenced more by their perception of their social network's approval of family planning, than by their own approval. For norm change to occur, group members need to shift both their perception of what the majority of others prefer, and their belief about what is expected of them. There are a variety of mechanisms through which these shifts can occur, and two of the most widely discussed within evolutionary frameworks are prestige bias and conformity bias.

Prestige-biased social learning is a strategy in which individuals choose to imitate those who are known to be successful, knowledgeable, or skillful (Henrich & Gil-White, 2001). Evidence for prestige-biased transmission comes from mathematical modeling and experimental studies indicating that people differentially attend to more prestigious individuals, and that cultural traits diffuse more quickly when adopted by role models or 'opinion leaders' (Valente & Pumpuang, 2007; Atkisson *et al.*, 2012). Interventions in public health have also shown evidence for prestige bias. Among women in rural Bangladesh, the influence of prestigious ingroup members on attitudes towards contraception has shown to be substantial: government programs to promote contraception are more successful when conducted as group discussions in the homes of local opinion leaders, than when field workers visit homes individually (Kincaid, 2000). Prestige bias could foster the adoption of a new norm in one of two ways. First, if ingroup members view outgroup members as more prestigious, outgroup norms could become pervasive through general intergroup exposure (Boyd & Richerson, 2002). Second, in some cases individuals privilege local people of high status over those from other groups (Richerson & Boyd, 2005). In this case, if a few prestigious local actors switched to the outgroup behavior, prestige bias could occur on a local scale, with minimal general contact between the in- and outgroups (Bunce & McElreath, 2017). This might occur if those who were highly regarded within the community also had more exposure to town or outside groups (see below Henrich & Gil-White, 2001).

Another way in which individuals may choose which norms to adopt is by attending to the frequency of different norms in their group. For example, in studies of contraceptive uptake in Bangladesh and Poland, attitudes about contraception held by others within the social network were more predictive of women's contraceptive use than individual-level factors (Gayen & Raeside, 2010; Colleran & Mace, 2015). In another example, Rogers and Kincaid (1981) show that in Korea use of particular contraceptives is clustered by village, again indicating localized copying. Conformity bias occurs when individuals display a disproportionate likelihood of copying the majority, beyond what would be expected by random

copying (Boyd & Richerson, 1985; Henrich & Boyd, 1998). Conformity bias is predicted to be an important driver of norm change once the initial stage of norm adoption has passed and a new norm has emerged as the most common (Rogers, 1995), and is particularly adaptive in relatively stable environments and when enough cultural models are available (Perreault *et al.*, 2012).

Where norm adoption occurs via intergroup interaction, early and frequent exposure to the outgroup can lead to increased copying of the outgroup norm. In a study on interethnic interaction in Peru, Bunce and McElreath (2017) show that indigenous Matsigenka who frequently interact with an ethnic outgroup through market participation and education show more outgroup norm adoption. In their study the timing of exposure to outgroup norms was important: earlier favorable exposure, such as through education, and positive experiences with an outgroup were associated with more outgroup adoption. Exposure to an outgroup has also been shown to influence the adoption of perinatal care practices. Existing studies on facility-based births have linked years of education with increased use of medical delivery services (e.g. Shahjahan *et al.*, 2017; Nunu *et al.*, 2019), while previous experiences of mistreatment, discrimination and inadequacies in care have been shown to decrease women's use of services (Afsana & Rashid, 2001; Duong *et al.*, 2004; Bohren *et al.*, 2015; Sacks *et al.*, 2017). The effects of exposure to outgroup norms can be strengthened through interethnic assortment on norms: individuals that already hold more outgroup norms are likely to interact more with that outgroup.

The importance of social influence in promoting behavior change is also underlined in much public health research, where it is widely accepted that knowledge and information alone do not drive behavior change, and that social norms can be important determinants of health behavior (Kelly & Barker, 2016). However, this work also focuses on practical facilitators and barriers of norm change. Individual differences in wealth and access to resources are consistently associated with whether or not women switch to practicing new health-care practices. Bohren et al. (2014) find that logistical and monetary barriers significantly inhibit

hospital births for women in low- and middle-income societies. Women may be required to walk or use public transportation to reach medical facilities, and finding transportation during off-hours can be costly or impossible (Wild *et al.*, 2010; Mwangome *et al.*, 2012; Essendi *et al.*, 2015). Higher levels of contraceptive uptake have been found among women with more individual wealth and among women in wealthier households (Stephenson *et al.* 2007; Elfstrom & Stephenson 2012, but see Mace *et al.* 2006). When deciding to spend money by visiting the hospital, not only hospital fees but also hidden costs of hospital visitation such as medical supplies, food and lodging for family members can be prohibitive (Ezechi *et al.*, 2000; Wild *et al.*, 2010; Mwangome *et al.*, 2012; Bohren *et al.*, 2014). Furthermore, the cost of hospital delivery is sometimes seen as extraneous and unnecessary when childbirth is perceived to be a non-medical event (Wild *et al.*, 2010). Insufficient wealth and resource access can thus be important barriers to the practice of medically recommended behaviors among women who would prefer to adhere to them. individuals with fewer resources may be less inclined to plan to follow more costly medical recommendations, or may plan to follow a recommendation but as a result of insufficient funds be unable to.

1.1.2 Norm change: Preferences, Plans and Practices

An important link between social norm preferences and actual practices has been highlighted in the public health and development literature (Macky *et al.*, 2015). An individual's preference for a social norm can be influenced by her perception of the opinions of the reference group, those people whose expectations matter to her in the situation of a norm. Important aspects of social influence are what she thinks others in the reference group do, and what she thinks others in the group approve of (Macky *et al.*, 2015). Situational factors can act as either barriers or facilitators of the ability to behave in accordance with preferred norms, potentially leading to discrepancy between preferences and practices. For example, discrepancy occurs when someone who prefers to give birth at home, but is rushed to the hospital due to complications, or conversely, when someone intends to give birth at the hospital but

Predictions	Preferences	Plans	Practices
Women are more likely to adopt the norm they think most others in their group support	Strong support	Strong support	Strong support
Women who would rather be like outgroup-assimilating others are more likely to adopt medical recommendations	No support	No support	No support
Women who interact with the outgroup more frequently are more likely to adopt outgroup norms	No support	No support	No support
Women who have more access to resources are more likely to adopt outgroup norms	-	No support	No support

Table 1.1: Predictions and summary of results.

is unable to secure the necessary resources to pay for transport to town.

The current study examines how social learning processes and situational factors affect the uptake of medical recommendations at three levels. We examine women's personal preferences, their plans for their next birth, and their actual practices during a previous birth. Within this context we examine the following question: How do various cultural evolutionary processes affect preferences, plans and practices related to perinatal care among Himba mothers? We have identified a series of predictions derived from cultural evolution theory and public health to ascertain the relative influence of four key factors: conformity bias, prestige bias, interaction frequency and resource access (table 1.1).

1.2 Methodology

1.2.1 Study Population

Around 15,000 Himba live in the Kunene region in Northwest Namibia, where most are semi-nomadic agro-pastoralists. Although Himba have a long history of interaction with neighboring ethnic groups, policies of the previous German and South African colonial gov-

ernments and the post-independence Namibian government historically restricted trade and participation in the cash economy, leading to isolation from mainstream markets and commercial centers (Bollig, 1998). Today, Himba are becoming increasingly market-integrated, although communities vary in their distance to town, proximity to the main road and participation in the cash-economy (Bollig, 1998, 2006; Moya & Scelza, 2015). Most Himba women continue to give birth in the community, and many return to their natal homes from late pregnancy until 1-6 months after birth in order to obtain help and care from their maternal kin (Scelza, 2011; Scelza & Hinde, 2019). Women's mothers commonly act as midwives, provide support in learning to breastfeed and oversee postpartum care. However, in accordance with WHO guidelines, the last decade has seen an increase in maternal health care programs. Professional health care workers visit Himba settlements in the region, where they educate women about breastfeeding and prenatal care and encourage them to give birth at the regional hospital.

The regional hospital is located in Opuwo, and a small clinic providing basic care is located in Okongwati, a village 15 km south of Omuhanga. Since 2013, a government-employed health worker has been stationed in Omuhonga, and a maternal health outreach program by Red Cross Namibia was active in the region until 2016. The hospital, clinic and nurse station both provide free contraception (injectables, pills and condoms at the clinic and hospital, condoms at the nurse station). The health worker visits compounds in Omuhonga on a monthly basis, distributes free condoms and promotes WHO-recommendations. Women are encouraged to visit the hospital for pregnancy check-ups and to give birth there. Birth-assistance is provided at the clinic in emergencies only.

Data was collected in July and August 2018 in Himba settlements within a 15 km radius of the regional capital Opuwo (peri-urban sample), and in the Himba settlement of Omuhonga, which is located 122km northwest of Opuwo (rural sample). Two sampling locations were used to be able to detect whether acculturation was higher among women living closer to town, and whether women in the peri-urban area faced fewer logistical barriers to utilizing

the formal health-care system.

1.2.2 Focus Groups

Two focus groups were held in Omuhonga during the first phase of the project, with a total of 7 women between 18 and 42 years old. The conversations addressed norms and practices regarding behavior of pregnant women, childbirth practices and care for both mother and infant in the perinatal period. In addition, two unstructured interviews were conducted with health workers posted in Omuhonga and Opuwo. Information was acquired in these interviews about medical care available in the region, health interventions and medical outreach programs.

Together, these discussions were used to create a list of eight norm domains we believed would differ between traditional practices and local medical recommendations (table A.1) to be used in the structured interviews. Five of the norms are commonly recommended by medical workers (giving birth in the hospital, immediate onset of breastfeeding, washing both baby and mother with water after birth, and the use of contraceptives to limit fertility). Another three are traditional postnatal practices: the use of *mopane* (*Colophospermum mopane*) steam for the mother to stem bleeding and prevent infection, putting a paste of cow butter and herbs on the baby's skin (*otjizumba*), and wearing a special necklace (*oruhai*) in the weeks before birth, which is believed to protect the infant from getting their umbilical cord wrapped around their neck during birth.

1.2.3 Structured Interviews

An opportunistic sample of women was recruited for structured interviews, conducted in Omuhonga and the peri-urban area surrounding Opuwo. The only inclusion criterion was that participants must have given birth in the last two years. The interviews had three parts: demographic data, questions related to the key predictors, and questions about perinatal

preferences, plans and practices. First, we collected basic demographic information including age, education and a reproductive and marital history, as well as information about previous contact with health workers.

Next, we asked questions related to our four main predictor variables (table 1.3). To test for the effect of perceived Himba majority preferences, we asked women which norms they think most other Himba women prefer (e.g. hospital or home birth). To measure prestige bias, we showed women two drawings: one depicting a woman in traditional Himba dress, who we explained lives in a small village, owns livestock, and has a traditional Himba lifestyle, and another showing a woman wearing western clothes, who we explained lives in Opuwo, has a salary-paid job, and is Himba but does not live a traditional Himba life and practices perinatal care norms as recommended by medical workers. We then asked participants: 1) Which woman would you prefer to be like? 2) Which woman would you like your daughter to be like? Similar questions have been used in surveys addressing perceived prestige (Cheng *et al.*, 2010; Brand & Mesoudi, 2019). To measure interaction with the out-group we recorded years of schooling, proximity to the provincial capital Opuwo, frequency of visits to Opuwo and their previous use of the hospital. Finally, individually owned wealth and access to cash informed us on women's access to resources. Marital status was also used as a measure of resource access, as married women typically have better access to household-level wealth than unmarried women. The interview questions are further described in table 1.2.

To generate data for our three main outcome variables, we asked which perinatal care norms participants personally prefer, which norms they plan to practice for their next birth and which norms they had practiced for their most recent birth (e.g. "Do you think it's better to give birth at home, or at the hospital?", "For your next birth, are you planning to give birth at home or at the hospital?", "For your last child, did you give birth at home or in the hospital?").

Finally, in order to confirm that the qualitative data from our focus groups used to construct the norms questions was accurate for the focal sample, we asked respondents

which norms they believed a Himba woman who follows traditional practices and what is recommended by medical workers.

1.2.4 Model Descriptions

We modeled the adoption of medical recommendations as a Bernoulli distribution where the probability of adopting a recommendation is a logit-linear function of the population-level effects described below. All models included varying intercepts per individual ID, per norm and per village, and population-level effects for age, age-corrected parity and a dummy variable indicating whether or not the participant's mother was alive. This last variable was included because mothers often act as midwives and are important sources of advice, knowledge and help during the perinatal period (Scelza, 2011; Scelza & Hinde, 2019).

Our baseline model included only these variables. Other models included effects for our measures of conformity bias, prestige bias, and access to resources as described in table 1.2, with varying slopes per norm. In the conformity bias models, we compared whether women's preferences, plans and practices matched their perceptions of the ingroup majority preference. The main predictor variable in the prestige model was a composite score of the questions who the participant wants herself and her daughter to be like (see above), and the resources model included separate variables for the different types of resources as listed above. Our models for outgroup interaction frequency included only effects for education and proximity to Opuwo, but not hospital visitation or visits to Opuwo, as visiting the hospital is required for practicing two of the medical recommendations (hospital birth and using birth control), and the hospital in Opuwo was most often utilized for this. These variables can be both a cause and an effect of adopting the medical recommendation in these cases. To avoid collider bias (McElreath, 2016; Rohrer, 2017) we ran a bivariate model of the effect of hospital visitation on practices excluding the norms of birth location and birth control. The same models were also run to predict women's preferences including only those women who at their previous birth behaved conform the traditional practice, as these women had

Predictions	Model	Operationalization	Measurement
Women are more likely to adopt the norm they think most others in their group support	Conformity bias	Do you think most other Himba women prefer [traditional norm] or [medical recommendation]?	Traditional Himba norm or medical recommendation (binary)
Women who would rather be like outgroup-assimilating others are more likely to adopt medical recommendations	Prestige bias	Vignettes and drawings of a woman living a traditional Himba lifestyle and an outgroup- assimilating woman.	Composite score (0-2)
Women who interact with the outgroup more frequently are more likely to adopt outgroup norms	Interaction frequency	Education	Years completed (0-10)
		Proximity to Opuwo	Rural or peri-urban (binary)
		Number of visits to Opuwo over the last six months	Count (0-6)
		Hospital visitation	Never or ever visited (binary)
Women who interact with the outgroup more frequently are more likely to adopt outgroup norms	Resource access	Do you have N\$100 right now?	No or yes (binary)
		If you needed money to go to the hospital, would you be able to borrow it from someone?	No or yes (binary)
		Tropical livestock units (TLU)	No. of cattle x 0.7 + sheep/goats x 0.1
		Marital status	Unmarried or married (binary)

Table 1.2: Description of variables included in multivariate models and their operationalizations per prediction.

the potential to shift to the medical recommendation.

1.2.5   Data analysis

Data cleaning and analysis took place in RStudio (version 1.1.463). 2% of data points were missing and this data was imputed with multiple imputation (R package `mice`). Continuous variables were centered around the mean (fig. A.3 shows the correlation of predictors before centering). To examine the extent to which the models for conformity bias, prestige bias, outgroup interaction, resource access, and the null model) explain adoption of medical recommendations in personal preferences, planned behavior and previous birth behavior, these models were tested through Bayesian logistic regression (R package `brms`, Bürkner 2017). Bivariate and multivariate models were run with 3 chains of 5000 iterations each, including a warm-up of 1000 iterations. Weak priors were assigned to all parameters to ensure model fit. We then compared the multivariate models based on their predicted out-of-sample deviance using PSIS-LOO with K-fold cross-validation, which produces robust weight scores for low sample sizes (Piironen & Vehtari, 2017; Vehtari *et al.*, 2017).

After selecting the model with the lowest out-of-sample deviance, we made counterfactual predictions to calculate the absolute effects of the main predictor by varying only this predictor and holding the other variables constant. Then we subtracted its posterior predictions of women's previous practices from the posterior predictions of their current preferences, to calculate how much the posteriors of practices and preferences differed per norm.

1.3   Results

We interviewed 101 women who had given birth within the last two years. One woman dropped out after completing less than 25% of the questions, leaving a sample of 100. Table 3 describes the main characteristics of our participants. Participants were between 16 and 48 years old (average 26), with parity ranging between 1 and 12 (average 3.8). Women in the

N		100
Age	Mean	26.76
	SD	7.43
	Range	$16 - 48$
Parity	Mean	3.81
	SD	2.47
	Range	$1 - 12$
Marital status	Percentage married	56
Mother alive	Percentage	90
	Mean	0.98
Years of education	SD	2.04
	Range	$0 - 10$
	Mean	1.26
Tropical livestock units	SD	2.08
	Range	$0 - 14$
	Preferences	6.0
Medical recommendations adopted	Plans	5.7
	Practices	5.3

Table 1.3: Demographic characteristics of the sample.

rural sample owned more livestock and had completed more years of education than women in the peri-urban sample, but otherwise the two samples were very similar (table A.2). All women had been visited by health workers at least once before the start of our study. These visits typically included recommendations and information about hospital birth, immediate and exclusive breastfeeding and use of contraception.

Confirming our expectations, respondents showed strong agreement about which behaviors they associated with the reference categories of Himba women practicing local traditions and medical workers (see table A.1). There was one exception: respondents believed that most Himba women use at least one contraceptive method introduced by medical workers (condoms, contraceptive pill or injection), signifying adoption of these recommendations has already occurred. Out of the nine norm domains examined, on average participants had preferred, planned and practiced 6.0, 5.7 and 5.3 medical recommendations respectively. Urban and rural women were similar in number of recommendations preferred and planned, but

urban women had practiced on average one recommendation more than women in the rural sample (see fig. A.1). For all norms, women were quite accurate in reporting the preferences of the majority of other Himba women; those norms preferred by most women in our sample were also most often nominated as majority preference (see fig. A.2).

1.3.1 Social transmission and norm change

We fit five multivariate models (one base model and one model for each of our main predictions: conformity bias, prestige bias, outgroup interaction and access to resources (see fig. A.3 for the correlation between predictor variables), and compared them using their predicted out-of-sample deviance. Figure 1.1 shows the posterior distribution of our predictors on the probability to adopt a medical recommendation on average for all norms.

Across our three outcome variables (preferences, plans and practices) the conformity bias models scored best in minimizing out-of-sample deviance and each is assigned over 99% of the model weight (fig. A.4). These models indicate that women who believe most others have adopted more medical recommendations are more likely to prefer, plan and practice medical recommendations themselves.

We find little support for the prestige-bias hypothesis that women who would rather be like outgroup-assimilating others are more likely to adopt medical recommendations. Although this predictor seems to be positively correlated with preferences and plans to practice medical recommendations in the multivariate models, the prestige model has little weight when compared to the other models. Although the adoption of medical recommendations was slightly higher in the urban than in rural sample, the effect of living in the urban region disappears when considering other variables determining interaction frequency. In this model, years of education is weakly associated with more recommendations planned but not with preferences or practices. When we model the effect of hospital visitation and frequency of visits to Opuwo on practices excluding norms that require hospital visitation (birth location and birth control), we found no effect on practicing medical recommendations. The

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same results were found when only including those women who at the time of their previous birth followed the Himba tradition and who thus had the potential to shift to the medical recommendation (fig. A.5 and A.6).

Because the conformity bias models were assigned over 99% of the model weight in preferences, plans and practices, we now shift our focus to these models for the rest of our analyses. Counterfactual predictions based on these models (in which the variable of interest is manipulated and the other variables are held constant) indicate that the absolute effects of women's perception of others' preferences are considerable (fig. A.9). The effect is strongest for women's own preferences, increasing her chances of preferring the same medical recommendation from 28 to 75%. It is also an important influence on the plans women make (41 to 74%), as well as on the norm they followed during their most recent birth (44 to 63%).

Next, we aimed to examine ambiguities between practices and preferences. In the current study, we asked women to project forward by asking them about their plans and preferences, and we also asked them about their previous behavior. This allows us to create a proxy for the baseline distribution of behaviors (frequency of past behaviors) and compare that to people's preferences now.

We found considerable variation in norm adoption across the eight behaviors we studied (fig. 1.2). For five of the eight norm domains, the proportions of Himba women preferring and practicing the medical recommendation do not differ significantly from each other. This means that random copying alone could produce results similar to those in our findings. However, in two cases there is strong evidence that a shift away from a traditional practice toward a preference for a medical recommendation that exceeds what would be expected from random copying (fig. 1.3). When asked about use of medical contraception, 77% of women report having ever used contraceptives whereas 91% prefer to do so now or in the future. In the second case, less than half of women (47%) reported having actually given birth in the hospital, whereas 85% of women reported a preference for giving birth in the hospital. One other norm showed clear differences between practiced and preferred behavior,

but in the opposite direction: while 83% of women prefer to wear the *oruhai* necklace, only 67% did so before their last birth.

These discrepancies between current preferences and previous practices may indicate that women were not able to behave in accordance with their preferences. In the case of the *oruhai* necklace, our ethnographic data suggest that circumstantial factors can prevent women from wearing the necklace, even when they want to. For example, the family may be unable to adhere to ritual requirements necessary for the *oruhai* ceremony, or the woman may not wear the *oruhai* necklace because she is required to wear another necklace, such as the one required when you are mourning a close relative. On the other hand, the observed increase in preferences for hospital birth and the use of contraceptives in comparison to previous practices could mark a true shift in preferences as the differences are significantly larger than would be expected under random copying, although again variation in the ability to practice one's preferred behavior or other learning biases such as content bias may also have caused this shift.
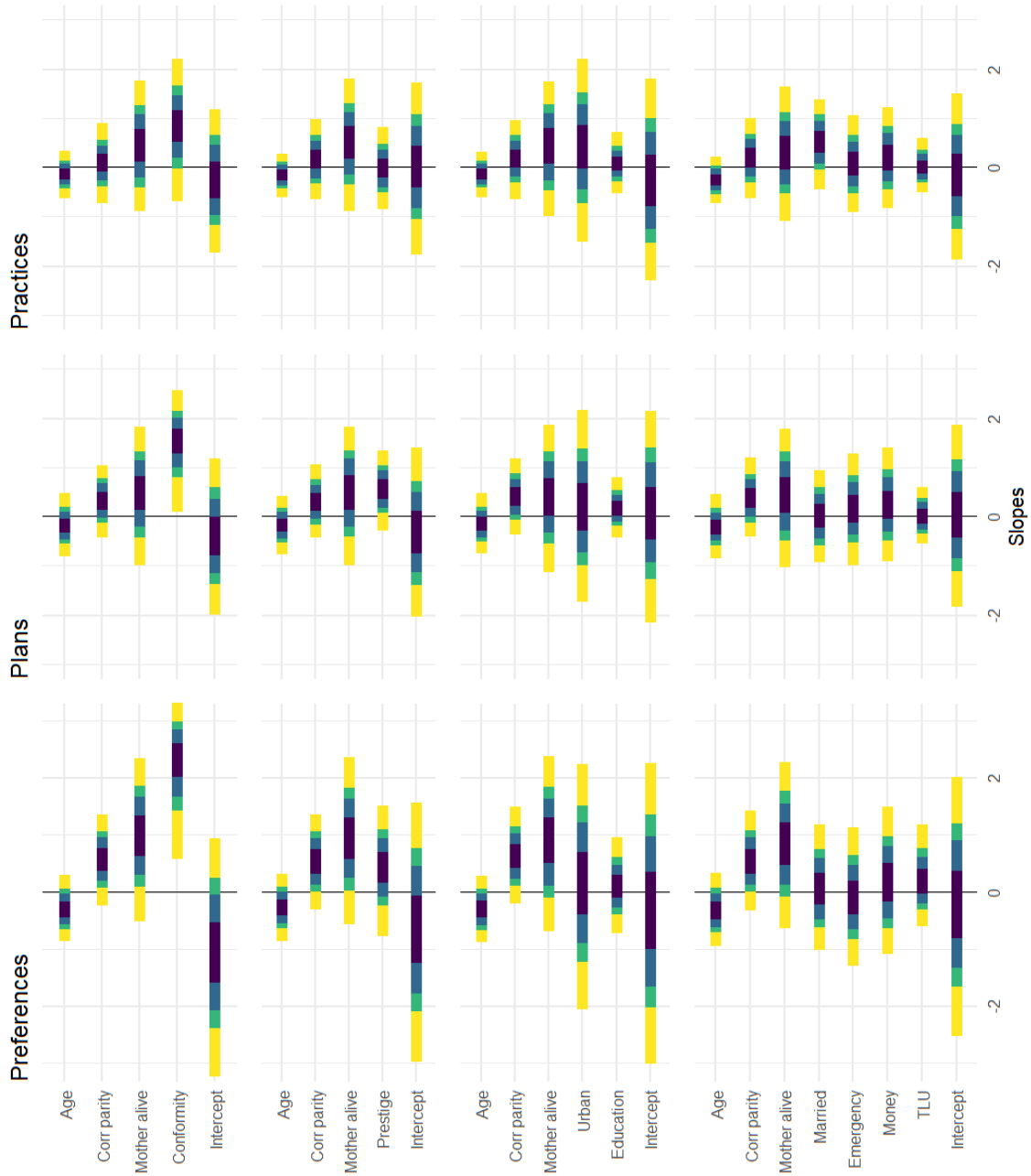
Figure 1.1: Posterior distributions of the population-level effect sizes averaged overall norms. Effect sizes for the models for conformity bias, prestige bias, interaction frequency, and access to resources are shown on a logit-scale. The colored bars indicate credible intervals 0.99 (yellow), 0.9 (green), 0.8 (blue) and 0.5 (dark blue) of the effect sizes. See figure A.3 for the numerical values of these distributions. These effect sizes indicate the average effect on all norms and in all villages, as varying intercepts for norm and village are not included. The variation between norms and between villages is shown in figs. A.7 and A.8.
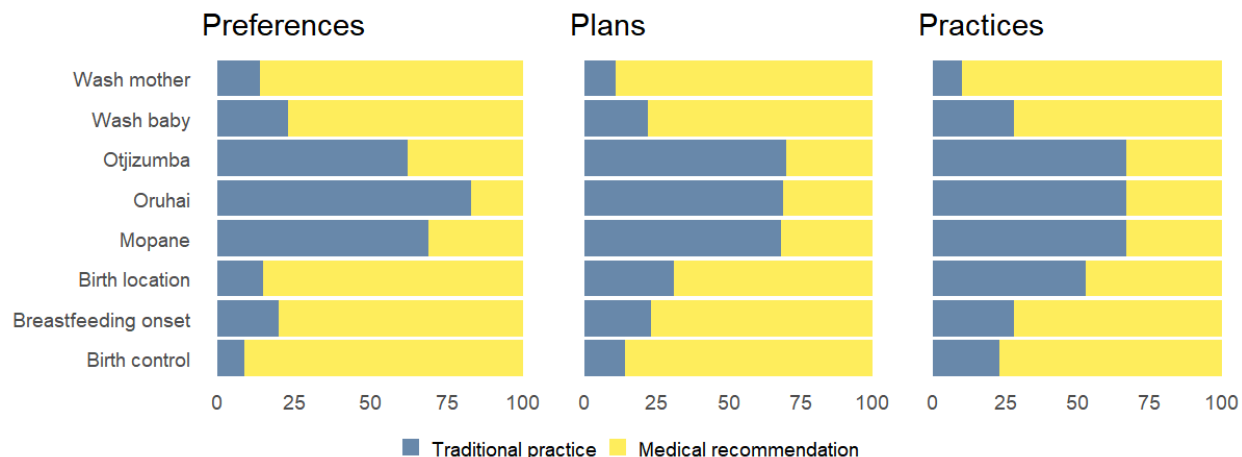
Figure 1.2: Frequency with which medical recommendations are adopted in preferences, plans and practices per norm domain. Percentage of individuals who adopted the Himba tradition is displayed in blue, percentage adopting the medical recommendation is displayed in yellow.
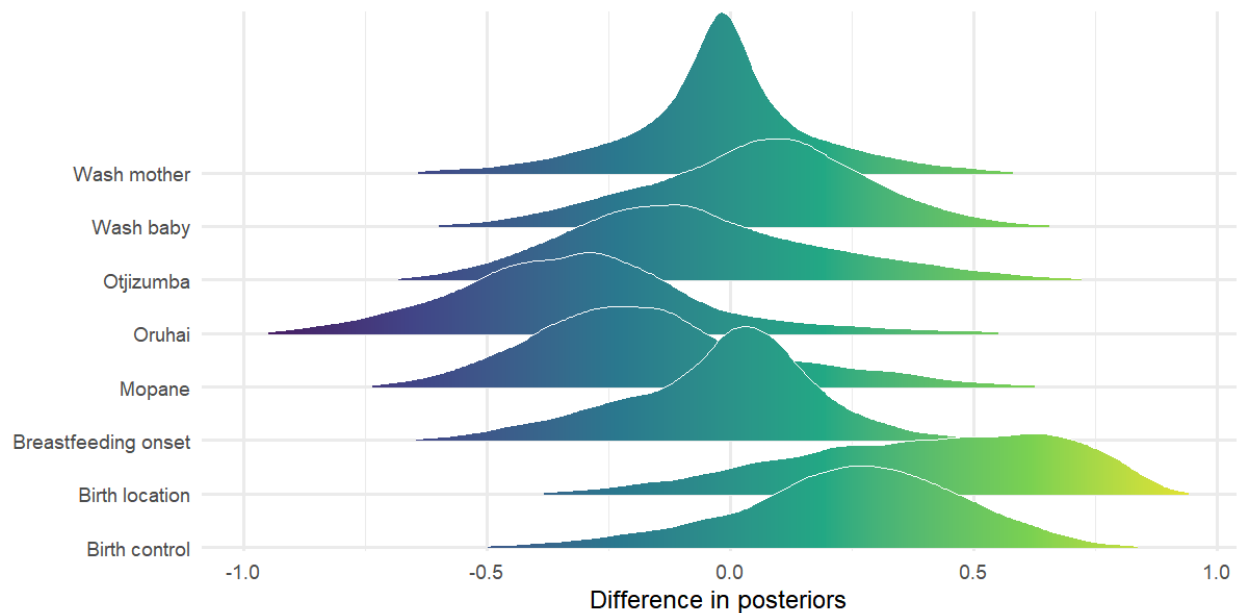
Figure 1.3: Per norm predicted difference in posteriors of practices and preferences. Positive values indicate norm domains in which the Himba tradition was more often practiced at women's previous birth but the medical recommendation is more often preferred, and negative values indicate the medical recommendation was practiced more often before but now more women prefer the Himba tradition. Values around zero indicate no change (as many people both practiced and prefer either the Himba tradition or the medical recommendation). The parameter values used in this model are listed in table A.4.

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1.4   Discussion

Choosing where to give birth, and how to feed and care for newborn infants can have important fitness consequences. Labor complications are often unpredictable and can be life-threatening, and immediate professional health care can greatly reduce maternal and infant mortality in the perinatal period (WHO, 2005, 2019). Similarly, immediate and exclusive breastfeeding has been shown to reduce the risk of infection-related infant mortality, because of immunological and nutritional benefits as well as reduced exposure to contaminated water (Jason *et al.*, 1984; Shahidullah, 1994; Arifeen *et al.*, 2001; Edmond *et al.*, 2006; Sankar *et al.*, 2015). Because of this, health practitioners are highly motivated to influence women in rural areas to take advantage of healthcare facilities and adopt WHO recommended practices. However, empirical case studies of norm change remain rare, limiting the use of cultural evolution theory for practical purposes, a gap that we address in this study.

For norm change to occur, group members need to shift both their perception of what the majority of others prefer or do, and their belief about what is expected of them. We find strong evidence of norm change related to perinatal practices among the women in our study. The majority of women sampled had shifted many of their preferences, plans and practices to match medical recommendations. Women are more likely to support medical recommendations when they think that most others prefer these norms, showing that social transmission is a driver of norm change. A closer examination comparing previous practices and current preferences per norm domain suggests that although some of these dynamics can also be explained as the result of random copying, we detected significant changes in some norms, particularly birth location and use of contraception. These findings are consistent with predictions from conformity-biased social learning, but we cannot exclude the possibility that other learning processes such as content or prestige biases or random learning are what is driving the changes.

Importantly, while we have shown that preferences and practices do not always align, the

cultural evolution literature currently does not address whether individuals should attend to others' behavior or their beliefs when deciding which cultural traits to copy. As hospital births were not the most common behavior until recently, the currently stronger preference for hospital births can only result from conformity-biased learning if women based their choices on others' preferences. It is plausible that this is the case, as the women in our study were accurate in reporting others' preferences. Additionally, more rapid change can occur when individuals change their preferences in response to what they believe most others prefer rather than what they actually have done. This may be especially relevant to norms related to behaviors that are more spaced in time, like births. In support of this, on-the-ground ethnographic observations of this population over the last 10 years indicate that there have indeed been rapid shifts in both the uptake of contraception and utilization of the hospital for births. In a 2010 survey conducted by one of us (BAS), hospital births were extremely rare even among younger women ($<1\%$ of all recorded births, n $= 428$) and contraceptive use was also quite limited. In the last 10 years access to information about both have increased dramatically.

Prestige bias, as measured in our study, did not affect the uptake of outgroup norms in our study. 49% of women found outgroup-assimilating Himba women prestigious, but those who did so were not more likely to adopt outgroup norms themselves. These findings indicate that a bias towards outgroups or outgroup-assimilating individuals was not influencing outgroup norm adoption at the time of study, although we cannot rule out that the women in our study preferentially copied prestigious others who practice or prefer medical recommendations but otherwise are more like themselves. In addition, many of the studied outgroup norms were already quite common at the time of our study. Prestige bias may have been more important in the initial spread of new perinatal care norms, which our data do not capture. Ethnographic data suggests that this period might be quite brief. Women only began mentioning that they were being encouraged to go to the hospital to give birth in 2017, one year before these data were collected. In 2010, the last time systematic data on

birth location was collected, only 3 women out of 118 had given birth in the hospital.

Contrary to our expectations, living closer to the provincial capital is not associated with more outgroup norm adoption. Other factors which have been shown to be important in previous studies were not predictive here. Schooling had no effect on adoption of outgroup norms. Although we had included years of education as a measure for intergroup interaction, an ethnographic perspective on the Himba context offers clues as to why education does not increase outgroup norm adoption. Most of the women who had received any education (83%) had gone to schools in villages close to Himba settlements, where they shared classrooms with students from other ethnic groups but away from urban centers.

1.4.1 Disparities in norm adoption

Looking at each of our eight norm domains individually highlights some important patterns. We do not see uniformity in the adoption of new practices. While we clearly show that peri-natal care norms promoted by medical workers are steadily being adopted, some traditional practices remain robust. Giving birth in the hospital, immediate initiation of breastfeeding; use of contraceptives, and washing of both mother and infant after birth had already been adopted by the majority of women in our sample at the time of this study.

Traditional practices that conflict with medical recommendations, e.g. home delivery vs. hospital birth and delayed vs. immediate onset of breast feeding, are most susceptible to replacement. But as our results show, perceptions of a majority preference for the new norm do not invariably lead to the erosion of traditional practice. Traditional norms that are not in conflict with new norms, such as wearing a traditional *oruhai* necklace in the perinatal period, and using a mixture of herbs to clean the baby, persist among Himba women. These norms are not discouraged by outgroups, are relatively cost-free and are important cultural markers signaling Himba identity. Whether a traditional norm stays or goes likely depends on the perceived benefits of change, as well as the costs of maintaining the tradition.

The gap observed between previous practices and current preferences regarding birth control, birth location and use of the *oruhai* necklace is possible evidence of conformity bias; however, another explanation is that there were unmeasured barriers preventing women from enacting their preferences. Some women cited situational barriers as reasons why they were unable to use the hospital, such as not being able to get to the hospital in time. Given this, we expected that access to resources might have an effect on outgroup norm adoption (Bohren *et al.*, 2014), but we did not find evidence for this. It may be that the measures of resource access we used were too crude, or that logistical barriers such as access to transportation, or circumstantial factors (e.g. going into labor earlier than expected) could be leading to the difference between plans and practice. Similarly, in a highly mobile, rural population like this, women may find that uptake of contraception is difficult even when desired. Circumstantial barriers also likely played a role in the difference between preferences and practices in wearing the *oruhai* necklace, a norm domain in which the traditional practice remains widespread. These examples highlight the importance of bringing ethnographic context into empirical studies of cultural evolution.

1.4.2   Study limitations

In this study, we examined which social learning biases influence the spread of a set of norms that were already fairly common in the population. We did not address how new norms were first adopted into the social group and our study may have missed important processes that were prominent during the initial spread of new norms. In order for a new norm to first enter a group, some individuals need to be 'innovators'. When unfamiliar norms become available through contact with outgroups, several mechanisms can lead to the introduction of this norm by group members. When social learning is biased by perceptions of prestige, individuals may copy norms of outgroups that are perceived as prestigious, or they may ascribe prestige to and copy those members of their own group who themselves display outgroup norms. Alternatively, content or payoff biases can instigate the introduction of

an outgroup norm. Conformity bias can only act on norms that are already common in an individual's reference group (Rogers, 1995), although when some group members include outgroup individuals in their reference group, conformity bias could lead to the adoption of outgroup norms into a social group.

Second, we should consider the possibility that an unmeasured confounder affected both the respondent's belief and the beliefs of those whose preferences she seems to copy. All women in our sample have received health recommendations through government-led and NGO outreach programs, but this study did not capture fine-grained information on individual variation in the frequency, intensity or content of contact with health workers. However, our model indicated an effect of conformity bias that is beyond the effect of living in the same village. Therefore, although we cannot rule out that similarity in experiences between women and their peers not addressed in this study led to the consistency in their beliefs, we believe this effect is minimal.

Third, our measures of prestige and conformity bias, as in many empirical studies, are imperfect, as we aimed to balance ecological validity and ease of interpretation with theoretical precision. As Acerbi et al. (2016) note, patterns in norm change that are expected under conformity bias may also be created by other processes, such as individual preferences for one variant or selective copying of a subset of the population, for example as a result of prestige bias. We have aimed to rule out prestige bias as a significant driver of norm change, but subsequent research is still needed to provide more definite proof of conformity bias. Our measure for prestige was based on questions asking about a participant's wish for herself or her daughter to be like someone who practices medical recommendations. While these questions have been part of other surveys addressing notions of prestige, these studies also included interview items that address respect and admiration (Cheng *et al.*, 2010; Brand & Mesoudi, 2019; Jiménez & Mesoudi, 2019). It is possible that because our measure was more limited, we missed other important aspects of this concept.

1.5 Conclusions and implications

Most previous applications of cultural evolution theory related to reproduction have focused on contraceptive uptake (Mace & Colleran, 2009; Alvergne *et al.*, 2011; Colleran & Mace, 2015). Our study shows that this theoretical framework can be usefully applied to consider other kinds of perinatal care norms and practices. Access to health care is on the rise for Himba women in Northwest Namibia, and women are frequently approached by governmental and non-governmental health workers promoting WHO-recommended perinatal care practices, such as hospital birth and immediate and six months of exclusive breast-feeding. We find that conformity bias may be one important factor in the adoption of WHO-recommended perinatal care norms among Himba women. However, the promotion of new behavior does not necessarily lead to the erosion of all traditional perinatal care practices: women in our study continued to practice traditional norms that were not in conflict with WHO-recommended norms. Norm change interventions can make use of these findings by increasing awareness of the attitudes and behavior of individuals in the target population once the majority has adopted the recommended behavior, as this may encourage non-adopters to adhere to the new norms of their peers.

Cultural evolution theory has the potential to inform public policy aimed to instigate behavior change (Efferson *et al.*, 2019; Muthukrishna, 2019). Our research suggests that once a new norm is common in the group, initially hesitant individuals will soon follow. By looking not only at behavior, but also at people's plans and preferences we also highlight differences in these three outcomes, which may be useful in future models. We suggest that in some cases people may be attending more to changes in majority preferences, rather than actions, which could lead to rapid norm change. This may be particularly relevant in cases where behaviors are rare (as with births). Subsequent research could parse these differences more clearly by using longitudinal data on both preferences and behavior.

CHAPTER 2

Why do women support patriarchal gender norms? Evidence from four East Asian populations

2.1 Introduction

It is a common observation that not only men, but also women may endorse norms about gender that could be considered unequal, patriarchal or sexist (Johnson, 1983; Doku & Asante, 2015; Kray *et al.*, 2017). Gender norms are learned in childhood and adolescence (Lou *et al.*, 2012; Blum *et al.*, 2017), and feminist scholars have pointed to the cultural hegemony of patriarchy to explain how women come to disregard and perhaps misunderstand their own interests. For example, girls and women have been argued to hold a 'false' or 'contradictory' consciousness that blinds them from recognizing their own oppression under the prevailing gender ideology of their community (Kandiyoti, 1998; Chatterjee, 2012). Others critique this view, stating that it denies that women have agency and are able to understand their 'true' interests (Agarwal, 1997; Kabeer, 2000; Mahmood, 2006). They instead emphasize examples of resistance to existing gender norms as evidence that peoples' beliefs are not solely determined by the dominant gender ideology (e.g. Vale, 2020). Others again question whether women's agency *should* always be interpreted in reference to resistance against patriarchal hegemony (Mahmood, 2005, 2006), and caution against viewing women's interests from the perspective of western feminism (Abu-Lughod, 2002). Critical here is an often overlooked consideration that women may sometimes benefit from supporting patriarchal norms, including via benefits accrued to their male heirs (Kandiyoti, 1988; Brooks & Blake, 2021). Yet

despite the variety of perspectives on this topic, and their fundamental relevance to contemporary societal issues and social change, the assumptions that underlie these perspectives remain largely untested.

This study aims to understand whether there are causes beyond the social transmission of norms (such as through someone's upbringing, religion and education) that contribute to variation in women's attitudes towards patriarchal gender norms. Specifically, I ask how socio-demographic differences between individuals may lead to variation in their interests in patriarchal or egalitarian gender norms, and tests whether these hypothesized interests are reflected in people's stated attitudes towards such norms.

2.1.1   Power and gender norms

Anthropologists have long theorized about power structures underlying social norms. In discussing the relationship between culture and power under capitalism, Gramsci (1971) famously argued that the working class voluntarily consent to the social hierarchy and political ideology of their capitalist society as a result of the cultural hegemony of the ruling elites; workers have been persuaded to believe they themselves benefit from the cultural norms enforced by these elites. They consider the system as an unquestionable and unchangeable given. The masses thus hold a 'false' or 'contradictory' consciousness in which their beliefs are not based on a rational consideration of their interests, but of the cultural domination of those in (economic) power (Gramsci, 1971; Hall, 1986). Although at times a critic of Gramsci, Althusser (1971) similarly interpreted cultural norms as ideas promoted by those in power and internalized by the masses. He coined the term *Ideological State Apparatus* to describe cultural institutions that "exert power not primarily through repression but through ideology [. . .], indoctrinating people into seeing the world a certain way and of accepting certain identities as their own within that world" (Allison, 1991, p. 196). These perspectives have been applied to argue that gender inequalities are perpetuated by cultural practices that are also internalized by women themselves (Allison, 1991; Chatterjee, 2012).

Others reject the notion of cultural hegemony in explaining the opinions of seemingly repressed groups. Examples of resistance to capitalist and patriarchal norms are presented as evidence against lower-class farmers' and women's false consciousness (Scott, 1985; Vale, 2020); while scholarship on women's position in Islamic societies has argued that western feminism is not equipped to understand Muslim women's true interests (Abu-Lughod, 2002; Mahmood, 2005, 2006).

2.1.2 The evolution of the patriarchy

Coming from a very different theoretical grounding, evolutionary anthropologists too have hypothesized that the origins of patriarchal gender norms stem from power differentials and diverging interests between females and males. In a path-breaking paper, Smuts (1995) first proposed that patriarchal gender norms ultimately are the result of the different reproductive biologies of male and female mammals. Most importantly, this includes the uncertainty of males' paternity and females' greater obligatory parental investment due to gestation and lactation. Both of these factors contribute to a conflict of interest over female sexual autonomy as males have a stronger interest in controlling female sexuality than vice versa (Smuts, 1992, 1995; Muller & Wrangham, 2009). According to this theory, sexual conflict has contributed to the emergence of numerous norms and cultural practices that benefit men more than women, including claustration, purdah, and veiling, as well as restrictions on women's sexual autonomy (Strassmann, 1996; Blake *et al.*, 2018). This leads to my first hypothesis:

H1) Women have a stronger interest in gender-egalitarian as opposed to patriarchal gender norms than men.

The same theoretical premise can be used to understand systems where female autonomy is relatively high. For example, among pastoralist Himba in Namibia, prolonged spousal separation (as result of men's longer periods of absence when they are herding cattle) contributes to a context where the costs of restricting female sexual autonomy are very high

for men, and there are substantial benefits to women in having multiple partners (Scelza *et al.*, 2021). Here, the outcome of sexual conflict is increased female autonomy, rather than restriction. A closer examination of some gender norms viewed as sexist today contradicts common assumptions that these always reflect women's and men's opposing interests. For example, limiting women's freedom of movement is not always in the interests of husbands, such as when women work outside the home and bring back pay that benefits their family (Lawson *et al.*, 2021a).

2.1.3   Women's varying interests in patriarchal gender norms

In addition to the differential interests and drivers of women's and men's behavior, individuals of the same gender do not necessarily share the same interests. Interests in gender norms likely depend on demographic and social factors that can change throughout life, and in this study I test hypotheses that address four axes along which interests may diverge.

Besides individuals' own gender, a second factor hypothesized to affect interest in gender norms is the gender of close relatives. If gender norms have arisen from an evolutionary conflict of interests between women and men, we should expect that it is not only someone's own gender that determines their interests in these norms, but also the gender composition of their families. Brooks and Blakes (2021) formalized this 'gendered fitness interests hypothesis'. Aided by computational modeling work they predict that gender-based differences in interests will be small, due to inclusive fitness interests from male and female relatives. Gendered fitness interests in patriarchal norms are expected to balance out with age, as individual's own reproductive value decreases and their interests become more dependent on inclusive fitness benefits through offspring and non-descendant relatives. As women grow older their interests in patriarchal norms may grow, while men's interests are expected to become relatively more egalitarian. This predicted gender difference will help us test the age hypothesis in cross-sectional data like those used in this study, where older women as well as men likely hold more patriarchal norms due to generational shifts in gender ideology.

H2) Women's interests in patriarchal norms becomes stronger with age and this age-effect is stronger than for men.

Furthermore, children's gender is expected to have a stronger effect on parents' gender norms early in their reproductive career but becomes less important over time, as grandchildren and more non-descendant relatives arrive and likely balance out the number of relatives from each gender. The role of sons in women's interests in patriarchal norms has been ethnographically observed by Wolf (1972) and Kandiyoti (1988), who notice that women in the Taiwan of the 1950s and 60s suffered from their subordinate place in the traditional patriarchal family before and early in marriage, but enjoyed the benefits and even enforcing these norms themselves as they aged and gave birth to sons. Brooks and Blakes found some support for their hypothesis in that Tunisian and Pakistani women and men with more male relatives show less support for women's right to choose whether to wear a veil (Blake *et al.*, 2018, 2021). However, an important limitation of these two studies is that the relationship between having more sons and opinions about women's veils is likely confounded by traditional norms that influence both whether families try to have more sons and their views about women's chastity. In this study I aim to address this limitation by examining the different effects of offspring gender on norms specifically about son preference as well as other gender norms.

H3) Having more sons than daughters is associated with a stronger interest in patriarchal norms, and this effect decreases with age.

Some gender norms, particularly those related to gender *roles*, may not result from conflicting interests between genders. Instead, norms prescribing a gendered division of labor may have arisen as a result of efficiency benefits to heterosexual couples (Brown, 1970; Becker, 1985; Marlowe, 2007; Gurven & Hill, 2009). This hypothesis does not necessitate that women and men benefit equally from such gender roles; it merely predicts that both women and men can be better off specializing their economic behavior in line with normative gender roles than not cooperating at all (O'Connor, 2019). It is important to note that

such norms can persist due to processes of cultural inertia even when the pressures that initially gave rise to these norms are no longer in place. In addition, new circumstances my contribute to a maintenance of traditional practices. For example, gender discrimination in the job market today can act as new incentive for heterosexual couples to prioritize men's careers over women's, and influence choices about who stays at home and who works for pay.

I predict that women's marital status may impact their interests in patriarchal norms for two reasons. First, sexual conflict predicts that the fitness interests of sexual partners increasingly overlap when they share more of their reproduction with each other. Marriage typically indicates that a relationship is relatively stable, and marital partners usually form a household, resulting in even more intertwined interests. Second, as detailed above, norms regarding gender roles may facilitate more efficient cooperation among couples, and thereby benefit partnered women and men.

H4) Married women have a stronger interest in patriarchal norms than unmarried women.

A last factor considered in this study is women's social status. Patriarchal norms are thought to function to support the continuation and success of the patrilineal family (Fei, 1998; Whyte, 2003; Yan, 2003; Harrell & Santos, 2017). Upholding these traditional norms may be especially important to members of high-status patrilines, who benefit more of the continuation of the patrilineal tradition because of the status they enjoy from their family affiliation. Women of high-status patrilines may have more to gain from upholding those norms, if these secure their affiliation to these patrilines. The relationship between social status and gender norms may be specifically important when considering norms about gender *roles*, as wealthier families likely require fewer of their members to work for pay see for example Sechiyama, 2013, p. 129, who shows that women's employment is lower among higher-income households in Japan. Such families can perhaps more easily afford a division of labor where men are the sole breadwinners and mothers focus on domestic labor. Following these arguments, I expect that women in high-status families are more supportive of patriarchal gender norms. This hypothesis contrasts with expectations from a cultural

hegemony perspective, which suggests there will be few class differences in peoples' support for patriarchal norms.

H5) Women in families of higher social status have a higher interest in patriarchal gender norms.

2.1.4 East Asian patriarchy and gender norms

This study examines women's interests in and attitudes towards gender norms in four East Asian populations: China, Japan, South Korea, and Taiwan[a]. These countries were selected because of their shared cultural history as part of the East Asian cultural sphere, and because of the availability of comparative data.

Confucian ideology has had a profound and persisting influence on gender norms throughout East Asia. In this school of thought, gender relations are embedded in a broad configuration of social norms that not only govern the behavior of women versus men, but also prescribe behavior regarding other interactions, such as those between parents and children, and elders and younger people (Fei, 1998; Whyte, 2003; Yan, 2003; Harrell & Santos, 2017). Relations between women and men are shaped by moral prescriptions that support a strong patrilineal tradition. For example, the Three Obediences and Four Virtues prescribe women's moral obligation to obey their fathers, husbands, and sons, while practicing ethical behavior in marriage. Traditionally, women were expected to manage the home while their husbands went out to work (Ko, 1994; Mann, 1997). Also central to Confucian patriarchy is a preference for sons who continue the patriline.

Confucian ideology originates in China, and its influence on Chinese gender norms has been strong although regionally varying. A broad pattern in gender relations and the societal position of women has emerged from the effects of rice- or wheat-centered agricultural

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[a]For clarity and brevity, I use 'China' to refer to the People's Republic of China, 'Taiwan' for the Republic of China, and 'South Korea' for the Republic of Korea.

systems on women's work: rice-based systems of South China entailed women's higher economic participation in comparison to the wheat-centered agriculture dominating North China (Sechiyama, 2013, p. 182-3). These historical differences in agricultural practices have had long-lasting effect on women's labor participation that persisted even during periods of industrialization and urbanization. The role Confucianism has played in the cultural histories of the countries under study furthermore varies greatly, as it arrived in different regions at different times and mixed with local customs that in some places included bilateral descent or house-based kinship systems with higher levels of female autonomy (Ochiai, 2020; Sechiyama, 2013). For example, son preference was mostly absent, and divorce, women's remarriage and extramarital births - although proscribed in Confucian thought - were historically common in Japan, where Ochiai (2020) and Sechiyama (2013) suggest that Confucianism never truly penetrated the practices of common people. Conversely, Confucian norms fully permeated society on the Korean peninsula, perhaps even more so than in China itself (Sechiyama, 2013, p. 64). Here patrilineal descent became a crucial factor in determining social status, and gender roles and norms on gender segregation at home were strictly followed. In Taiwan, most of the current-day population is descendant from Southern Chinese Han colonists. These brought with them traditional Confucian practices such as foot binding, but also the relatively high labor participation of women due to the rice-farming practices in their region of origin (Sechiyama, 2013, p. 182).

The more recent histories of gender norms in these countries show both similarities and differences due to their adoption of Western concepts of gender as well as state-level legislations and labor market structures that affect gender relations (Kim & Shirahase, 2014; Takeuchi & Tsutsui, 2016; Ochiai, 2020). Gender relations underwent rapid change in China since the early 1900s and with the implementation of multiple waves of political and economic reforms. Women's labor force participation rose rapidly until the 1980s but has steadily declined since then. Opposite labor trends exist in the other populations under study, although South Korean women lag behind those in Japan and Taiwan (Sechiyama, 2013, p. 150, 177).

A longer tradition of women's farm work among descendants of Han Chinese in Taiwan set the scene for further growth in women's labor participation in the 20th century, and these numbers are currently highest of the countries under study (Sechiyama, 2013, p. 188, 195). Furthermore relevant for this study, the average income is lower and income inequality is greater in China than the other populations.[b]

Since the 1980s Chinese and South Korean sex ratios at birth rose rapidly due to the availability of sex-selective abortion and in China also as a result of child-limiting policies (Scharping, 2003). While the sex ratio at birth has decreased in South Korea since the late 1990s, the number is still abnormally high in China. In 2016-2017 (the time of data collection for this study), 116 Chinese boys were born for every 100 girls, compared to a ratio of 105 in both South Korea and Japan, and 107 in Taiwan (UN Population Division, 2022). Japan never experienced an elevated sex ratio, which perhaps is further proof of a more 'shallow' adoption of Confucian norms into Japanese society (Ochiai, 2020). Meanwhile, China still knows near-universal marriage (especially for women), whereas marital unions are on decline in South Korea, Japan and Taiwan. Throughout East Asia, the demographic transition to fewer children and a shift to nuclear-family households is accompanied by a decline in the importance of Confucian norms of filial piety (Yi & Chang, 2020; Jankowiac, 2020; Tamiya, 2020; Song, 2020).

Some literature from this region has attempted to explain women's strong support for norms that the ethnographers themselves considered were against women's interests. In line with the predictions above, Kandiyoti (1988) and Wolf (1972) observed that while young women in pre-revolution China and in Taiwan suffered high costs from the gender norms governing the patriarchal family configuration, they would benefit from the norms that initially harmed them after they had sons (see also Mann, 2002)). These authors argue that women benefitted from patriarchy not solely through the payoffs to their sons, but also describe how women gained status themselves from birthing sons and thereby more securely

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[b]Source: ILOSTAT through `www.gapminder.org`

establishing themselves in their husband's family.

Above I laid out how patriarchal gender norms are thought to have evolutionary *origins* in the converging or diverging interests of women and men. I suggest that the *persistence* of these norms may in part be driven by the current interests of some in upholding patriarchal norms and will test whether these hypothesized interests are reflected in peoples' stated attitudes in four large-scale surveys.

2.2   Methodology

2.2.1   Data

In this study I use data from the 2016 Taiwan Social Change Survey (TSCS 2016b), the 2017 Chinese General Social Survey (CGSS 2017), and the South Korean and Japanese data of the 2016 East Asia Social Survey (EASS 2016a). These nation-wide surveys all aimed to obtain representative population samples of adults in each country through stratified sampling. Respondents were asked for information on their age, gender, marital status, income, ethnicity, socio-economic status, as well as their attitudes towards a wide variety of topics. Relevant for this research are reported attitudes towards statements regarding gender norms. Most of these statements address norms about gender roles, such as "A husband's job is to earn money; a wife's job is to look after the home", "It is more important for a wife to help her husband's career than to work on her own career" and "It's not good for a pre-school child if the mother is working". Other examples are "When both the husband's family and the natal family need help, a married woman should help her husband's family first" and "The authority of father in a family should be respected" (see table B.1 for the full list). In the Chinese data, only 33% of respondents were asked to answer gender norm questions. I found no significant differences in the age, gender, income or education of respondents who were asked these questions versus those who were not (see supplemental information and figures B.1, B.2 and B.3).

2.2.2 Variables

The outcome variables used in the main models are respondents' responses to items asking for their level of agreement with statements regarding gender norms. These questions concerned traditional gender roles, as well as the authority of fathers and the importance of continuing the patriline. Responses were recorded on a 5-point Likert scale for some items and a 7-point scale for others. For the analyses I rescaled these variables so that their center and limits are matched. All are coded so that lower scores indicate more patriarchal attitudes, and higher scores indicate more egalitarian attitudes. Respondents' gender (woman = 1, man = 0), their age (centered around the mean and scaled), and the percentage of their children that are sons (0 for only daughters, 1 for only sons, .5 for equal number of sons and daughters or no children) are used as predictor variables testing hypotheses 1-3. Marital status is scored 0 for unmarried women, and 1 for married women. Because the surveys did not include questions specifically referring to the social status of women's patrilineal families, I use their ratings of their own social status as proxy (measured on a 10-point scale). I include several additional variables that may confound the relationship between these predictors and the outcome or otherwise affect attitudes towards gender norms: education (level of education in the Taiwanese and Chinese data, years of education in the South Korean and Japanese data), a categorical variable that indicates how urbanized the respondent's location is (not available in Chinese data), and a latent variable estimating how traditional people's attitudes generally are. To compute this traditionalism variable, I averaged responses to items about Confucian traditions not directly related to gender. These mostly concern filial piety (see table B.2 for details). All continuous predictors are centered around zero and scaled to a standard deviation of 1.

2.2.3   Approach to causal inference

I utilize a Directed Acyclic Graph (DAG) to represent the predictions and assumptions relevant for testing our hypotheses (see fig. 2.1). DAGs are also helpful in selecting the appropriate statistical method and determining which variables need to be included or excluded in the statistical model (Pearl, 2009; Peters *et al.*, 2017; McElreath, 2020). Peoples' stated attitudes towards certain gender norms, the outcome variable in the model, are assumed to be a direct result of their real attitudes. My hypotheses concern the effects of individuals' interests on their attitudes towards gender norms, as caused by their gender, age, the gender of their children, marital status and their social status. I further assume that people's attitudes are also affected by socially learned ideas acquired through schooling, being part of a religious community, and through growing up in a specific generation. The DAG also includes other variables that I consider relevant, such as income as result of one's education and cause of social status. However, because I expect no direct causal link between income and attitudes that do not pass through social status, I do not include income as predictor in the model. Similarly I expect that religion has an effect on people's gender attitudes, but use a latent variable representing how traditional respondents' beliefs are as a more direct measure of this source of social influence.

2.2.4   Analyses

I analyzed these data with multi-level Bayesian linear regression models computed in R (version 4.0.4, R package `brms`, Bürkner, 2017). The linear predictors were linked with the ordered outcome (questionnaire items answered on a Likert-scale) using a cumulative probit link function (Bürkner & Vuorre, 2018). This model class is also known as proportional odds model and assumes that the observed ordinal variable Y (respondents' responses to the items) results from partitioning a latent continuous variable $\check{Y}$ (the actual attitudes that exist in the population) into $K + 1$ response options. This method is preferred for ordinal
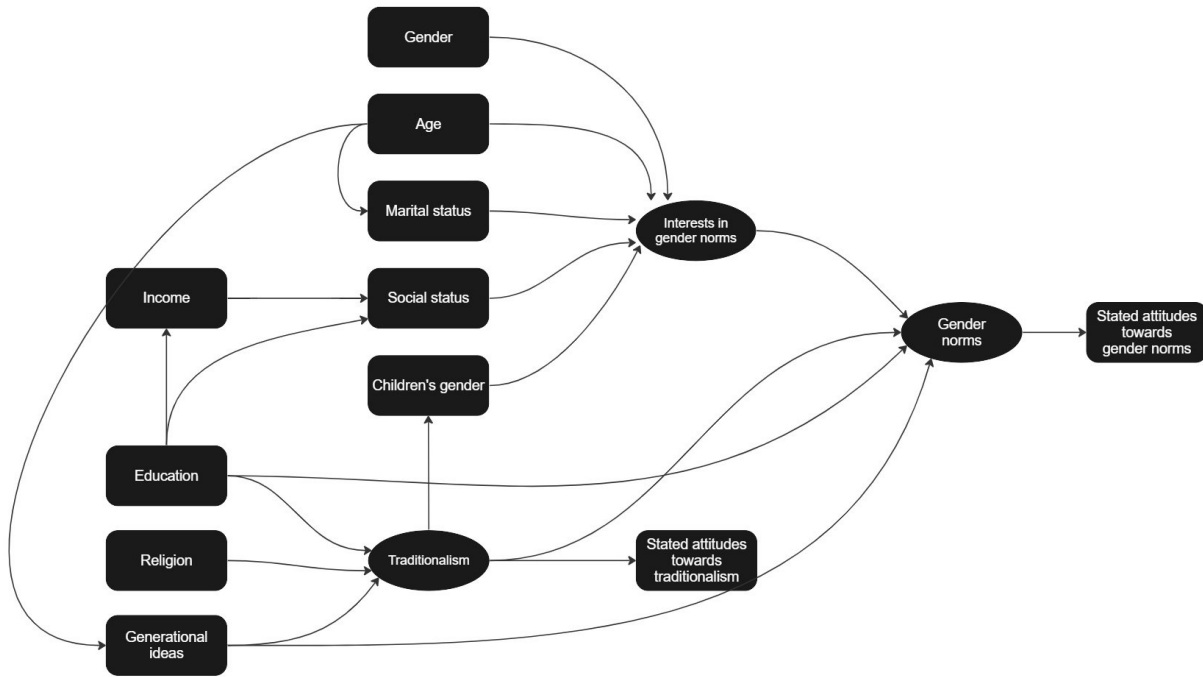
Figure 2.1: Directed Acyclic Graph of the causal model. In this representation, arrows represent assumed and tested causal relationships. The relevant variables are represented with boxes and ovals; boxes indicate observed variables, and ovals indicate unobserved variables.

outcomes as it does not assume that the distances between the response options are equal, and only latent variable $\check{Y}$ is assumed to follow a normal distribution, not observed variable Y (Bürkner & Vuorre, 2018). I fitted two main models, the first model testing the effects of gender and age (hypotheses 1 and 2) on the complete sample of women and men, and a second model testing the effects of children's gender, women's marital status and their social status (hypotheses 3, 4 and 5) on a subset of the data including only women. Model 2.1 predicts $\check{Y}$ with the following regression:

$$\check{Y} = \theta_{ij} + \beta_j age + \beta_j gender + \beta_j age * gender + \beta \ urban + \beta \ education + \beta \ traditionalism$$
(2.1)

The models include varying intercepts per participant ID i and norm item j, and varying slopes on the main predictors per norm item j. The Japanese and South Korean models also

have varying intercepts per region, while in the Chinese models ethnicity was used as this variable is more likely to be informative of cultural differences between informants in the Chinese sample. To further account for the effects of social influence of norms, all models also include as predictors education and the latent traditionalism variable. The Taiwanese, Japanese and South Korean models also include a predictor for level of urbanization, which was not available in the Chinese data. In model 2.2 I predict $\check{Y}$ as follows:

$$\check{Y} = \theta_{ij} + \ \beta_j age + \beta_j perc\ sons + \beta_j age * perc\ sons + \beta_j married +$$
$$\beta_j social\ status + \beta\ urban + \beta\ education + \beta\ traditionalism \tag{2.2}$$

We can then model the probability of $\check{Y}$ as equal to Likert scale category k given the linear predictors η with cumulative distribution function F:

$$Pr(\check{Y}|\eta) = F(\tau_k - \eta) - F(\tau_{k-1} - \eta) \tag{2.3}$$

Models were run on three Markov chains with 3000 iterations each (including a warm-up of 1000). These same models also estimated missing predictor data (5.5% or less in all data sets) using Bayesian multivariate inference (in which the model used to predict missing datapoints is specified by the researcher and fitted only once, see Bürkner, 2022). Rows with missing outcomes were excluded from the main analyses but retained to estimate missing predictor data. For each predicted effect I report the means of posterior distributions and percentage of the posterior distribution that falls in the expected direction.

2.3 Results

The data of all populations combined represent a total of 18,317 individuals (53% women) (see table 2.1). For those gender norm questionnaire items that were included in all countries, average scores per country were similar (see fig. B.4).

Country	China		Taiwan		Japan		South Korea	
Gender	male	female	male	female	male	female	male	female
N	5935	6647	1012	1012	1255	1405	475	576
Age								
(mean)	51.1	50.9	45.2	47.2	47.4	51.4	54.6	55.2
(range)	18, 103	18, 101	19, 94	19, 97	18, 89	18, 99	20, 89	20, 89
Daughters								
(mean)	.75	.8	.64	.9	1.1	1.17	1.01	1.04
(range)	0, 11	0, 10	0, 5	0, 9	0, 5	0, 6	0, 5	0, 5
Sons								
(mean)	.87	.94	.79	.94	.78	1.1	.88	.96
(range)	0, 19	0, 11	0, 5	0, 5	0, 5	0, 6	0, 4	0, 6
Social status								
(mean)	0.34	0.35	0.57	0.56	0.44	0.43	0.50	0.50
(range)	0, 1	0, 1	0, 1	0, 1	0, 1	0, 1	0, 1	0, 1

Table 2.1: Summary statistics of main predictors. Education and traditionalism are left out in this table because their scales are not comparable across countries.

In model 2.1 I used the complete datasets including both women and men to test the predicted effects of gender and the interaction between gender and age on attitudes (see fig. 2.2). In line with hypothesis 1, women have less patriarchal and more egalitarian attitudes than men in Taiwan ($\beta = .11$, $P(\beta > 0) = .89$), China ($\beta = .14$, $P(\beta > 0) = .99$) and Japan ($\beta = .31$, $P(\beta > 0) = .99$), although not in South Korea ($\beta = -.02$, $P(\beta > 0) = .43$). The posterior distribution of the interaction terms of gender and age shows following hypothesis 2, women's norms become more patriarchal with age at a rate that is faster than men's in Taiwan ($\beta = -.07$, $P(\beta < 0) = .90$), China ($\beta = -.10$, $P(\beta < 0) = .99$) and perhaps South Korea ($\beta = -.06$, $P(\beta < 0) = .77$, see fig. 2.3). However, a visualization of the conditional effects show there is substantial uncertainty in these predictions. I found no interaction between gender and age in the Japanese data ($\beta = .00$, $P(\beta < 0) = .50$). No differences between these countries was predicted, although both in South Korea and Japan the main effect of age is strong for both women and men compared to the other countries (South Korea: $\beta = -.26$, $P(\beta < 0) > .99$; Japan: $\beta = -.26$, $P(\beta < 0) > .99$).

In the following paragraphs I report the results related to hypotheses on women's atti-
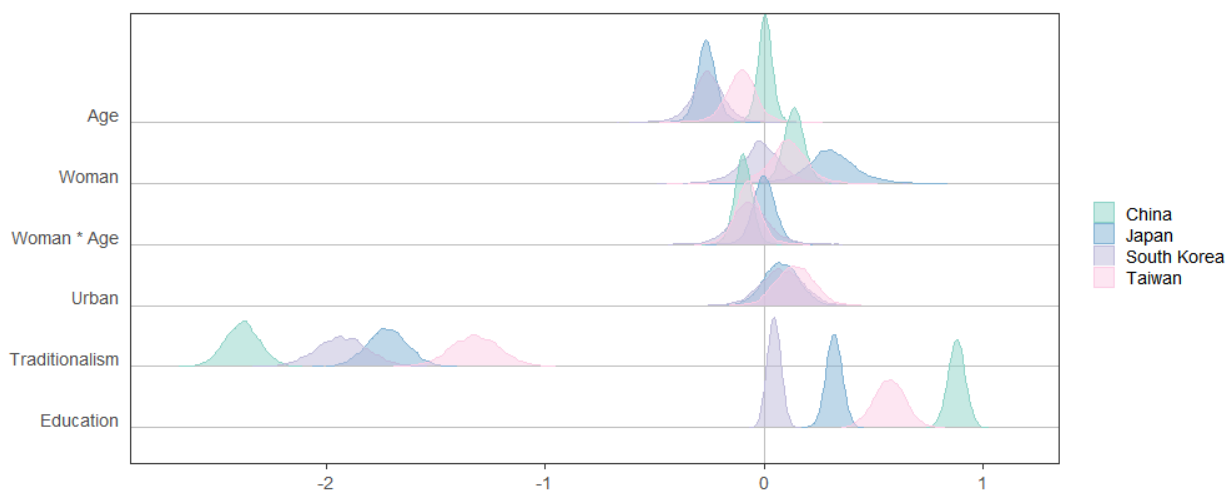
Figure 2.2: The posterior distributions of the predictors on attitudes towards gender norms in model 2.1, showing population-level predictors with effects averaged over all individuals and norms. Negative estimates indicate that a predictor is associated with more patriarchal norms, positive estimates indicate that a predictor is associated with more egalitarian norms. For example, a .11 point estimate for gender indicates that on the latent norm scale $\check{Y}$, women have .11 SD more egalitarian attitudes than men.

tudes specifically. These hypotheses were tested with model 2.2, using a subset of the data including only women (see fig. 2.4). For hypothesis 3 I tested whether there is an effect of children's gender, and an interaction-effect of children's gender and age on gender norms. The gendered fitness hypothesis predicts that children's gender should have a small effect on norms, with more sons leading to more patriarchal norms and more daughters leading to more gender egalitarian norms. Estimations of the main effect of percentage of sons matches this prediction for Chinese ($\beta = -.08$, $P(\beta < 0) = .90$) and South Korean data ($\beta = -.24$, $P(\beta < 0) = .94$), but not for Taiwanese ($\beta = .02$, $P(\beta < 0) = .43$) and Japanese data ($\beta = .17$, $P(\beta < 0) = .12$, see fig. 2.5). When looking at the varying effects of this variable across gender norms, the average effect seems to be driven mostly by one norm, which specifically concerns son preference and patriliny ("To continue the family line, one must have at least one son"). For most other norms there is no effect, and when the son preference norm is removed from the model the effect of having sons on egalitarian norms becomes less negative (or more positive in Taiwanese and Japanese data). Only in South

Korea and China is having more sons still associated with more patriarchal norms after the son preference norm is excluded from the model (the effect after removing the norm is $\beta = -.19$, $P(\beta < 0) = .93$ for South Korea, and $\beta = -0.04$, $P(\beta < 0) = .87$ for China, see fig. B.6). The predicted interaction-effect of children's gender and women's age is found only in Taiwan; for Taiwanese women with more daughters have more egalitarian norms at younger ages, and with age norms become more patriarchal at a rate faster than women with more sons ($\beta = .10$, $P(\beta > 0) = .85$). In the other countries there is no effect or the effect is in the opposite direction (China: $\beta = .01$, $P(\beta > 0) = .58$, Japan: $\beta = -.25$, $P(\beta > 0) = .00$, South Korea: $\beta = -.14$, $P(\beta > 0) = .12$).

Next, in line with hypothesis 4 I found that married women in all countries hold more patriarchal norms than unmarried women (in a model where age is also included as predictor, China: $\beta = -.07$, $P(\beta < 0) = .95$, Japan: $\beta = -.16$, $P(\beta < 0) = .98$, South Korea: $\beta = -.23$, $P(\beta < 0) = .94$, Taiwan: $\beta = -.13$, $P(\beta < 0) = .99$, see fig. 2.6). This relationship does not vary consistently between the norms that directly address a gendered division of labor and other gender norms included in this study.

Hypothesis 5 that women who perceive their social status as higher hold more patriarchal norms, is not supported by the data (China: $\beta = .10$, $P(\beta < 0) = .11$), Taiwan: $\beta = .42$, $P(\beta < 0) = .01$), Japan: $\beta = -.004$, $P(\beta < 0) = .61$, South Korea: $\beta = -.03$, $P(\beta < 0) = .56$, see fig. 2.7). Here I was unable to identify specific norms that drive these results. Lastly, to determine whether the effect of social status differed for women and men, I conducted a post-hoc analysis on the complete datasets including age, gender, social status and an interaction-effect for gender and social status (models also controlled for urbanism, traditionalism and education, see fig. B.7). This led to mixed results. The interaction-effect indicated that higher social status has a more positive correlation with egalitarian norms for women compared to men in China ($\beta = .37$, $P(\beta > 0) > .99$), Taiwan ($\beta = .29$, $P(\beta > 0) = .89$), and Japan ($\beta = .17$, $P(\beta > 0) = .80$), but not South Korea ($\beta = -.37$, $P(\beta > 0) = .06$).
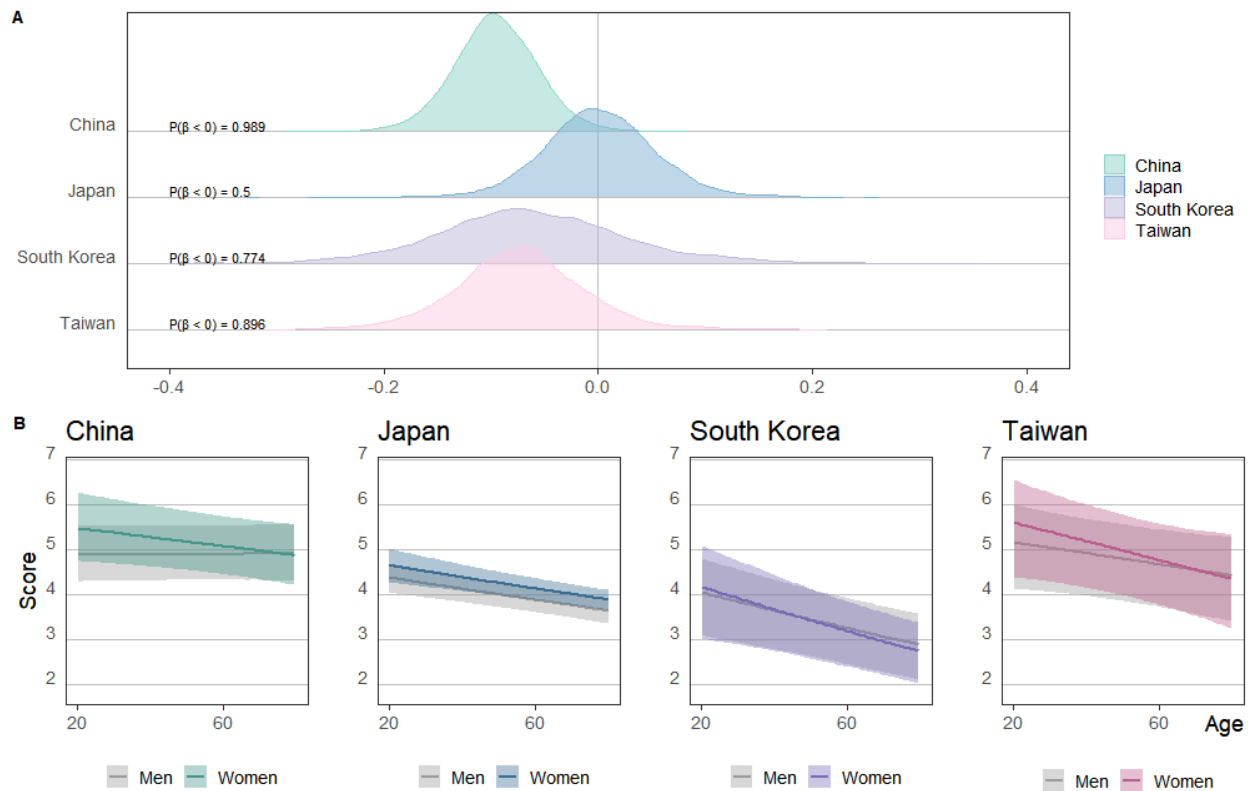
Figure 2.3: Posterior distributions and predictions for the interaction-effect between gender and age in model 2.1. Plot A shows the posterior distributions of the interaction-effect between gender and age as a predictor of attitudes towards gender norms. Negative estimates indicate that age is more strongly associated with more patriarchal norms for women than for men, positive estimates indicate that age is more strongly associated with more egalitarian norms for women than for men. For example, a .11 point estimate for gender indicates that on the latent norm scale $\check{Y}$, women have .11 SD more egalitarian attitudes than men. Noted on the left is the proportion of the distribution that falls in the predicted direction; e.g. $P(\beta < 0) = .896$ indicates there is a 89.6% probability that women's norms become more patriarchal with age at a rate faster than men's. Plot B visualizes the conditional effects of age and gender on average norm scores in the same model. This plot shows a simplified visualization, with the *average* norm score on the Y-axis. The ribbons indicate 90% credible intervals. See figure B.5 for a more complete visualization of the effect of age and gender on the probability that each answer option is selected.

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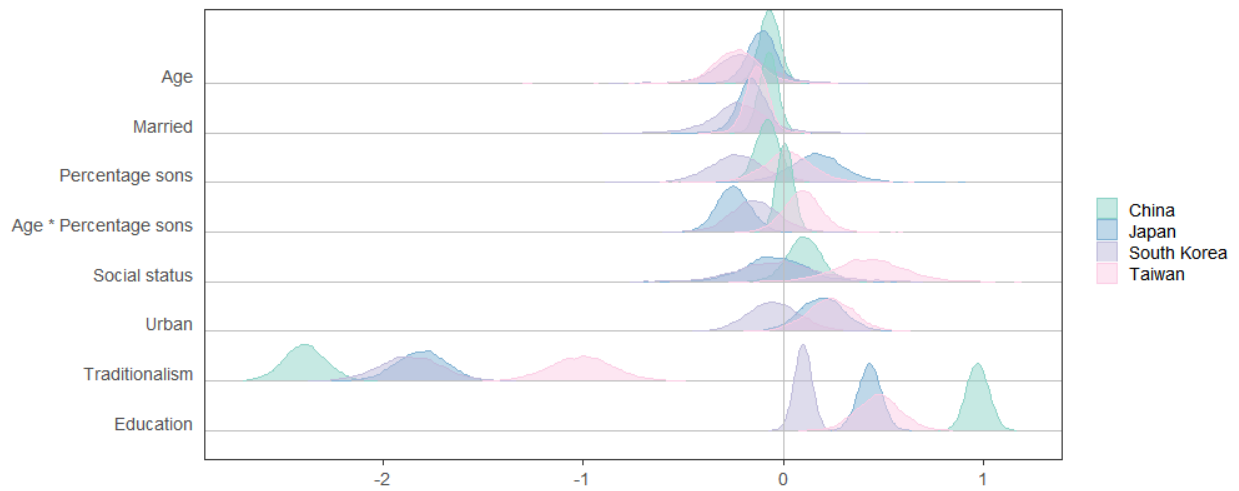
Figure 2.4: The posterior distributions of the predictors on women's attitudes towards gender norms in model 2.2, showing population-level predictors with effects averaged over all individuals and norms. Negative estimates indicate that a predictor is associated with more patriarchal norms, positive estimates indicate that a predictor is associated with more egalitarian norms. For example, a -.13 point estimate for married indicates that on the latent norm scale $\check{Y}$, being married is associated with -.13 SD more patriarchal attitudes compared to being unmarried.
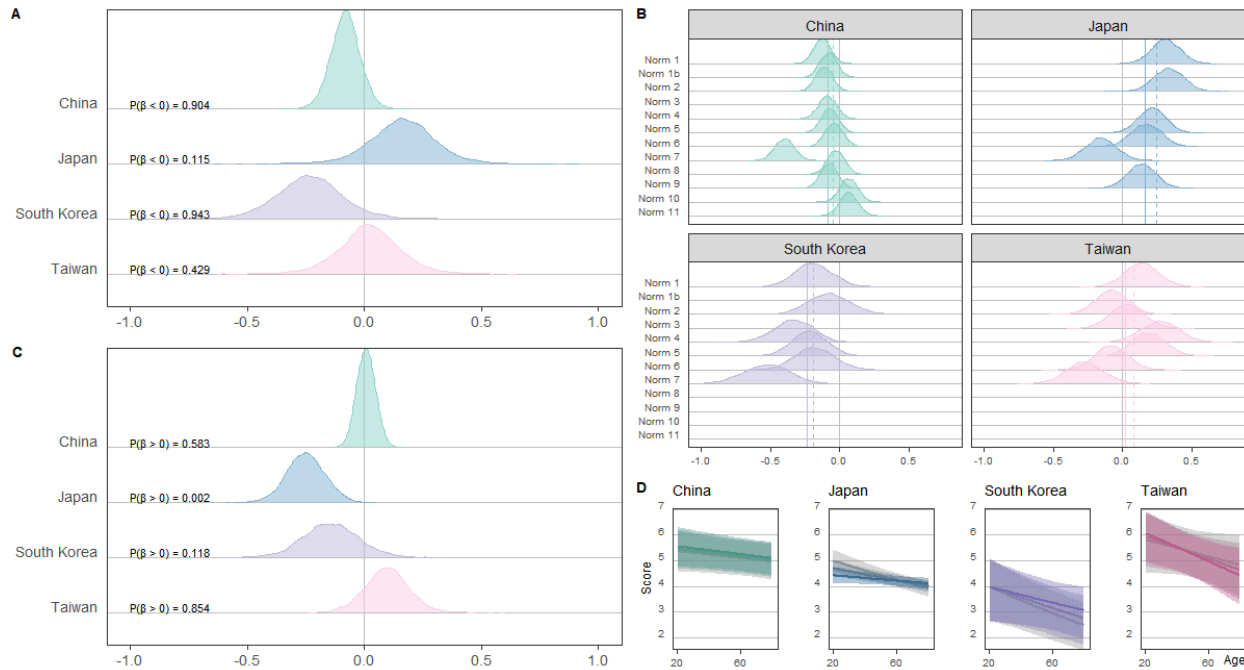
Figure 2.5: Posterior distributions and predictions for percentage sons in model 2.2. Plot A shows the posterior distributions of percentage sons as a predictor of women's attitudes towards gender norms. Negative estimates indicate that having more sons than daughters is associated with more patriarchal norms, positive estimates indicate that having more sons than daughters is associated with more egalitarian norms. Noted on the left is the proportion of the distribution that falls in the predicted direction. Plot B illustrates the posterior distributions of the group-level effects per norm of the percentage of sons among women's children on their attitudes towards egalitarian gender norms in model 2.2. Having more sons is most strongly associated with norm 7 ("To continue the family line, one must have at least one son"). The posterior distributions of the other norms overlap significantly more with zero, indicating that an association between sons and norm preferences for these other norms is less likely. Solid lines indicate the average effect size of all norms, and dashed lines show how this average moves to the right when norm 7 is excluded from the model. Plot C indicates the posterior distributions of the age * percentage sons interaction in model 2.2. Lastly, plot D shows the conditional effects of percentage sons and age. This plot shows a visual comparison of the expected norm scores (means and 90% credible interval) for women with only daughters in color, with expected norm scores for women with only sons in gray.
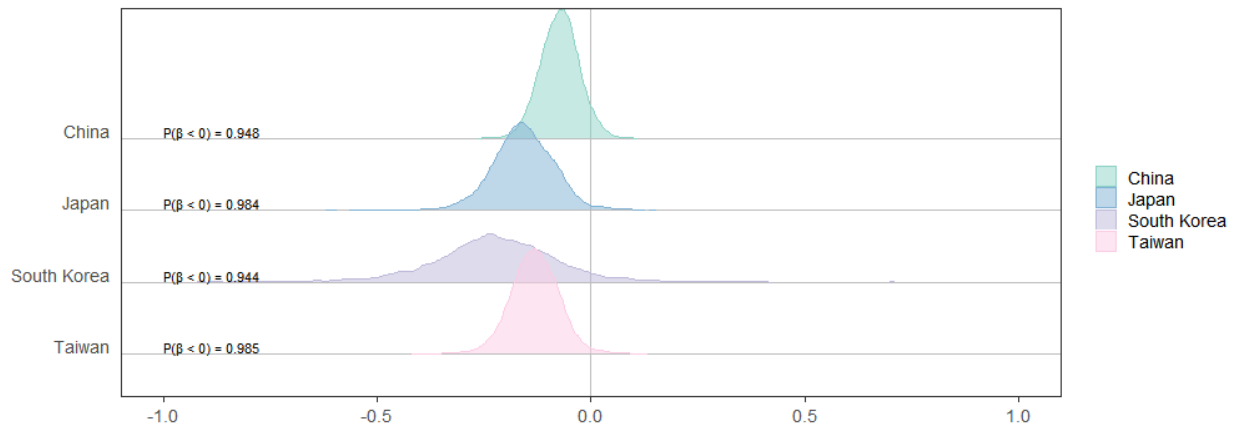
Figure 2.6: The posterior distributions of being married as a predictor of women's attitudes towards gender norms in model 2.2. Negative estimates indicate that being married is associated with more patriarchal norms, positive estimates indicate that being married is associated with more egalitarian norms. For example, a -.13 point estimate for married indicates that on the latent norm scale $\check{Y}$, being married is associated with -.13 SD more patriarchal attitudes compared to being unmarried. Noted on the left is the proportion of the distribution that falls in the predicted direction.
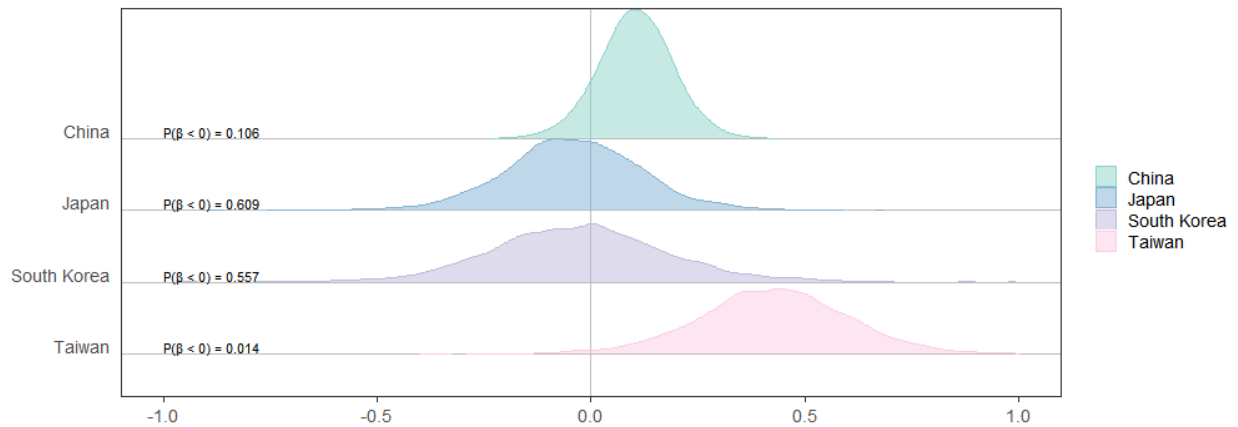
Figure 2.7: The posterior distributions of social status as a predictor of women's attitudes towards gender norms in model 2.2. Negative estimates indicate that higher social status is associated with more patriarchal norms, positive estimates indicate that higher social status is associated with more egalitarian norms. For example, a .42 point estimate for social status indicates that on the latent norm scale $\check{Y}$, having high social status is associated with .42 SD more egalitarian attitudes compared to being low social status. Noted on the left is the proportion of the distribution that falls in the predicted direction.

2.4 Discussion

2.4.1 Women's norms become more patriarchal with age, and at a rate that is faster than for men

Women more often support gender-egalitarian norms than men, but among women attitudes towards patriarchal gender norms vary. We predicted that women's interests in patriarchal norms increase with age, and found that this negative age-effect was reflected in their attitudes more so than for men. While a correlation between norms and age is expected in cross-sectional data like these, which do not allow for a separation of age- and generational effects, this observed gender difference is in line with predictions. Other studies testing for age-effects on gender norms have found mixed results; for example Charles (2020) reports that in an African survey that is similar to the surveys used in this study, older men show higher support of female empowerment compared to younger men. Conversely, Lawson et al. (2021a) do not find an association between gender norms and age among Tanzanian men between 25 and 40. An important difficulty in this work is separating a possible change in fitness interests associated with age from confounding cohort effects. Here I argue that a comparison of women and men is needed, as different age-effects are expected for each gender. A useful next step to further scrutinize this gender-age-interaction is the use of longitudinal data tracking changes in women's and men's attitudes over time.

2.4.2 Gender norms affect number of sons more so than vice versa

I did not find evidence in support of other predictions derived from the gendered fitness interests hypothesis (Brooks & Blake, 2021). In China and South Korea, women with more sons are more likely to support patriarchal gender norms, but this correlation is primarily driven by a preference for sons and is weaker for other gender norms. The effect of children's gender on women's attitudes does not decrease with age as predicted by the gendered fitness hypothesis. One possible reasons is that the gender distribution among non-descendant

relatives matters a lot and masks any effect of children's gender, and I did not test this in this study. However, the causal relationship between having sons and son preference is most likely reversed in our data; women who value sons will try to have more children after first having a daughter, or are less inclined to have another child after a son (Mattison *et al.*, 2016; Dubuc, 2018). This suggestion is further supported by the fact that the effect of having sons is particularly strong in China, where child-limiting policies drove up child sex ratios throughout the reproductive lifespan of the women in our sample (Scharping, 2003), and in South Korea, which also experienced particularly high sex ratios at birth until the late 1990s (Yoo *et al.*, 2017). Studies supporting the gendered fitness interests hypothesis (Blake *et al.*, 2018, 2021) utilize data from countries in which the sex ratio is strongly male-biased due to a strong tradition of patriarchal gender norms and a preference for sons (Chao *et al.*, 2019). Here too the effect may be at least in part reversed: people with more traditional gender norms are more likely to have more sons, and perhaps even be part of families where other relatives also have more sons.

2.4.3   Married women have higher support for patriarchal norms

I find that support for patriarchal norms is higher among married than unmarried women, in a model accounting for age-effects. Norms regarding gender roles are often hypothesized to benefit heterosexual couples as a whole by facilitating an efficient division of the various tasks required to maintain a household (Brown, 1970; Marlowe, 2007). In my data there is no consistent difference between married women's support for norms that prescribe a gendered division of labor compared to other patriarchal gender norms, but married women's interests may be closer to those of their husbands' as the fitness interests of long-term partners are more intertwined. One alternative explanation that I cannot test in this study is women's marital status in otherwise related to their gender ideology. For example, women with more gender-egalitarian norms may purposefully delay or even avoid marriage, or have more difficulties finding a partner of their liking (Hong Fincher, 2016). My analyses account for

age- and education-effects, but are not able to fully exclude this possibility.

2.4.4 Higher social status is not associated with women's support for patriarchal norms

I further hypothesized that after accounting for social influence-effects (such as education, living in an urban environment, and general traditionalism in norms) women of high-status patrilines would exhibit increased support for patriarchal norms, as they may have a higher interest in upholding the patriarchal norm system. Furthermore, I predicted this effect could result from the higher feasibility of single-income households (in which the mother stays at home) in wealthier, higher-status families as most of the norms included in this study concern women's domestic labor and work outside the home. This hypothesis was not supported. In Japan and South Korea social status is unrelated to women's attitudes towards gender norms, whereas in China and Taiwan higher social status is associated with *more* egalitarian norms. The absence of a relationship between women's social status and gender attitudes is surprising especially in South Korea, where the historical importance of the patriline as determinant of one's social status suggests that higher-class individuals should benefit more from upholding traditional norms (Sechiyama, 2013, p. 64, 141-8). The finding could align more with a cultural hegemony-hypothesis, in which the lower class has internalized ideas that benefit higher strata of society rather than themselves (Gramsci, 1971; Hall, 1986; Althusser, 1971). However, the unexpected association between higher status and egalitarian norms in China and Taiwan warrants another explanation. Perhaps women of higher social status have more 'social bargaining power' to contest the dominant norms in their community. Deviating from the prevailing gender ideology in one's community can be costly, for example because deviance can result in ostracism or unfavorable treatment (Weber *et al.*, 2019). Women of higher social status may be less vulnerable to such risks and therefore able to publicly deviate from the dominant gender ideology. This prediction assumes that the costs women suffer from patriarchal norms are greater than any benefits

these norms present for those of higher status. In addition, if higher social status is protective of the negative consequences of contesting the dominant gender ideology, we should expect that social status correlates more with egalitarian norms for women than for men. In a post-hoc analysis I indeed found this predicted effect in China, Japan and Taiwan; although this is not the case in South Korea. Additional research is necessary to further investigate the relationship between the women's social status, their ability to publicly contest patriarchal gender norms, and their interests in such norms.

2.4.5 Limitations

Future work can improve on this study in several ways. This study is limited by its reliance on self-reported attitudes towards contentious topics. Both women and men may have reasons to mask their true opinions about patriarchal norms, depending on how they think they will be perceived by interviewers. Unfortunately I do not have access to detailed information about the interviewers who collected the data for the surveys used here, but if people's tendency to hide their true attitudes is related to any of my predictors this may have resulted in systematic error. Several survey methods have aimed to reduce social desirability bias, such as through indirect questioning (Gibson *et al.*, 2018) or the use of spouses' reports of each other's attitudes (Lawson *et al.*, 2021a). The current study was furthermore limited by its data on socio-economic status; available questionnaire items ask respondents to rank their own position on the social ladder compared to others, but do clarify who to compare themselves to. This is important, because one may answer very differently depending on whether they compare themselves to their social network, others in their community, or the whole population. Furthermore, the relationship between social status and interests in patriarchal gender norms can be further examined by considering more gender norms other than those about gender roles (for example norms about women's freedom of movement or about double standards for sexual behavior), as the common ideal of male breadwinner and female homemaker may be too costly to uphold for families of lower socio-economic status.

2.5 Conclusion

Overall, this study provides supporting evidence for the hypothesis that variation in people's attitudes towards patriarchal gender norms is partially explained through their varying fitness interests in such norms. Women have a lower interest in patriarchal norms and are less likely to support these norms than men, but men's and women's interests and attitudes seem to converge with age. Married women show higher support for patriarchal gender norms, perhaps because their fitness interests are more aligned with those of their husbands. Women's ability to contest the locally dominant gender ideology may further play into their interests in existing norms, and future research should investigate whether social status can provide women with more social 'bargaining power' to contest dominant norms.

CHAPTER 3

Sex ratios, gender norms, and why you need both to understand sexual conflict in humans.

3.1 Introduction

When two individuals mate, they have both converging and diverging interests. For example, they share an interest in the success of any joint offspring, but differ in the optimal trade-offs between current and future reproduction, and the benefits of inclusive fitness (Parker, 1979; Arnqvist & Rowe, 2005). Conflict occurs any time two partners cannot simultaneously reach their optimal outcome (Parker, 2006). Sexual conflict theory is a framework in evolutionary biology that seeks to explain how such conflicts result in adaptations over evolutionary time, including behavioral flexibility within the lifespan of individuals. One important determinant is the number of reproductive options that each party has outside of their current partnership, which can depend on individual-level characteristics as well as the structure of the population. In other words, how much bargaining power each partner has.

Anthropologists are increasingly applying sexual conflict theory to understand reproductive strategies of humans (e.g. Käär *et al.*, 1998; Bird, 1999; Borgerhoff Mulder & Rauch, 2009; Schacht & Borgerhoff Mulder, 2015; Schacht & Smith, 2017; Lawson *et al.*, 2021b). In recent years, interest has grown in examining local sex ratios and their effect on reproductive decision-making and bargaining power in romantic relationships (e.g. Abramitzky *et al.*, 2011; Francis, 2011; Wei & Zhang, 2011; Lainiala & Miettinen, 2013; Schacht & Borgerhoff Mulder, 2015; Porter, 2016; Uggla & Mace, 2017; Schacht & Smith, 2017), and scholars

have extended the theory to test predictions on how sex ratios may influence gender norms (Guttentag & Secord, 1983; Grosjean & Khattar, 2019; Brooks *et al.*, 2022).

In this article I will propose a revision of sexual conflict theory when applied to humans, and discuss important considerations that are necessary to understanding the relationship between human sex ratios, bargaining power and gender norms. Here I define gender norms as social norms, rules or ideals that govern what counts as socially acceptable and virtuous behavior and that apportion resources, roles, power and entitlements based on (perceived) sex (Ridgeway & Correll, 2004; Cislaghi & Heise, 2020). The term social norm can be used to describe conventions, or common behaviors in a particular community, but often norms are injunctive or prescriptive; they refer to moral values and societal standards (Bicchieri, 2005). Social norms are thought to have evolved because they render the actions of others more predictable and thereby facilitate coordination between community members (O'Connor, 2019). Violation of norms can be costly because it can lead to miscoordination with cooperative partners, or when deviance from prescriptive norms is punished. Gender norms pertain to behavior related to marriage, divisions of labor, respectful conduct, and other forms of behaviors depending on one's sex. They are often not merely descriptive, but prescribe 'morally right' behavior. While theoretically they could culminate to complete gender egalitarianism, gender norms cross-culturally describe a gender hierarchy in which men have more power and higher status than women (Schneider & Gough, 1961; Smuts, 1995).

The evolution of social norms is an important topic of study in research on cultural evolution, but this field of inquiry has somewhat ignored gender (Lawson *et al.*, 2023). Cultural evolution theory has been fruitful in showing the importance of biased transmission in the spread and maintenance of cultural traits (Boyd & Richerson, 1985; Henrich & Boyd, 1998; Boyd & Richerson, 2002; McElreath *et al.*, 2003; Efferson *et al.*, 2008; Mesoudi, 2011b), but limited consideration is given to power dynamics and their role in the spread of ideas (Cofnas, 2018). Here social influence is mostly considered in the form of deference and voluntary copying of the behavior of high-status individuals rather than coercion by powerful individu-

als. In order to gain a deeper understanding of how gender norms spread, persist and change over time, and of how sex ratios and gender norms interact to affect gendered bargaining dynamics, sexual conflict theory and cultural evolution theory need to be integrated and applied together.

First, I will summarize sexual conflict theory and discuss how it has been applied to understand the influence of sex ratios on the reproductive behavior of non-human animals. Then I will examine how in human populations, sex ratio-effects on gendered bargaining power can interact with culturally-specific gender norms in important ways. I propose that to understand this complex relationship, we need to consider gender norms both as products of sexual conflict and variables affecting sexual conflict by constraining women and men's market values and their freedom of choice in reproductive decision-making. Importantly, gender norms can directly affect sex ratios and at the same time how people respond to market dynamics. I argue that an integration of models of cultural evolution with sexual conflict theory is necessary to understand sexual conflict in humans.

ASR	Adult sex ratio, ratio of adult men to women in a given population. High sex ratios refer to populations where men outnumber women, low sex ratios refer to populations where women outnumber men.
OSR	Operational sex ratio, ratio of reproductively available males to females, which excludes juveniles, pregnant or lactating females and post-reproductive individuals.
Cultural evolution theory	Theoretical framework in evolutionary anthropology that hypothesizes that cultural traits, like social norms, are subject to processes similar – but not identical - to Darwinian evolution as traits vary and some are more likely to spread than others. At the micro-level, this theoretical framework considers how cultural traits are passed on between individuals, such as through biased social learning.
Gender norms	Social norms, rules or ideals that govern what counts as socially acceptable and virtuous behavior and that apportion resources, roles, power and entitlements based on (perceived) sex (Ridgeway & Correll, 2004; Cislaghi & Heise, 2020). Gender norms prescribe behavior related to marriage, divisions of labor, respectful conduct, and other forms of behaviors depending on one's (perceived) sex.
Gender ideology	A collection of social norms or 'cultural beliefs that justify particular social arrangements, including patterns of inequality' (Macionis, 2010, p. 257). Gender ideologies then refer to collections of norms that justify a particular hierarchy (or lack of hierarchy) between people on the basis of their (perceived) sex.
Sexual conflict theory	Theoretical framework in evolutionary biology that seeks to explain how conflicts of interest between females and males result in adaptations over evolutionary time, including behavioral flexibility within the lifespan of individuals.
Adaptive lag	A period of mismatch when adaptations have not yet caught up with current selection pressures.
Mate guarding	Behavior aimed at maintaining exclusive sexual access to a sexual partner, for example by physically preventing a partner from interacting with other potential partners. In humans, behaviors such as preventing a partner from leaving the house or limiting a partner's financial independence may be interpreted as mate guarding.

Table 3.1: Glossary.

3.2 Theory and applications of sexual conflict theory and sex ratios in non-human animals

Research on non-human animals shows that female and male interests may diverge over shared physiological (Trivers, 1972; Kokko & Jennions, 2008), morphological (Bonduriansky & Chenoweth, 2009) as well as behavioral traits, such as the number of matings (Galliard *et al.*, 2005), control over fertilization (Parker, 2006), and levels of parental investment (Arnqvist & Rowe, 2005). This theory posits that the degree of bargaining power individuals have in conflicts of interest depends on the relative value of all possible conflict outcomes for each partner, which includes the opportunities each has outside the current interaction. Sexual conflicts of interest are expected to be resolved in favor of the party with a better bargaining position.

A crucial factor for determining each party's bargaining power in sexual conflict is the quality and number of alternative partners available to each. Holding all else equal, the party with more alternative reproductive opportunities has more leverage to achieve their interests. A classic example of sexual conflict is parental investment: when two individuals reproduce, both are interested in the survival of their offspring, but either party may prefer that the other provide the parental investment required so they can spend their own time and energy pursuing other reproductive opportunities. The individual with more alternative partners available to them has a better 'fallback position'. The partner with the stronger bargaining position will, on average, see the conflict resolved closer to their optimal outcome.

At the level of the population, the ratio of males to females strongly affects the reproductive options of each sex, and the significance of sex ratio as a determinant of bargaining power in sexual conflict has been exemplified in numerous experimental and observational studies (Carroll, 1991; Székely *et al.*, 2006; Karlsson *et al.*, 2010; Liker *et al.*, 2013; Carmona-Isunza *et al.*, 2015; Eberhart-Phillips *et al.*, 2018).

Sex ratios are usually operationalized as the ratio of males to females in a population;

where high sex ratios reflect a bias towards more males, and low sex ratios a bias towards more females. There are several sex ratios that are commonly used in these studies. One is the adult sex ratio (ASR), the ratio of reproductively aged males to females. Another is the operational sex ratio (OSR), the ratio of reproductively available males to females, which excludes pregnant, lactating and post-reproductive individuals (Emlen & Oring, 1977) and in humans sometimes excludes married people. The ASR and OSR do not always track each other because of the higher temporal variation of the latter, especially in smaller populations (Carmona-Isunza *et al.*, 2017; Jennions & Fromhage, 2017). In addition, because the time and energy individuals spend on reproduction is in itself a product of sexual conflict dynamics (Kokko & Jennions, 2008; Kappeler *et al.*, 2022), which ratio is most relevant depends on the reproductive biology of the species, and on the phenotypic trait and evolutionary time-scale being studied (Jennions & Fromhage, 2017). For example, when testing for ASR-effects on male mate guarding behavior in primates, the ratio of adult males to estrous females may be most relevant, but when examining sexual conflict over parental investment, the OSR is a dependent rather than an independent variable and ASR may be more appropriate. ASR is usually a suitable measure for considering behavioral plasticity and short-term responses to environmental cues in within-species comparisons, and is the measure that is used in most contemporary human studies (Kappeler *et al.*, 2022).

One important domain of sexual conflict is parental investment. Following the principle of allocation, organisms have limited time and energy available to spend on reproduction. In sexually reproducing species a trade-off exists between allocating time and energy towards behaviors aimed at accessing sexual partners and behaviors associated with caring for existing offspring, as the same resource unit cannot be spent on both (Trivers, 1972). This trade-off can result in a conflict of interest between sexual partners over parental investment, where either partner is better off if the other provides the investment needed to produce surviving offspring so that their own resources are free to be spent on mating effort (Clutton-Brock, 1991; Székely & Cuthill, 2000).

The extent to which individuals can improve their fitness through investing time and energy in mating or parenting behavior depends on species-level, population-level and individual factors. For example, species vary in the amount of parental care required to raise offspring to adulthood, population-level differences in environments may lead to variation in the costs of parental investment and mating effort, and individuals' reproductive opportunities are partly determined by their ability to compete for mates with others of the same sex. At the population level, the density and ratio of adult males to females shapes the relative payoffs of mating and parenting behaviors, as it determines the number of potential sexual partners and the severity of competition between members of the same sex. For example, when the sex ratio is skewed, mate scarcity can make it more profitable for the abundant sex to devote energy into obtaining and maintaining reproductive access to their current mate rather than into competing for additional mates (Kokko & Jennions, 2008). To increase their chances of mating, members of the abundant sex can respond to an unfavorable sex ratio by appealing to the preferences of the rare sex, such as by providing more parental care. In addition, the opportunity costs of parental investment go down as the relative benefits of searching for mates decrease due to strong mating competition. Conversely, members of the rare sex can drive a harder bargain in situations of sexual conflict because they have more reproductive options, for example forcing their mate to provide more care while they go back into the mating pool sooner. We should expect ASR-responsive flexibility in reproductive strategies to occur in species where at least some paternal care is present, and where there is limited reproductive skew (when few males account for most or all offspring in a population, the effect of sex ratios on bargaining power will be minimal). Furthermore, the relationship between reproductive strategies and ASR is dynamic. For example, the mortality risks of parenting and mating strategies can affect the ASR. If increased mating effort leads to higher mortality, the sex ratio becomes more extreme because of a self-reinforcing process where the rarer sex (which would benefit the most from mating effort) becomes even rarer (Kokko & Jennions, 2008).

Shorebirds (*Scolopaci* and *Charadrii spp.*, sandpipers, plovers and allies) have provided an informative model for testing the relationship between sex ratios and mating and parenting behavior. They have broad inter-specific variation in their mating systems and the ability of both sexes to provide full parental care on their own, paired with general similarity in ecology and variation in sex ratios as result of sex-biases in juvenile survival (Bennett & Owens, 2002; Székely *et al.*, 2006; Liker *et al.*, 2013; Carmona-Isunza *et al.*, 2015; Eberhart-Phillips *et al.*, 2018). In line with predictions, research on these species has found that although sex differences in parental investment cannot be fully explained by considering the ASR alone, female-biased adult sex ratios are linked with more female care and higher levels of polygyny (Liker *et al.*, 2013; Eberhart-Phillips *et al.*, 2018). In species with male-biased adult sex ratios, males are more likely to provide the bulk of parental care, female multiple mating is more common and females have more showy plumage, a trait that is generally associated with investment in mating competition (Liker *et al.*, 2013). A competitive mating market can thus motivate individuals to provide more parental care to existing offspring, or may lead the more common sex to help at the nest longer before dispersing (Komdeur *et al.*, 2017). Similar evidence for parenting behavior as a flexible response to ASR has been observed in other taxa, such as rails (Maynard Smith & Ridpath, 1972) cichlids (Grüter & Taborsky, 2005), and dung beetles (Rosa *et al.*, 2017).

The evidence in non-human primates for a sex ratio-effect on reproductive strategies is limited, as direct paternal care is absent in most species (Rosenbaum & Silk, 2022), although some supportive evidence comes from callitrichids. Callitrichids are known to have flexible mating systems. While monogamy is most common, polyandrous bonds become more prevalent when the sex ratio is high; under these circumstances one breeding female may be supported by two caring males (Goldizen, 1987; Dunbar, 1995). Breeding pairs may receive help from the male's brother, who has little chance of siring offspring himself but for whom the opportunity costs of caring are small.

Mating systems can thus be sensitive to a population's ASR, as it affects both the value

of parenting and mating behaviors for each sex, as well as their bargaining power (Székely *et al.*, 2014). Appealing to the preferences of members of the rare sex however is not the only possible response to an unfavorable sex ratio. Sexual conflict theory also predicts that males can use coercion to regain bargaining power lost through a skewed sex ratio, as has been observed in many taxa. Higher ASR is associated with increased rates of male-to-female aggression in crab spiders (Holdsworth & Morse, 2000), common lizards (Galliard *et al.*, 2005), monk seals (Johanos *et al.*, 2010), and possibly feral horses (Regan *et al.*, 2020), although not all studies have found evidence for a sex ratio effect (e.g. Head & Brooks, 2006; Baniel *et al.*, 2017). Aggression used to obtain sexual access to females against their will has been seen in multiple primate species (Smuts, 1992; Muller & Wrangham, 2009; Muller *et al.*, 2011), but there is less evidence that this behavior is responsive to ASR in primates. Among chimpanzees at Ngogo females received higher rates of aggression from males when the operational sex ratio was higher (Watts, 2022), although it is unclear whether the results indicate that males increased their aggressive behavior towards females when they had many competitors or whether received aggression was proportional to the number of males present. The latter seems to be the case among mountain gorillas studied by Robbins (2009); the number of males present did not affect rates of aggression by males, but females did receive more threatening behaviors (chest-beating) when they were in a multi-male versus single-male group. I am not aware of studies testing the effect of sex ratio on male-to-female aggression among bonobos. One relevant finding comes from Fruth and Hohmann (2003), who find that although female bonobos with sexual swellings are preferred targets of male aggression, male-to-female aggression is not dependent on the number of females in the group exhibiting swellings (Fruth & Hohmann, 2003).

Mate guarding is another tactic used to monopolize the reproduction of a partner when strong competition due to a male-biased ASR makes finding a new mate unlikely (Harts & Kokko, 2013). ASR-sensitive mate guarding has been observed among males of some populations of soapberry bugs (Carroll & Corneli, 1995), water striders (Rowe, 1992; Vep-

salainen & Savolainen, 1995), beetles (Rosa *et al.*, 2017), various crustaceans (Wada *et al.*, 1999; Mathews, 2002; Karlsson *et al.*, 2010; Takeshita & Henmi, 2010), and Soay sheep (Clutton-Brock, 2016, p. 632). Mate guarding is also common in some primate species, such as baboons (Bulger, 1993), sifakas (Mass *et al.*, 2009), mandrills (Setchell *et al.*, 2005) and chimpanzees (Watts, 1998). Again there is little existing research testing whether this behavior in primates is sensitive to sex ratios, and the samples in existing studies are small (usually consisting of one or two groups whose ASR varies temporally). In one longitudinal study of Japanese macaques, Takahashi (2001) was able to capture variation in male mating behavior in relation to temporal changes in OSR. He found evidence that resident males more often violently interfered with floating males' mating attempts in periods when the sex ratio is more male biased, although this observation could simply mean that mate guarding was less successful during these times. Conversely, the OSR does not predict how often female chacma baboons are subject to aggression by males in their group (Baniel *et al.*, 2017). Perhaps the effect of sex ratios on mate guarding behavior is limited in primates because other population- and species-level factors are more important in determining its payoffs. For example, mate guarding often prevents effective foraging and can increase predation risk (Clutton-Brock, 2016), and these costs are expected to vary between local environments. Mate guarding also is more costly when ovulation is inconspicuous; the absence of a clear signal of females' fertility makes it difficult to determine when guarding will pay off (Clutton-Brock, 2016, p. 480-2). The low reliability of bonobos' sexual swellings as a signal for ovulation (Reichert *et al.*, 2002; Douglas *et al.*, 2016) may therefore partly explain why mate guarding and male-to-female aggressive behaviors are rare compared to chimps.

When males adopt a mate guarding strategy, this can pave the way for paternal care by decreasing the opportunity costs of care as active guarding places males in closer proximity to their offspring. Several scholars have suggested that male mate guarding preceded the evolution of pair bonding in mammals (Lukas & Clutton-Brock, 2013), and more specifically in humans (Schacht & Bell, 2016; Loo *et al.*, 2017), but see Gavrilets (2012) for an alternative

view. Loo et al. (2021) hypothesize that mate guarding as a response to high sex ratios may have preceded the high level of paternal care common in callitrichids.

The summary of current research shows that biased sex ratios can drive sexual conflict by affecting the reproductive opportunities of individuals in the population and are an important source of bargaining power in situations of sexual conflict. Having fewer reproductive options changes the interests in different reproductive strategies of both sexes, and can lead to individuals adhering more to the preferences of potential mates. Alternatively, males have been shown to respond to an unfavorable bargaining position with physical coercion of females. Evidence for this sex ratio-effect is weak in primates. This could be due to the difficulties in obtaining large sample sizes of populations that vary in ASR but where other factors affecting mating behavior are held constant (or are statistically accounted for). Alternatively, small sex ratio effects can be obscured if other ecological factors play a larger role in determining the costs and benefits of parenting and mating strategies.

3.3 Applying sexual conflict theory and sex ratio predictions to human populations

Following theory and findings on the role of ASR and sex ratio effects on mating systems of non-human animal populations, sex ratios are also thought to influence the payoffs for different reproductive strategies in humans. Going one step further, sex ratios are also hypothesized to affect the status and treatment of women, a point first made by Guttentag and Secord (1983). They argued that while men hold 'structural' power in patriarchal societies, women can gain 'dyadic' power from a male-biased marriage market and thereby gain higher status within the domain of the household and family. While coming from a different academic tradition, Guttentag and Secord's (1983) predictions on sex ratio-effects somewhat overlap with evolutionary hypotheses. Where Guttentag and Secord do not question the origins of men's 'structural power', evolutionary anthropologists have argued that patriar-

chal norm systems are the result of a long evolutionary history of sexual conflict (Smuts, 1995). According to this view, the reproductive biologies of females and males result in men's higher interest in control over women's reproduction than vice versa, over evolutionary time resulting in gender norms that justify men's dominance over women. Variation in women's status and bargaining power within marriage within cultural groups however is, similar to Guttentag and Secord's concept of dyadic power, hypothesized to depend on their alternative reproductive options which are partly determined by the population's sex ratio.

However, many studies testing sex ratio hypotheses on human reproductive behavior have suffered from methodological issues and yielded mixed results (reviewed by Schacht & Smith, 2017). One common issue with studies on sex ratio effects highlighted by Pollet et al. (2017) is the use of aggregate national-level data (such as in South & Messner, 1987; Diekmann, 1992; Barber, 2000; Kruger *et al.*, 2010). ASR is non-normally distributed at the national level, which can result in a strong but spurious effect of outliers. These analyses also often disregard the confounding effects of geographic clustering and shared cultural histories, which can lead to similarities between nearby populations that may mistakenly be interpreted as the result of shared ecological factors (Pollet *et al.*, 2017). More fine-grained studies have been able to avoid some of these issues by relying on localized sex ratio data, and these studies have been more successful in convincingly identifying cases in which biased sex ratios affect reproductive strategies in line with sexual conflict predictions. I will first review empirical work that uses local ASR data to study these topics, and then discuss how this work is limited by a disregard for the role of cultural norms.

Many studies find that romantic relationships are more stable in areas when the ASR is male-biased, supporting the sexual conflict prediction that men are more motivated to stay with current partners (and perhaps invest more in their children) when alternative partners are scarce (e.g. Pedersen, 1991; Pouget, 2017; Uggla & Mace, 2017; Uggla & Andersson, 2018; Grosjean & Khattar, 2019). Anthropologists have also looked for evidence of increased bargaining power of members of the rarer sex. For example, Pollet and Nettle (2008) examine

men's probability of marriage in a representative US sample from 1910. They found a positive interaction-effect between SES and local ASR on marriage; higher SES was a more important predictor for the probability of marrying in states where the ASR was more male-biased. This could indicate women's better ability to make demands on partners due to their better bargaining position, although this is not universally true. In a study of cohabitation patterns in Northern Ireland, Uggla and Mace (2017) find that women are more likely to cohabitate in areas with higher ASR, but do not find evidence that men's SES becomes more important as a predictor of their probability to be in a stable relationship when the ASR rises.

Schacht and Smith (2017) test for sex ratio effects in a historical sample from 19th century Utah, where the population-level sex ratio was male-biased due to the in-migration of Mormon men, while local differences correlate with variation in male mortality rates and child sex ratios, as well as the incidence of polygyny. Comparing 206 districts with varying sex ratios, their results show that men married later in districts with more male-biased ASR. Schacht and Smith interpret this as evidence for women's higher bargaining power when they are scarce, as women are expected to prefer older partners who are in a better economic position. In a study on the relationship preferences of women and men in French Guyana, Schacht and Borgerhoff Mulder (2015) find that men hold stronger preferences for long-term relationships in villages with higher ASR. Building on sexual strategies theory (Buss & Schmitt, 1993), they assume that, on average, women have a stronger interest in long-term versus short-term sexual relationships compared with men, and therefore argue that this result may indicate that men adjust their preferences to meet women's interests when they have a poorer market position. Another interpretation of their result is that men's varying preferences for stable relationships may reflect ASR-sensitive mate guarding. Another study describes that in Chinese regions where the ASR is higher, families with sons save more money (Wei & Zhang, 2011). These savings may function as parents' investment in the marital position of their sons where women (and their families) can make high demands on potential grooms. Also in China, Porter (2016) reports that in current-day China, men

smoke and drink less under more male-biased sex ratios, and proposes that this is an effort to make themselves more attractive as romantic partners. Similarly suggesting men's increased efforts to appease potential partners, Francis (2011) finds that when the ASR in Taiwan increased sharply after 1950 as male soldiers and refugees arrived from China, children were more highly educated in regions where sex ratios were higher. These findings are explained as evidence of men's higher parental investment in response to women's increased bargaining power. Finally, historical sex ratios in Australia have been found to predict current-day attitudes towards women's work: in areas that historically had high sex ratios due to the in-migration of European male convicts, women and men today are more likely to be in favor of traditional gender roles in which women stay at home while men are the sole breadwinners (Grosjean & Khattar, 2019). Women in areas with historically high ASR also report more leisure time, and men provide a larger share of the household income. The authors interpret these results as evidence of women's greater bargaining power, arguing that these historical bargaining dynamics are still reflected in today's norms.

One methodological issue in many of these studies is the comparison of only a few subpopulations: Often the behaviors or attitudes of people from only a few towns, regions or cities are compared, and the possibility that factors beyond ASR confound study results is always not considered. Cultural differences may covary with the ASR in consequential ways. For example, Uggla and Mace (2017) report that in their Northern Irish sample ASR is on average higher in rural areas as women more often leave the countryside to move to cities. This suggests that the cooccurrence of high ASR and higher cohabitation rates could at least in part result from cultural differences between urban and rural areas, and gender norms could confound the relationship between ASR and cohabitation rates if women migrate because of a dispreference for the qualities of rural men. In the Taiwanese study (Francis, 2011), the observed correlation between ASR and children's education could be caused by other factors. For example, education may have been more readily available in those areas that attracted more migrants.

Another important issue is the interpretation of various measures of bargaining outcomes. Francis (2011) regards women's lower fertility as evidence of women's higher bargaining power, while studies taking an evolutionary perspective usually see this as a negative outcome for women and therefore indicative of a lower bargaining position. Furthermore, Francis attributes men's higher paternal investment to women's increased bargaining power. While this is one possibility, the opportunity costs of paternal care decrease when partners are scarce, so this behavior is therefore not conclusive evidence of women's higher bargaining power. A similar point complicates the finding of higher endorsements of traditional gender roles in Australian regions that experienced high sex ratios in the past (Grosjean & Khattar, 2019). Grosjean and Khattar understand men's higher contributions to the household income and support for traditional gender roles as a result of women's high bargaining power. I suggest another – and perhaps more likely – explanation: men's willingness to be the sole breadwinner reflects a mate guarding strategy; men may have preferred for their wives to stay at home when they were faced with strong competition from other men in an unfavorable marriage market.

These examples illustrate how the interpretation of bargaining outcomes as favoring men or women is not always clear-cut. This is important, because theory and findings from the animal literature suggest that partner scarcity can lead to either coercive or conciliatory behavior. Currently the most conclusive evidence for people's use of coercion in response to unfavorable sex ratios comes from studies on intimate-partner violence (IPV) against women. IPV has been theorized as a male strategy to seek control over a female romantic partner in situations where she has a higher market value than he has (Macmillan & Gartner, 1999; Kilgallen *et al.*, 2021). Research in India (Bose *et al.*, 2013) and several US subpopulations (Avakame, 1999; D'Alessio & Stolzenberg, 2010; Vanterpool *et al.*, 2021) indicate that IPV is more prevalent in regions with male-biased sex ratios. Here the work of Bose et al. (2013) is most convincing. They use survey data from married women in the Indian National Family Health Survey 2005-6 to test the effect of ASR (measured at the level of the village

or neighborhood block) on their reports of husband-to-wife violence. India's male-biased ASR is the result of a strong son bias that has led to biased sex ratios at birth and gender differences in child mortality in many parts of the country. Bose et al. (2013) find a small positive association between ASR and physical, sexual and psychological IPV. Other studies have found results similar using data from the US. For example, D'Alessio and Stolzenberg (2010) use city-level data on male-on-female intimate-partner violent crime rate in the US (which includes murder, abduction, rape, sexual assault, etc.) as their dependent variable. They find that more IPV crimes occur in cities with male-biased sex ratios, although the very high coefficients in their model results (D'Alessio & Stolzenberg, 2010, table 2) are difficult to interpret and suggest their models may be overfitted or lack appropriate controls for variables correlated with ASR. Furthermore, it is unclear whether their results could be explained by a higher prevalence of marriage and lower divorce rates generally, factors that have been associated with high sex ratios (e.g. Angrist, 2002; Abramitzky *et al.*, 2011; Brainerd, 2017) but are not considered in this study. In a similar study, Vanterpool et al. (2021) recruited black women from the U.S. on MTurk, as black communities in the U.S. experience wide variation in ASR resulting from high incarceration rates in some areas. They too find an association between perceptions of high sex ratios and experiences of IPV, but their study is limited by the use of perceptions of both variables rather than demographic data.

Again, it is difficult to ascertain what causes the observed relationship between the ASR and IPV, especially in settings where biases in ASR result from patriarchal norms. In India for example, regional differences in ASR exist due to the occurrence of cross-cousin marriage, matrilocality and matrilineal inheritance in some parts of the country. These cultural traits are associated with a lack of son preference as well as with higher status and better treatment of women (Dyson & Moore, 1983; Chakraborty & Kim, 2010), leaving the possibility that differences in attitudes towards women's status explain variation in both ASR and the prevalence of IPV, without a causal link between the two.

While locally contextualized studies have shown the potential for ASR to affect reproductive strategies, I find that they rarely address the complex gender dynamics that form a pathway between ASR and resulting reproductive strategies. Examining the relationship between ASR, gender norms and reproductive strategies may help us to understand why simple mating market predictions sometimes fail to explain variation in reproductive strategies and bargaining power, as is also suggested by Schacht and Smith (2017). In the remaining part of this review, I revise existing theory to incorporate the role of gender norms and cultural evolution in human sexual conflict. I will focus on five important points that address how gender norms interact with sex ratios to affect mating market dynamics, reproductive strategies and gendered bargaining positions: 1) Gender norms do not always reflect bargaining outcomes but are subject to their own selective processes; 2) marriage rules create bounds on who can reproduce with whom; 3) gender norms have the potential to constrain people's reproductive decision-making power in a way that is unequal between genders; 4) biases in local ASRs themselves are often the result of gender norms; and 5) gender norms affect how individuals respond to biased sex ratios. Collectively these points show that sex ratio dynamics - and sexual conflict more broadly - in humans are deeply interlinked with gender norms (see fig. 3.1). I will conclude this chapter by arguing that human sexual conflict may be better termed 'gendered conflict' (Lawson *et al.*, 2023) because it can only be understood by explicitly modeling the role of gender norms, and by integrating models of cultural evolution.

3.3.1 Gender norms are a product of sexual conflict as well as other evolutionary processes

Evolutionary anthropologists have argued that gender norms are the result of a long evolutionary history of sexual conflict (Smuts, 1995; Hrdy, 1997). According to this view, the reproductive biologies of females and males result in male's higher interest in control over females' reproduction than vice versa. Smuts (1995) argues that patriarchal norms that justify
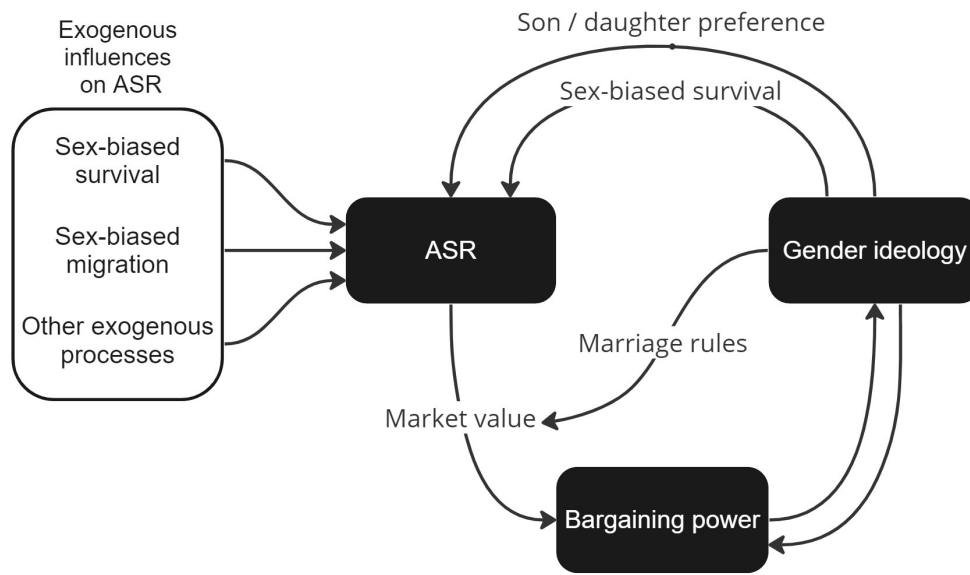
Figure 3.1: Schematic representation of the relationship between ASR and gender ideology.

men's dominance over women have evolved as a continuation and extension of male efforts to control female reproduction, common in the animal kingdom and specifically in mammals and primates. Importantly, "human males are not 'genetically programmed' to coerce and control women, and [...] women are not 'genetically programmed' to accept subordinate status." (Smuts, 1995, p. 21). The evolution of patriarchy refers to the *cultural* evolution of social norms prescribing male dominance, and Smuts argues how human residence patterns, male control over resources, and the uniquely human ability to convey information through language have enabled greater control of men over women than is possible in other animals (Smuts, 1995). Gender norms are socially enforced by group members (and often by the state) through punishment, e.g. social exclusion, or threats of punishment (Egan & Perry, 2001; Blakemore, 2003; Parrott, 2009; Skočajić *et al.*, 2020). They may adjust to changing community members' interests in norm-governed behaviors as well as their bargaining positions, and thus can be influenced by sex ratio dynamics. Extreme sex ratios can motivate a tolerance of polygamy (Starkweather & Hames, 2012), or in other cases have led to the relaxation of exogamy rules (Mishra, 2013; Larsen & Kaur, 2013). However, there are various reasons why norms do not always reflect a bargaining outcome of the optimal strategies of

individuals in a social group.

First, social norms are often subject to a period of mismatch when adaptations have not yet caught up with current selection pressures. Such 'adaptive lags' may be caused by a number of processes. One example is group members' efforts to coordinate behavior by adhering to social norms. Social norms structure human behavior in such a way that makes it predictable and facilitates smooth coordination between group members. People who deviate from the norm could experience costs simply from miscoordination (Young, 1993; Centola & Baronchelli, 2015; O'Connor, 2019). In addition, once a norm becomes an important part of the moral code of a group, deviance from the norm can lead to important social costs, such as exclusion or punishment by other group members. Deviance from culturally dominant gender norms can result in negative health outcomes via negligence or violence (Macmillan & Gartner, 1999; Weber *et al.*, 2019; Kilgallen *et al.*, 2021). The coordination benefits of norm adherence as well as the social costs of deviance thereby can lead to cultural inertia and result in a disconnect between a group's norms and group members' optimal behavior. Because of this, cultural phylogeny constrains changes in social norms, as is likely the case in marriage norms: In a phylogenetic analysis of cultural groups included in the Standard Cross-cultural Sample, the cultural history of populations explained twice the variance in local rules on polygyny and in the occurrence of polygyny as relevant ecological predictors (Minocher *et al.*, 2019). Here adaptive lag is one possible explanation for the lack of divergence between related groups.

Second, norms themselves are subject to evolutionary processes that are separate from the payoffs they provide to group members. Cultural evolution theory hypothesizes that cultural traits like social norms, are subject to processes similar – but not identical – to Darwinian evolution as traits vary and some are more likely to spread than others. At the micro-level, this theoretical framework considers how cultural traits are passed between individuals, such as through biased social learning (Boyd & Richerson, 1985; Boyd *et al.*, 2011; Mesoudi, 2011a; Richerson & Boyd, 2005). For example, the rate at which norms spread

depends on the cultural 'models' displaying those norms. Various studies have shown that people are more likely to adopt cultural traits held by high-status individuals (Henrich & Gil-White, 2001; Atkisson *et al.*, 2012; Chudek *et al.*, 2012). Common norms may also spread more easily by virtue of their popularity when people conform to the majority (Henrich & Boyd, 1998; Efferson *et al.*, 2008; Muthukrishna *et al.*, 2016; Hagen & Scelza, 2020). Specific to marriage norms, Henrich et al. (2012) have suggested that group-level benefits to monogamous marriage drove the spread of monogamy to many populations around the world. In their argument, social enforcement of monogamous marriage is argued to reduce intrasexual competition, result in more men being married and higher paternal investment. Henrich et al. (2012) argue that norms prescribing monogamy may have increased the economic prosperity of monogamous people, and that this prosperity helped spur its spread to other populations. If correct, this implies that marriage rules, like other gender norms, can spread as a result of biased cultural transmission.

In summary, gender norms are thought to in part result from an evolutionary history of sexual conflict. While the norms in a population are likely subject to change depending on the interests and bargaining positions of its members, they are also subject to other processes and are therefore unlikely to perfectly reflect sexual conflict-derived bargaining outcomes.

3.3.2 Gender norms constrain who is on the market

Marriage systems are a well-known constraint on reproductive strategies, and interact with ASR in important ways. Whether socially or legally enforced, norms about who is 'on the market' and which factors impact how they are valued are often not gender-neutral. For example, gender differences may exist in the social acceptance of remarriage after divorce or after the death of a spouse (Whyte, 1978), and the legal minimum age for marriage is lower for women than for men in 43 out of 201 countries (UN Statistics Division, 2013). Furthermore, the acceptance or rejection of polygamy plays a large role in determining the 'market value' of women and men. In populations where polygyny is culturally normative,

some men have the ability to monopolize the reproduction of multiple women. In populations where the ASR is female-biased, polygyny can increase the demand for women, which – all else equal - could improve their bargaining position (Becker, 1981). The costs to men in this situation may also be minimized, as a female biased sex ratio can lead to most men being able to have at least one wife (see fig. 3.2). This is very different from cultures where polygyny is allowed and the sex ratio is equal or male-biased. In these cases, reproductive skew would be exacerbated by the concurrent demographic and cultural restrictions on access to women. In 77% of cultures in the Standard Cross-Cultural Sample, men are allowed to have multiple spouses, whereas only 6.5% allow women to have multiple spouses (Whyte, 1978). Today polygyny is legal in 50 countries, and in these countries between 2 and 36% of people live in polygynous households (Pew Research Center, 2019). At least one study examines the level of polygyny in relation to local sex ratios: Pollet and Nettle (2009) find that in Uganda, the percentage of men in polygynous unions tracks the regional adult sex ratio, with more men in polygynous unions when the sex ratio is female-biased. Starkweather and Hames (2012) review the literature on non-classical polyandry and find that polyandry is sometimes practiced when populations are faced with an abnormally high sex ratio. At the same time however, strong cultural norms prohibiting polygamy prevent this from happening in many cultural groups. For example, the scarcity of French men after World War II led to higher bargaining power for men, but not to a tolerance for polygynous marriage (Abramitzky *et al.*, 2011). Therefore, while it is possible for polygamy to dampen sex ratio effects on marriage market dynamics, strong cultural norms and marriage rules can limit this potential.

When the sex ratio is skewed but all else is equal, does polygamy result in higher bargaining power for the abundant sex by increasing their demand, as follows from a marriage market approach (and is suggested among others by Becker, 1981)? Importantly, all else is usually not equal. As I argue in this paper, marriage rules, gender norms and sex ratios are all interlinked. Polygyny is often accompanied by a strong gender hierarchy, male-controlled access to resources and reduced decision-making power for women. This issue is further

discussed by Grossbard (2015).
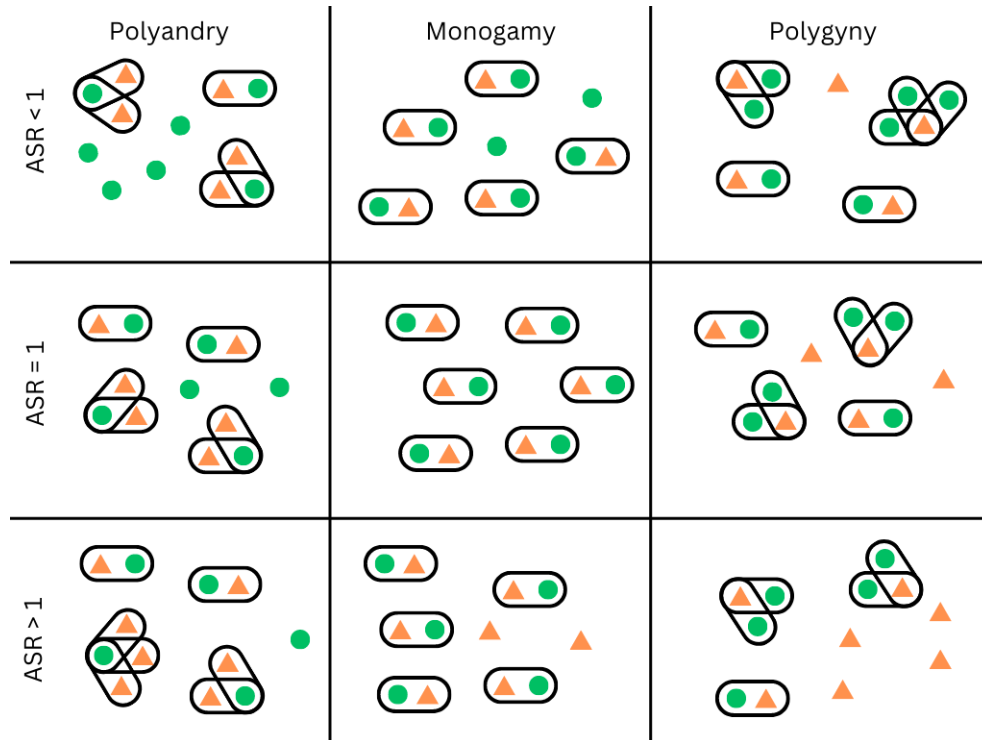
Figure 3.2: This diagram illustrates the effect of polygyny on partnership opportunities in social groups depending on the local ASR. Green circles indicate women, orange triangles refer to men, and lines around individuals indicate marriages or pair bonds. Rows represent different ASR, and columns vary in their marriage rules. The ASR and local marriage rules interact to determine marriage opportunities. For example, in the upper row the population ASR is female biased. When monogamy is the norm, some women remain without a partner. When men can have multiple partners, this dampens the effect of a female-biased sex ratio (and could even result in some men remaining partnerless). If polyandry occurs, this exacerbates the scarcity of partners for women.

3.3.3 Gender norms affect freedom of choice in a way that can override marriage market opportunities

In many populations, women and men do not have the same degree of freedom in reproductive decision-making. Sometimes individuals of only one gender can approach the other with a marriage proposal, allowing the other party only a choice between refusal or accep-

tance. Parents often influence the choice of spouse for children of both women and men, but cross-culturally men have a say in their own marriage choices more often than women (Whyte, 1978). Parents' and children's interests often do not completely overlap, especially when high marriage payments are involved or marriage is in another way consequential to a woman's family (Borgerhoff Mulder, 1998; Apostolou, 2009). Bridewealth is subject to market demands for women and can rise under male-biased sex ratios (Francis, 2011), increasing parental interests to control a daughter's marital decisions and causing further divergence of parents and daughters' interests. This can have the effect of limiting women's autonomy where their value on the marriage market is high. Here the function of the bridewealth is important. For example, in China bride wealth is skyrocketing due to male-biased sex ratios (Wei & Zhang, 2011), but much of the bride wealth devolves to the couple (for example in the form of real estate, cars or other valued goods), making it more similar to dowry (Yan, 2003; Wei & Zhang, 2011). Dowries can also be sensitive to the demand for men (Rao, 1993, e.g.), but high dowry does not lead to the same level of parental control because dowries often function as pre-mortem inheritance that will be owned by the married couple rather than as a 'payment' to the groom's family (Goody, 1976; Gaulin & Boster, 1990).

Second, normative restrictions on pre- or extra-marital sex constrain people's ability to benefit from a favorable marriage market. Premarital sex allows people entering the marriage market to learn about potential partners available to them while extramarital sex can make it easier to switch partners (Buss *et al.*, 2017; Scelza & Prall, 2023). A double standard where men have more freedom to engage in both premarital and extramarital sex is common throughout the world, limiting women's access to information about available partners (Broude, 1980).

Lastly, gender-based differences in the right and ability to initiate divorce (and remarry) potentially have a strong effect on women and men's bargaining power in marriage (Scelza, 2013). Bargaining power derived from a favorable mating market can be nullified if the costs of divorce are high, for example because of legal restrictions or social stigma on divorce (Bar-

gain *et al.*, 2020), and normative restrictions on women's ability to initiate divorce are more common than on men's (Broude & Greene, 1983). In most countries women and men legally have equal access to divorce, but restricted unilateral or fault-based divorce laws in some pose limits on divorce that disproportionately affect women's ability to leave their husbands. Furthermore, women's prospects after divorce may be further limited by their financial dependence on husbands (Leopold, 2018). Gender-based restrictions on divorce could lead to counter-intuitive situations in which a biased sex ratio results in a good bargaining position of one gender when looking for a marriage partner, but very little bargaining power in the marriage itself. These double standards on women's and men's freedom of choice in marriage are expected to lead to an asymmetric relationship between their market value as derived from the ASR and women's and men's bargaining power, where women are often more constrained in their ability to gain leverage from a favorable sex ratio due to stronger limits on their freedom of choosing partners, initiating divorce and having pre- and extramarital sex.

3.3.4   Gender norms directly affect sex ratios

To test mating market predictions, many studies understandably focus on populations in which the factors resulting in biased sex ratios are exogenous to bargaining dynamics. Many researchers purposefully select populations in which sex-biased migration (Angrist, 2002; Schacht & Borgerhoff Mulder, 2015; Uggla & Mace, 2017; Grosjean & Khattar, 2019), excess male mortality (Jones & Ferguson, 2006; Abramitzky *et al.*, 2011; Brainerd, 2017) or high male incarceration rates (Fossett & Kiecolt, 1993; Cready *et al.*, 1997; Vanterpool *et al.*, 2021) are the main cause of bias in the ASR, rather than the respective status of women and men. However, gender norms themselves in many cases directly influence local adult sex ratios. In the world's two most populous countries, China and India, a strong cultural preference for sons that is a direct consequence of these countries' patrilineal and patriarchal norm systems, has resulted in some of the highest sex ratios in the world (World Bank, 2022).

There are various pathways through which gender norms, and the differential valuation of boys and girls, can affect sex ratios. Among Mosuo people in Southwest China, where descent practices vary between communities, matrilineal descent practices are associated with an increased likelihood of continued fertility after a son, and patriliny is linked with continued fertility after a daughter (Mattison *et al.*, 2016). A preference for either girls or boys can be a strong motivator for parity progression and thereby have important demographic consequences. For example, in India the last-born child is more likely to be a boy than a girl, and Chaudhuri (2012) estimates that 7% of the births are the result of son preference. In addition, a preference for one gender can lead to inferior treatment of the other, resulting in biased mortality rates. Under-five mortality is biased against girls in the Caucasus and Central Asia, and biased against boys in Uganda, Guinea-Bissau, Uzbekistan and Mongolia (Alkema *et al.*, 2014). On top of these sources of bias in child sex ratios, access to sex-selective abortion in combination with child-limiting and family-planning policies have led to skyrocketing sex ratios at birth in India and China.

Although the effects can be somewhat mitigated through sex-biased migration, biased sex ratios at birth generally result in biased ASR in the next generation. Countries where the sex ratio at birth is statistically higher than would be expected in the absence of son-preference account for 38% of today's world population and for 91% of all people living in countries with an ASR over 1.05 (calculation based on population estimates from World Bank, 2022; Chao *et al.*, 2019). These numbers underline the significance of gender norms and their role in the origin of biased sex ratios. This relationship cannot be ignored, especially because of my final point: gender ideology affects how people may respond to their market value and how market value is translated into gendered bargaining positions.

3.3.5 Gender norms affect how people respond to gains or decreases in their market value

Theory and findings from the non-human animal literature suggest that men have two options in their treatment of women when faced with high competition on the marriage market. They can increase their chances by moving towards the preferences of a (potential) partner, which would indicate a true improvement of women's bargaining position and result in women's higher status. Alternatively, when men's market value is low because of a biased ASR, they can force their bargaining position through coercive tactics such as mate guarding or (threats of) social or physical coercion. Which of these strategies becomes prominent in a particular place is likely to reflect existing gender ideologies. For example, in a population that already strongly enforces men's dominance over women, the latter may be more prominent, while in more gender egalitarian settings conciliatory tactics might be more common. Guttentag and Secord (1983) were among the first to predict a role for gender ideologies in shaping people's responses to biased sex ratios. They argue that under a biased sex ratio, members of the rare sex gain 'dyadic' power in romantic relationships. However, they also state that the effect of high sex ratios on women's status will not mirror the effect of low sex ratios on men's status, as men disproportionately hold 'structural power' in human societies. According to Guttentag and Secord, female-biased sex ratios will lead to a devaluation of women in society and a consideration of women as mere sex objects, and a male-biased sex ratio, and consequently a dearth of women on the marriage market will lead to an increased appreciation of their reproductive value, rather than to women's empowerment as commonly understood in current Western views on feminism. Under a male-biased sex ratio, men "must treat [their partner] well or run the risk of losing her to another man. But their structural power is sufficient to allow them to place constraints on women's freedoms and impose a sexual morality on them" (Guttentag & Secord, 1983, p. 28). Where Guttentag and Secord do not question the origins of men's 'structural power', evolutionary anthropologists understand patriarchy to be the result of a long history of sexual conflict (Smuts, 1995; Hrdy, 1997).

However, my perspective is similar in that it predicts that the common gender ideology in a population influences how people respond to their market value as derived from the sex ratio. As reviewed above, responsivity to biased sex ratios has been documented in human populations for both conciliatory and coercive behaviors. However, I am not aware of empirical studies testing the hypothesis that this responsivity is dependent on people's gender ideology.

3.4   Discussion

Currently much of the research in the human literature is limited by its reliance on samples from only a few areas with a limited ecological range, making it difficult to separate sex ratio effects on gender norms from other differences between subpopulations. For example, environmental factors can correlate with sex ratios in a non-causal way and lead to false estimates of sex ratio effects. Importantly, not all variables interpreted as bargaining outcomes are conclusively indicative of women's or men's preferred bargaining outcome, further complicating this research. In order to effectively study this relationship between sex ratios and bargaining over reproductive strategies, anthropologists must reckon with the endogenous role of gender norms in sexual conflict dynamics. Gender ideology can be an important cause of biases in sex ratios, and likely affect how individuals respond to biased sex ratios. Gender norms thereby have the potential to influence how sex ratios translate to gendered bargaining dynamics, and future work should explicitly take this into account in their predictions as well as in the interpretation of their findings.

In this chapter I have argued that the interaction between gender norms and sexual conflict adds a layer of complexity that cannot be ignored when studying sexual conflict in humans. To explicitly foreground this important role of gender norms, I agree with Lawson et al's (2023) proposal of the term 'gendered conflict' when applying sexual conflict theory to human behavior. In this chapter I provide evidence and suggest hypotheses for some of the

myriad of ways in which gender norms and sexual conflict interact specifically in the context of sex ratios. As Lawson et al (2023) discuss, referring to gendered conflict does not negate the central role of sex and reproduction in conflict over evolutionary time, but is useful in that it helps underline the role of social and cultural influences and works to disessentialize differences between women and men.

I further argue that models of cultural evolution are crucial in understanding gendered conflict. At the same time, gender norms as well as bargaining and power dynamics are somewhat neglected in cultural evolution theory itself (Lawson *et al.*, 2023). Sexual conflict theory has been used quite extensively to model and measure bargaining over gender roles and over women's autonomy and decision-making power (e.g. Smuts, 1995; Käär *et al.*, 1998; Borgerhoff Mulder & Rauch, 2009; O'Connor, 2019; Kilgallen *et al.*, 2021). This work centers around the question of how fitness payoffs affect the spread and maintenance of gender norms and is mostly separate from the literature on cultural evolution theory, which has long studied the evolution of social norms but has somewhat ignored gender. Models of cultural evolution will be required to understand how gender norms spread, persist and change over time, but these models will need to consider how power dynamics and gendered fitness interests affect these dynamics. Future studies on sex ratio effects at minimum need to consider the processes leading to biased sex ratios and their relationship to gender ideologies. Where previous research has somewhat neglected the causal role of gender norms or simply avoided populations in which gender norms are an obvious source of variation in ASR, there is opportunity for future research to study these topics in populations where there is a direct link between gender ideology and ASR. Disentangling the complex links between sex ratios, gender norms and gendered bargaining power will be no easy feat. Finding suitable cases to test the proposed hypotheses is challenging, precisely because of this complex relationship, but exogenous factors that affect ASR and marriage rules may offer a way out. For example, to my knowledge there is currently no research that empirically tests whether levels of polygamy dampen the effect of sex ratios on the relative bargaining power of women and men

by changing the demand for partners. Future work may address this question by studying gendered bargaining dynamics in a population where the level of polygamy regionally varies due to ecological factors unrelated to gender ideology. Legislative changes of legal differences between regions can further provide natural experiments for studying how marriage rules or freedom of choice in marriage and divorce can constrain people's ability to gain leverage from a biased sex ratio.

3.5   Conclusion

A growing body of research addresses the effect of sex ratios on marriage patterns and reproductive behavior in humans. This research follows predictions from sexual conflict theory and findings from the non-human animal literature, where sex ratios have been shown to affect mating strategies and bargaining in many species in line with predictions. When a population's sex ratio is biased, this changes both the interests of each sex in parenting and mating strategies, as well as individuals' bargaining power in sexual conflicts of interest. Furthermore, the costs and benefits of different mating strategies in turn can influence sex ratios, resulting in a dynamic relationship between sex ratios and mating and parenting behavior. The fitness payoffs of these behaviors are also dependent on environmental factors, which can constrain the effect of sex ratios. In humans, sexual conflict dynamics are even more complex due to the role of cultural norms regarding gender, and here the term 'gendered conflict' may be useful in directing researchers' focus to this additional layer of complexity (Lawson *et al.*, 2023).

In this paper I argue that sexual conflict theory must be revised in order to understand these processes in human populations, where culture adds a layer of complexity that cannot be ignored. Gender norms themselves are in part a product of conflicts of interest between women and men. However as cultural traits they are also subject to cultural evolutionary processes, resulting in their detachment from expected sexual conflict outcomes and their

potential to in turn influence conflict dynamics. Gender norms play a central role in marriage market and bargaining dynamics by affecting who is on the market and how much freedom of choice individuals have, and by directly affecting sex ratios. Crucially, gender norms may also structure how individuals respond to market value gained or lost through biased sex ratios. Integrating sexual conflict theory and cultural evolution theory is crucial to understanding gendered conflict dynamics.

APPENDIX A

Supplemental information for Chapter 1

Data and code can be found at `https://osf.io/y85bq/`.

A.1 Agreement on Himba traditions and medical recommendations

Norm domain	Description	Traditional Himba practice	Medical recommendation
Birth location	Home or hospital birth.	Home (84)	Hospital (95)
Breastfeeding onset	Breastfeeding is started on the day of the birth (immediate) or at least one day after the birth (delayed).	Delayed (65)	Immediate (75)
Contraceptive uptake	Use of condoms or anti-conception pill or injection.	Not practiced (35)	Practiced (96)
Mopane steam bath	After giving birth, women squat over a hole in the ground that is filled with hot stones and soaked leaves of *Colophospermum mopane* to create steam.	Practiced (90)	Not practiced (89)
Oruhai necklace	Women replace their regular necklaces with a looser emphoruhai necklace in the weeks before the birth. The emic reason for doing so is to prevent the umbilical cord from tying around the infant's neck during birth.	Practiced (97)	No opinion (56)
Otjizumba	A paste of butter and herbs is rubbed on the infant's skin.	Practiced (89)	Not practiced (87)
Washing mother	The mother washes herself with water after giving birth.	Not practiced (62)	Practiced (94)
Washing infant	The infant is washed with water after the birth.	Not practiced (65)	Practiced (91)

Table A.1: Overview of Himba traditions and medical recommendations addressed. Numbers in parentheses indicate the percentage of women who believe Himba women living a traditional lifestyle practice and medical workers recommend a norm for each domain.

A.2   Study sample

		Rural sample	Peri-urban sample
N		44	56
Age	Mean	25.98	26.82
	SD	7.35	7.35
	Range	16-47	16-48
Parity	Mean	3.8	3.8
	SD	2.32	2.57
	Range	1-9	1-12
Marital status	Percentage married	55%	57%
Mother alive	Percentage	91%	91%
Years of education	Mean	1.43	0.62
	SD	2.07	1.97
Tropical livestock units	Mean	2.03	0.69
	SD	2.57	1.13
	Range	0-14	0-6

Table A.2: Demographic characteristics of the sample divided between rural and peri-urban participants.

A.3 Norm frequencies
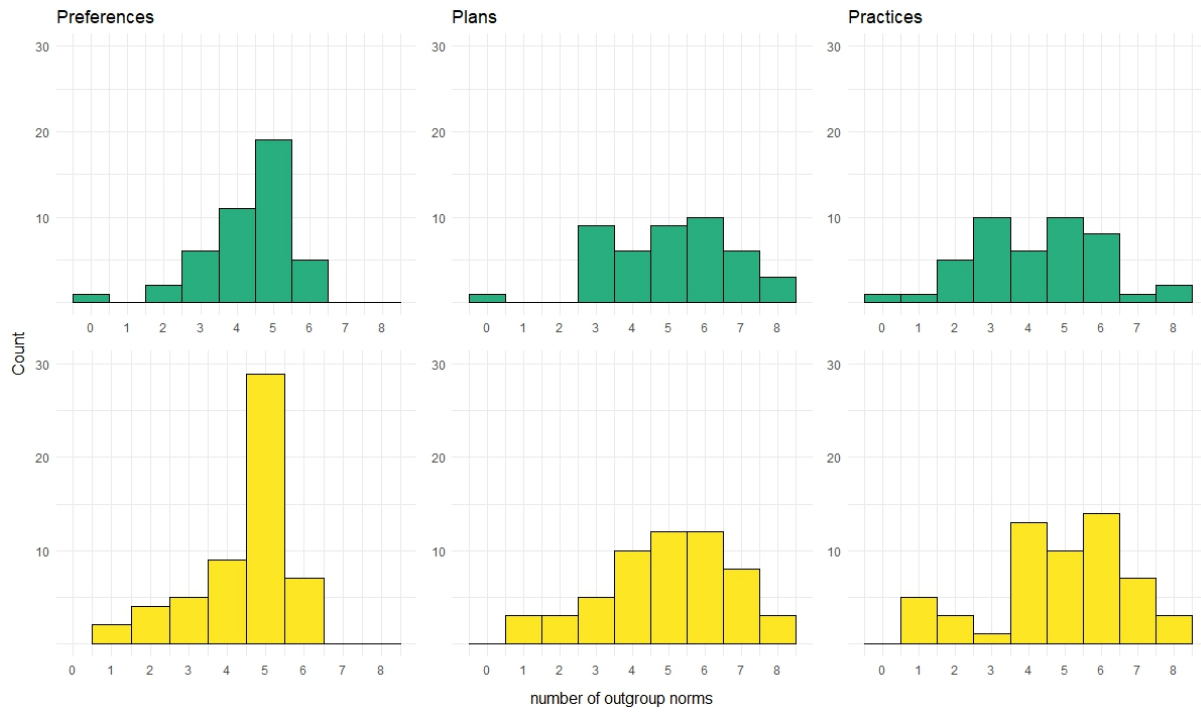
Figure A.1: Histograms of number of medical recommendations preferred, planned and practiced in the rural (green) and peri-urban (yellow) sample.

A.4 Perceived majority preference and self-reported preferences
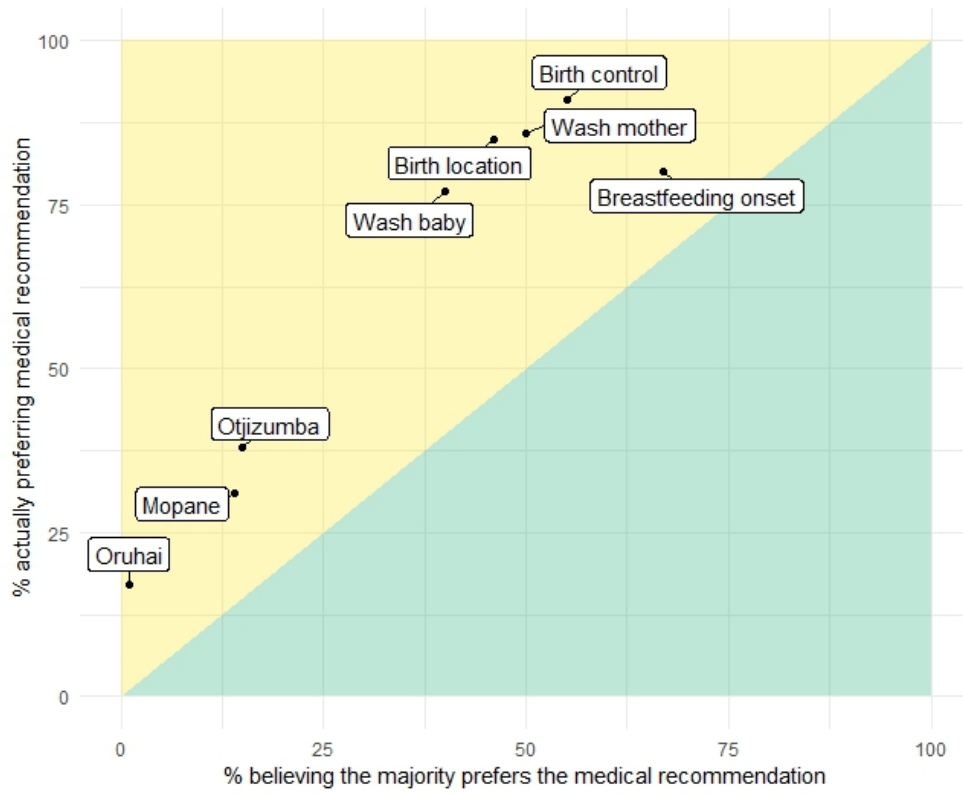
Figure A.2: A per-norm comparison of women's perceptions of medical recommendations preferred by the majority of Himba women, and women's own self-reported preferences. All norms fall in the yellow area, indicating that the norms that more participants self-report to prefer are also more often thought to be the majority-preferred norm.

A.5 Multivariate models
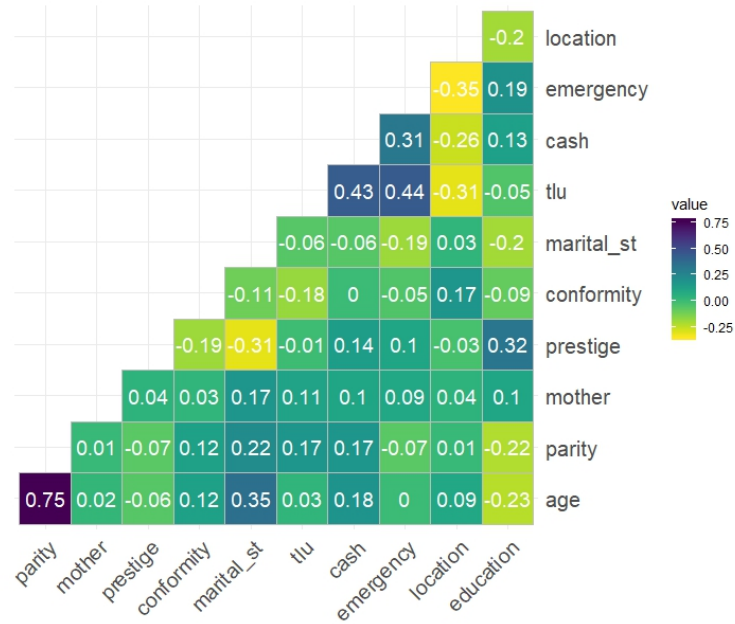
Figure A.3: Correlation plot of the predictor variables used in the multivariate models before scaling.
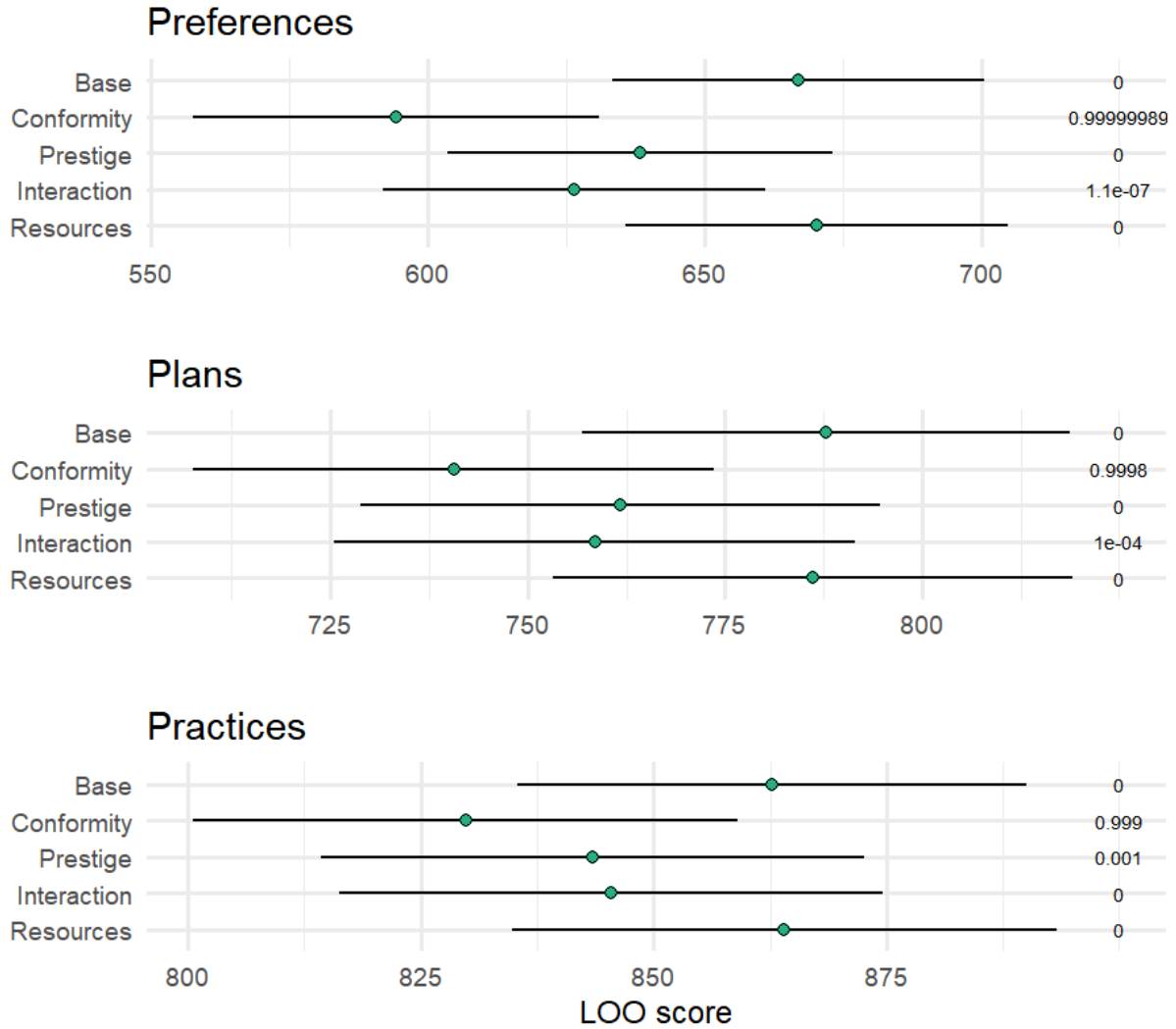
Figure A.4: PSIS-LOO comparison of the five models for preferences, plans and practices. Green dots and lines mark PSIS-LOO average scores and standard deviations. Lower values indicate less out-of-sample deviance, meaning better performance in predicting new data. Model weights shown on the right indicate that the conformity models score best for preferences, plans and practices.

	β	CI low	CI high	β $(p > 0)$
Preferences				
Conformity	2.29	1.53	3.06	99%
Prestige	.44	-0.25	1.08	87%
Years of education	.11	-.39	.60	64%
Rural or urban	.16	-1.08	1.62	58%
Married	.08	-.62	.75	57%
Emergency money	-.09	-.81	.66	42%
Money	.18	-.62	.75	64%
TLU	.21	.30	.76	74%
Plans				
Conformity	2.29	1.53	3.06	99%
Prestige	.57	.09	1.07	97%
Years of education	.18	-.18	.54	80%
Rural or urban	.21	-.96	1.42	61%
Married	.02	-.58	.61	53%
Emergency money	.17	-.48	.87	66%
Money	.25	-.44	.98	72%
TLU	.02	.33	.39	54%
Practices				
Conformity	.85	.00	1.69	95%
Prestige	-.01	-.50	.49	49%
Years of education	.09	-.27	.44	66%
Rural or urban	.43	-.74	1.51	75%
Visiting Opuwo[1]	0.02	-.25	.30	55%
Visiting Hospital[1]	.35	-.36	1.08	79%
Married	.53	-.03	1.09	94%
Emergency money	.09	-.50	.67	61%
Money	.22	-.40	.88	71%
TLU	.03	.30	.35	55%

Table A.3: Posterior distributions of the population-level effect sizes, with mean β, 90% credible intervals and the probability that the effect is above zero.

Figure A.5: Posterior distributions of the population-level effect sizes, on a subset of potential shifters (individuals who previously practiced the ingroup norm). These effects show the average effects for all norms and villages, as the model included varying intercepts for these variables (shown in Fig. A.7 and A.8). Effect sizes for the models for A) conformity bias, B) prestige bias, C) interaction frequency, and D) access to resources are shown on a logit-scale. The colored bars indicate credible intervals .99 (yellow), .9 (green), .8 (blue) and .5 (dark blue) of the effect sizes. The probability that the effect is positive is shown on the left-hand side of the plots.
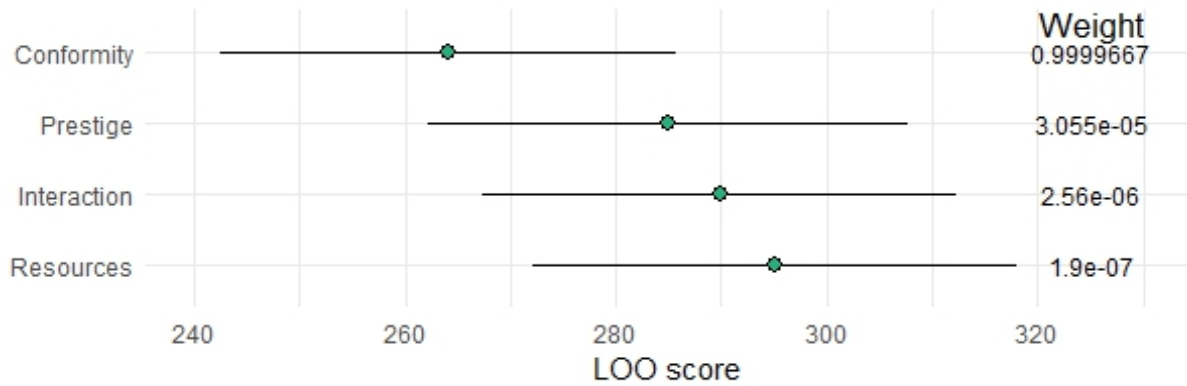
Figure A.6: PSIS-LOO comparison of the five models for the preferences of a subset of potential shifters (individuals who previously practiced the ingroup norm). Green dots and lines mark PSIS-LOO average scores and standard deviations. Lower values indicate less out-of-sample deviance, meaning better performance in predicting new data. Model weights shown on the right indicate that the conformity model scores best.
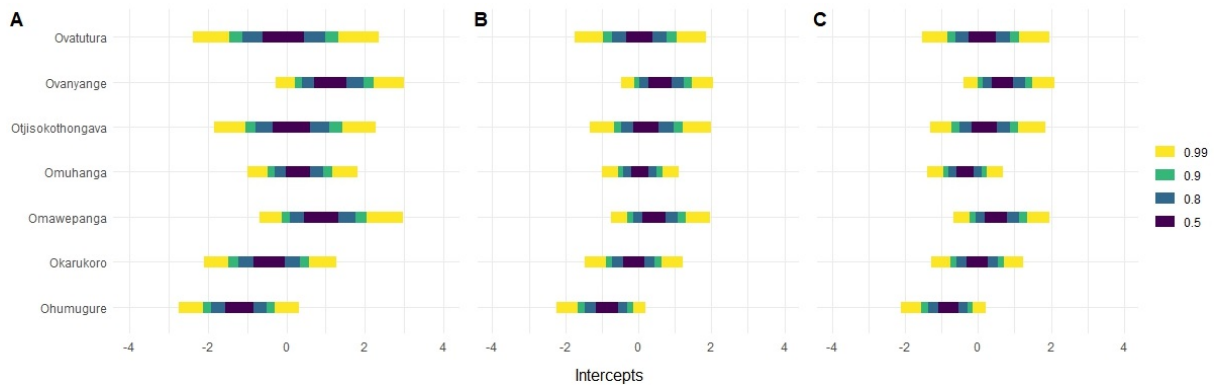
Figure A.7: Posterior distribution of the logit-scaled varying intercepts per village in the conformity models on A) preferences, B) plans and C) practices. The colored bars indicate credible intervals .99 (yellow), .9 (green), .8 (blue) and .5 (dark blue) of the effect sizes. The village in the rural area is Omuhanga, the other villages are in the peri-urban area.
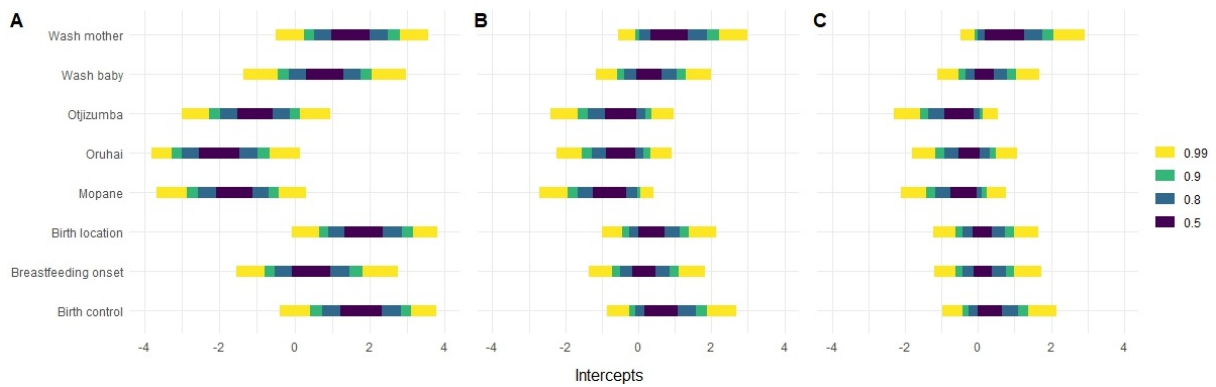
Figure A.8: Posterior distribution of the logit-scaled varying intercepts per norm in the conformity models on A) preferences, B) plans and C) practices. The colored bars indicate credible intervals .99 (yellow), .9 (green), .8 (blue) and .5 (dark blue) of the effect sizes.

A.6 Absolute predictions

Figure A.9: Violin plots of the predicted absolute effects of perceived ingroup majority preference on norm adoption, with the likelihood to adopt a medical recommendation on the x-axis. Predictions are fitted to counterfactual data simulated for a woman of average age and parity (parameter values listed in table A.4. Women are consistently more likely to have adopted a medical recommendation in their preferences, plans and practices when they believe most other Himba women prefer that recommendation.

Variable	Value	
Conformity	Highest value, lowest value	[0, 1]
Age	Mean value	-2.03
Age-corrected parity	Mean value	-3.07
Mother alive	No	0

Table A.4: The parameter values used in the counterfactual predictions of figures 1.3, A.9 and A.10.
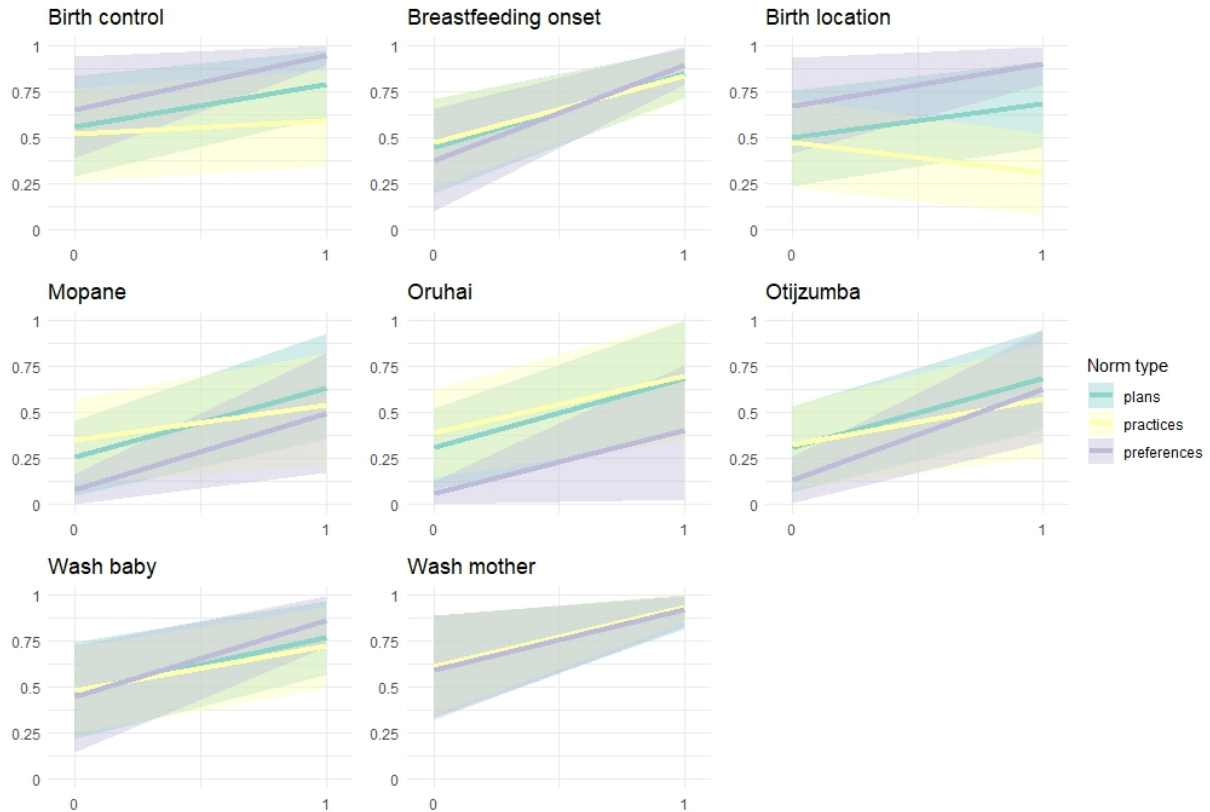
Figure A.10: Predicted absolute effects of perceptions of other women's norm preferences on one's own preferences, plans and practices per norm. Predictions are fitted to counterfactual data simulated for a woman of average age and parity (parameter values listed in table A.4). Lines and shaded regions indicate the mean and 90% credible interval, with purple for preferences, green for plans, and yellow for practices. Slopes reflect the effect of the variable on norm adoption. In most cases, women who perceive others as preferring a medical recommendation are more likely to adopt that recommendation themselves.

APPENDIX B

Supplemental information for Chapter 2

B.1   Data

B.1.1   Outcome variables

The questionnaire items addressing gender norms vary slightly between surveys. Table B.1 provides an overview of the norms addressed in each survey.

B.1.2   Confounders

The gender norms and norms regarding general traditionalism vary slightly between surveys (see Table B.2). The questionnaire item used for social status is: "In our society there are groups which tend to be towards the top and groups which tend to be towards the bottom. Below is a scale that runs from top to bottom. Where would you put yourself now on this scale?" This variable is measured on a 10-point scale. Education for Taiwan and China is a rescaled variable of completed level of education, for Japan and South Korea this variable reflects years of education completed. A variable representing how urban or rural the respondents' locations is, was only included in the models for Taiwan, Japan and South Korea, as these data were not available in the Chinese General Social Survey.

B.1.3 Missing data

33% of the Chinese sample was asked questions regarding social norms and the remaining 67% was therefore excluded from our analyses. I found no significant differences in the age, gender, income or education between respondents who were asked these questions and those who were not (see Figures B.1, B.2 and B.3). Some individuals reported over 20 children of a sex. It seems likely that this number is incorrect, and I therefore scored those data as missing.

The missingness in each sample was 3.1% for Japan, 5.5% for South Korea, .6% for Taiwan and .3% China (after excluding Chinese participants who were not asked norm questions). With the goal to preserve the available data in rows that had missing variables, we used Bayesian multi-variate inference to estimate missing predictors. Rows with missing outcome data were deleted.

Figure B.1: Comparison of age between CGSS respondents who were given the gender norm questions (in green) and those who were not (in orange). Vertical lines indicate the average age for both groups.
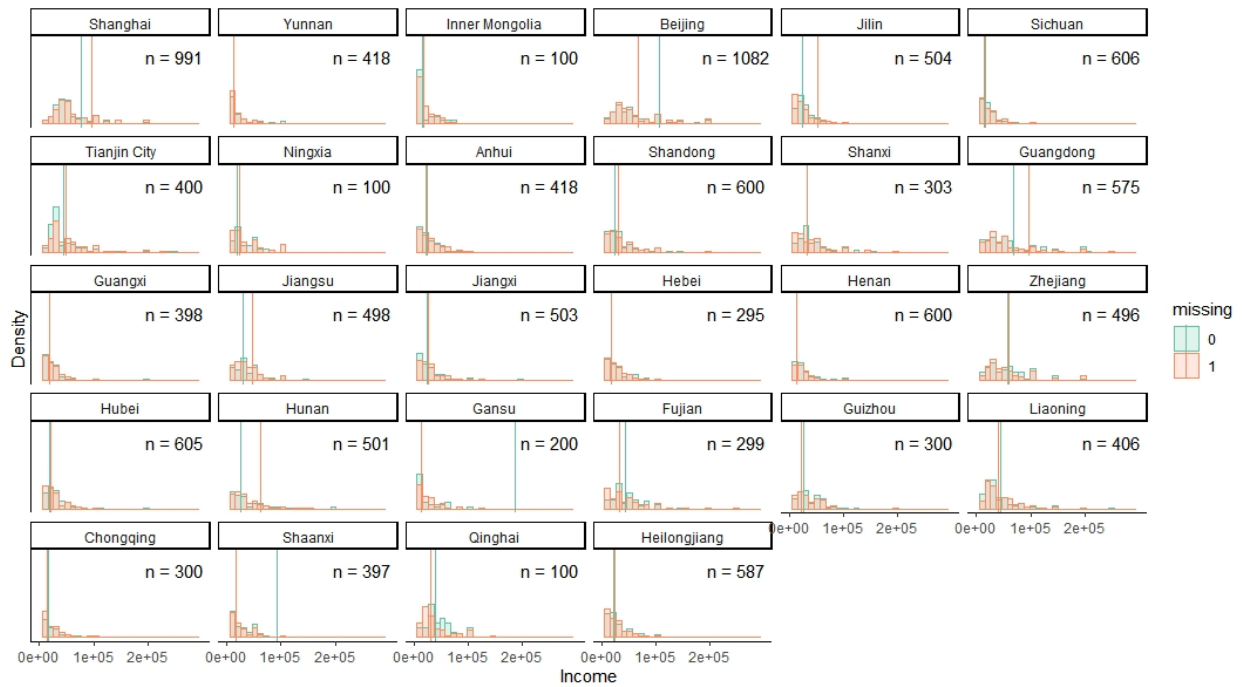
Figure B.2: Comparison of income between CGSS respondents who were given the gender norm questions (in green) and those who were not (in orange). Vertical lines indicate the average income for both groups.

	Questionnaire item	China	Taiwan	Japan	South Korea
1	A husband's job is to earn money; a wife's job is to look after the home	D182	D1a	V210	V210
1b	Men should focus on their career; women should focus on family	A421			
2a	It's not good for a pre-school child if the mother is working		D1b	V210N	V210N
2b	Before the child goes to school, the mother should not go out to work	D183			
3	Family life will always be affected if the wife has a full-time job		D1e		
4	In an economic recession it's alright if women are laid-off before men	A424	D1f		V212
5	It is more important for a wife to help her husband's career than to work on her own career	D181	F1ab	V209	V209
6	The authority of father in a family should be respected	D191	F1ad	V213	V213
7	To continue the family line, one must have at least one son	D193	F1af	V217	V217
8	Men are inherently better than women	A422			
9	When both the husband's family and the natal family need help, a married woman should help her husband's family first	D201		V218	V218
10	In terms of family responsibilities, men should do more at home than they do now (R)	D184			
11	Couples should share housework equally (R)	A425			

Table B.1: Questionnaire items from each survey used as measures of attitudes towards gender norms. In each survey, respondents were asked to rate their agreement or disagreement with these statements on a Likert scale

	Questionnaire item	China	Taiwan	Japan	South Korea
1	Children should do something that will bring honor to their parents	D192	E1i	V214	V214
2	Be grateful to your parents for raising you	D194	E1a		
3	Be nice and kind to your parents regardless of how they have treated you	D195	E1b		
4	You should give up your aspirations to meet your parents' expectations	D196	E1c		
5	You should support your parents' livelihood to make their lives more comfortable	D197	E1e		
6	Family happiness should take precedence over personal interests	D202			
7	The eldest son should inherit more property	D203			
8	You should live with your parents (in law) after getting married		E1d		
9	You should attend your parent's funeral no matter how far away you live		E1f		
10	You should say something good about your parents to save their face		E1g		
11	One must put familial well-being and interest before one's own			V219	V219
12	How did you get to know your current spouse for the first time?			V228	V228
13	To what extent do you think your own parent(s) influenced your decision of your current marriage partner?			V231	V231
14	Do you think it desirable for three generations (older people, their married children, and grandchildren) to share a home?			V250	V250

Table B.2: Questionnaire items from each survey used for the traditionalism index.
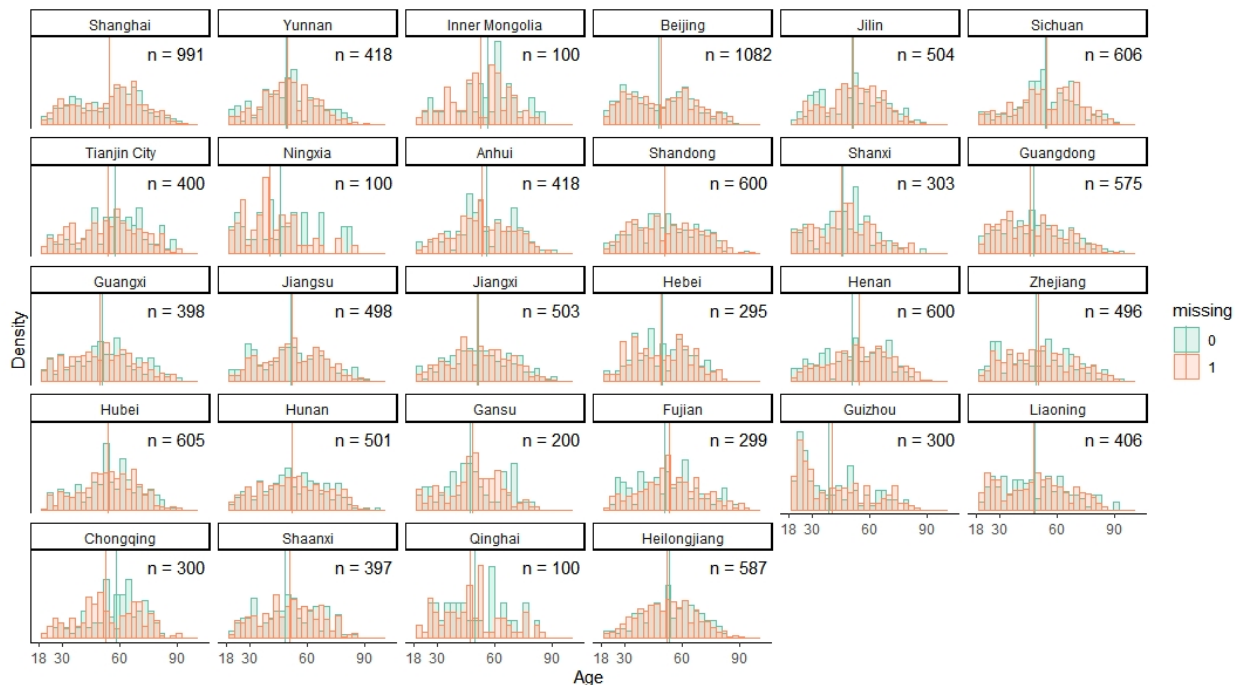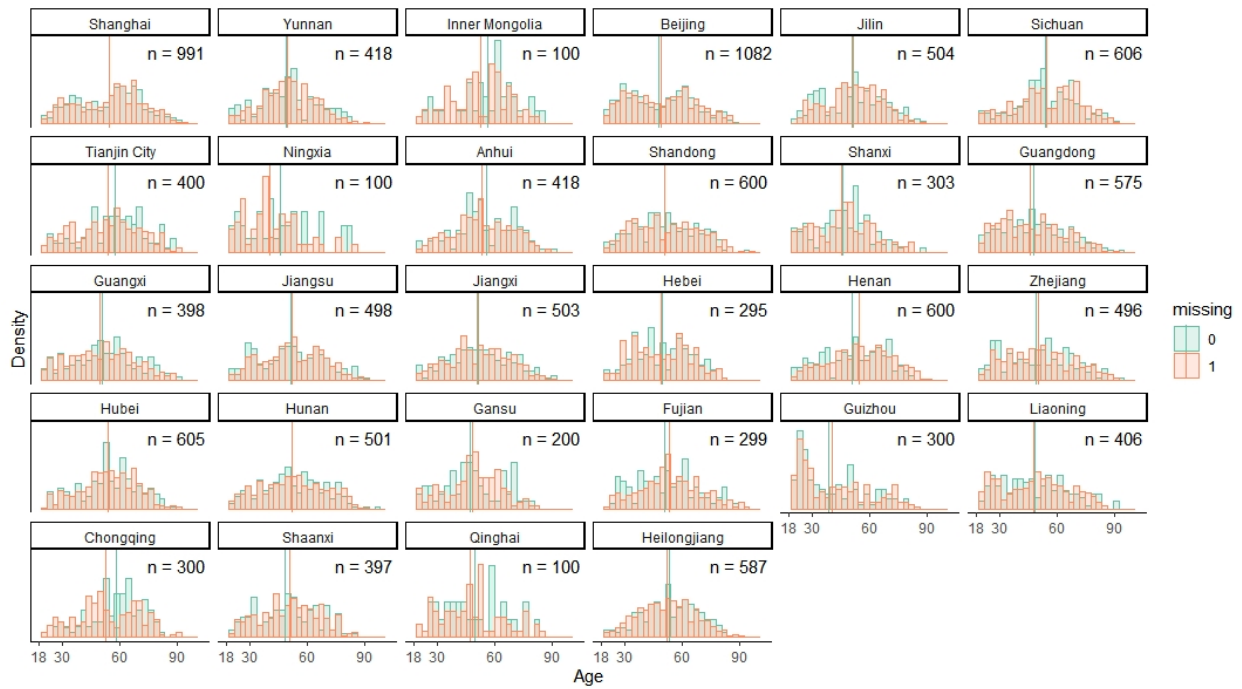
Figure B.3: Comparison of education between CGSS respondents who were given the gender norm questions (in green) and those who were not (in orange). Vertical lines indicate the average education for both groups.

B.2   Results
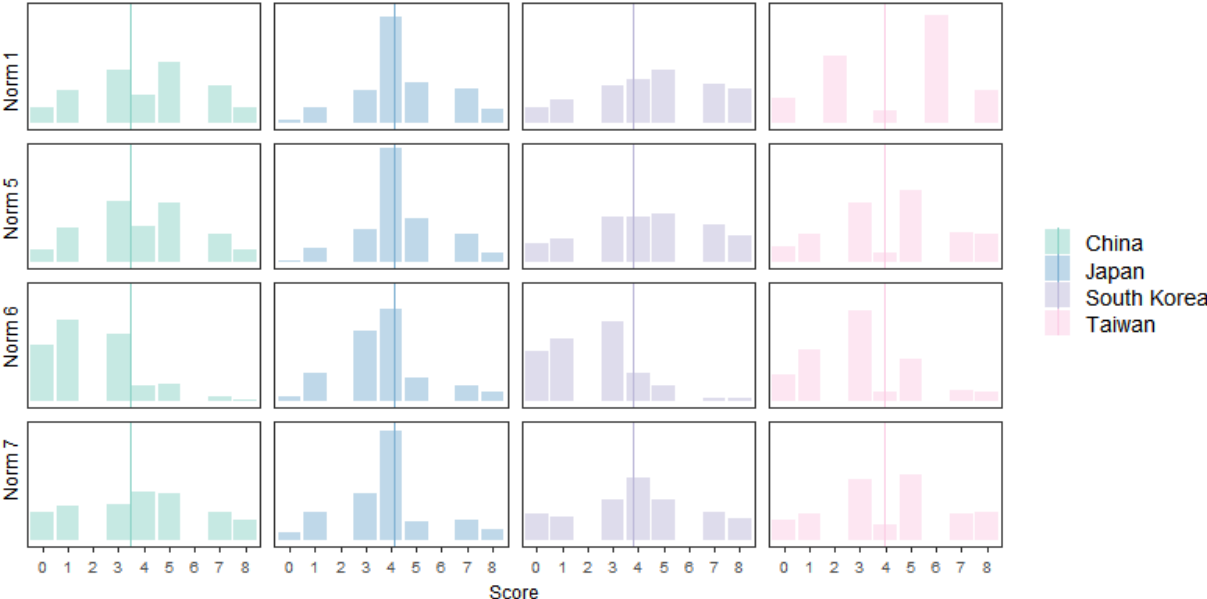
Figure B.4: Histogram of the norm scores per country for the four questionnaire items that were included in all countries' survey. Histograms are weighted using cross-sectional survey weights.
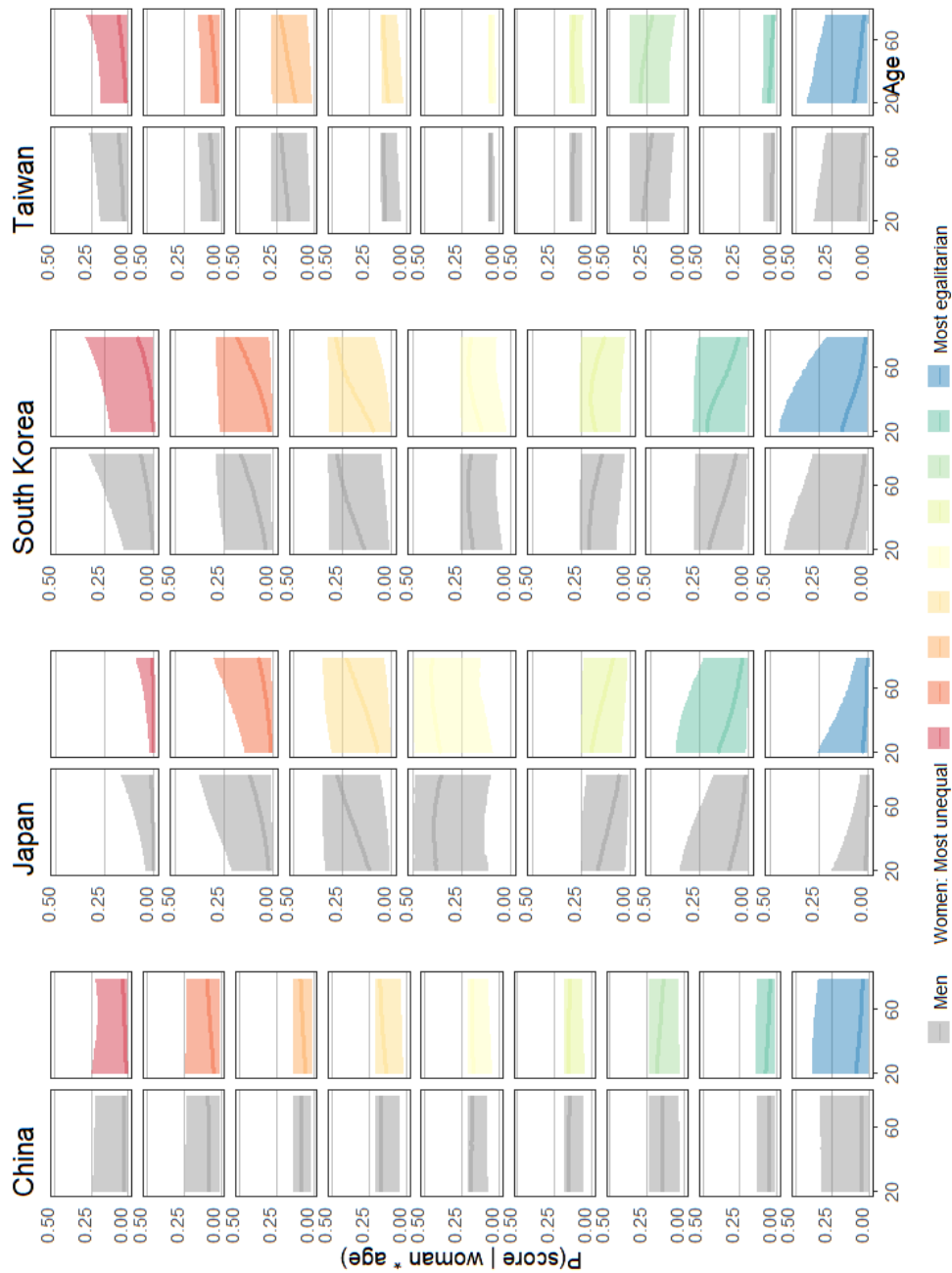
Figure B.5: Conditional effects of age and gender on the probability that each answer option is selected. The ribbons indicate 90% credible intervals. For each population, the first column represents the expected probabilities for men (in gray), and the second column represents the probabilities for women. The plot shows that for both women and men, unequal gender norms become more likely with age, and equal gender norms become less likely. In South Korea, China and Taiwan this effect is stronger for women than for men.
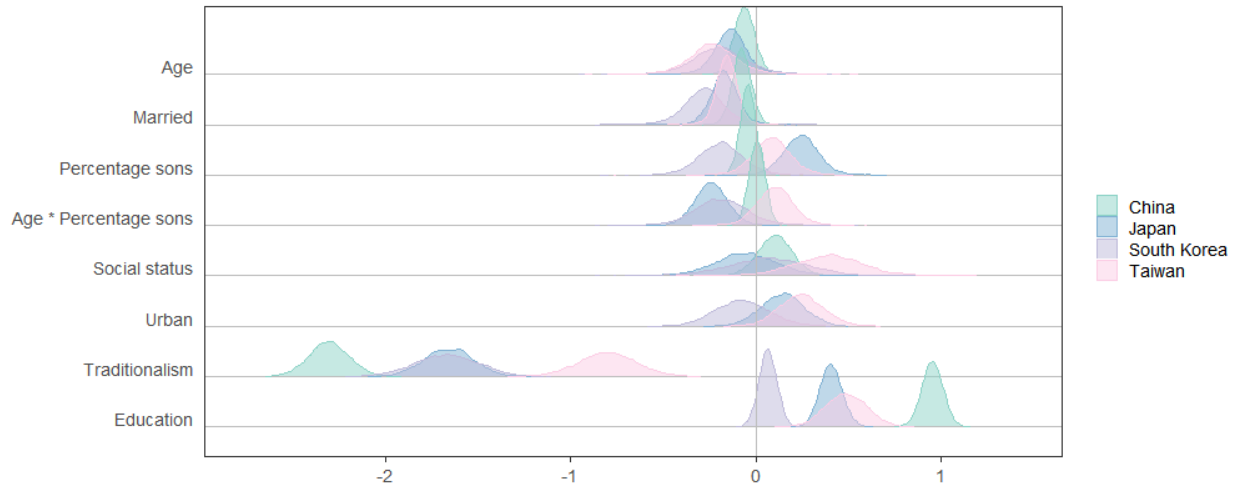
(a)
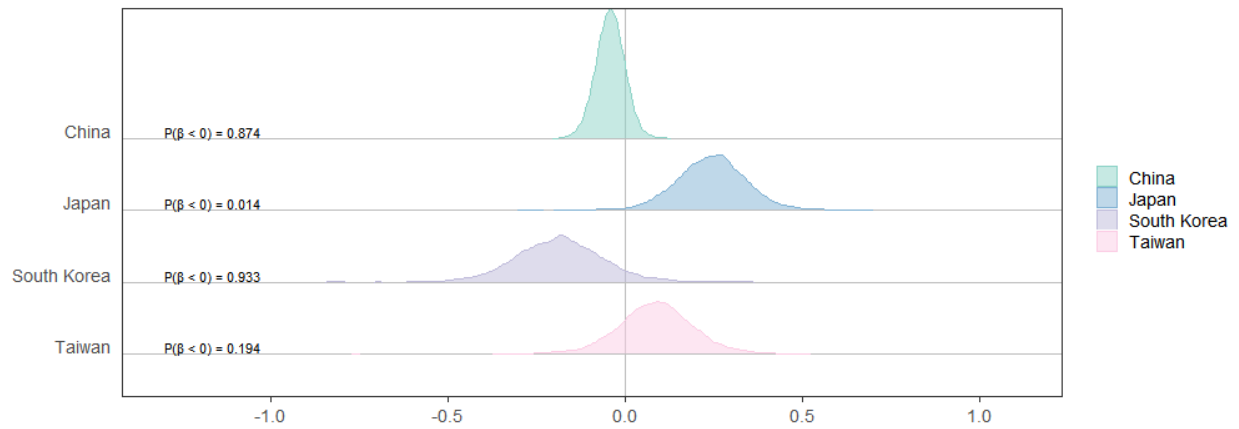
(b)

Figure B.6: The posterior distributions of the women-only model in which norm 7 ("To continue the family line, one must have at least one son") is excluded. These effects are averaged over all individuals and remaining norms. Plot A shows the distributions of all model predictors for all populations. Plot B displays the effects of percentage sons on women's attitudes, with on the left the proportion of the distribution that falls in the expected direction.
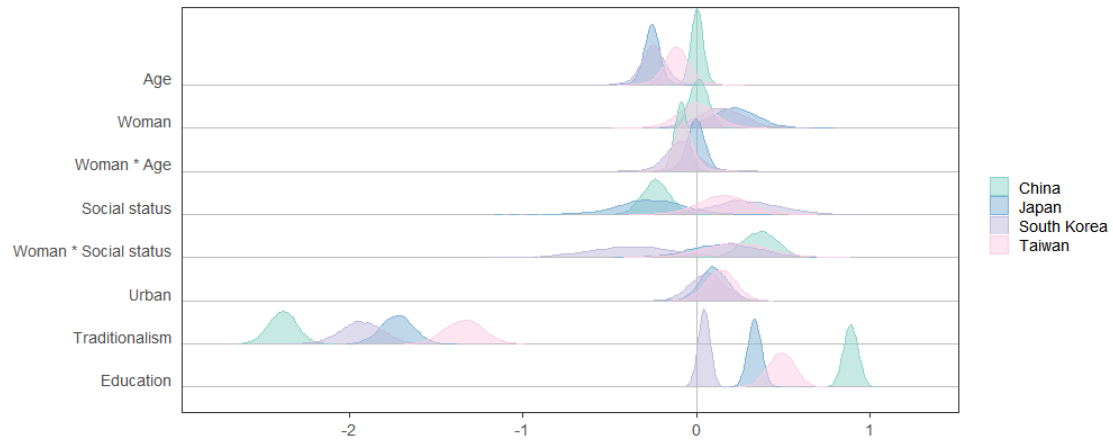
(a)
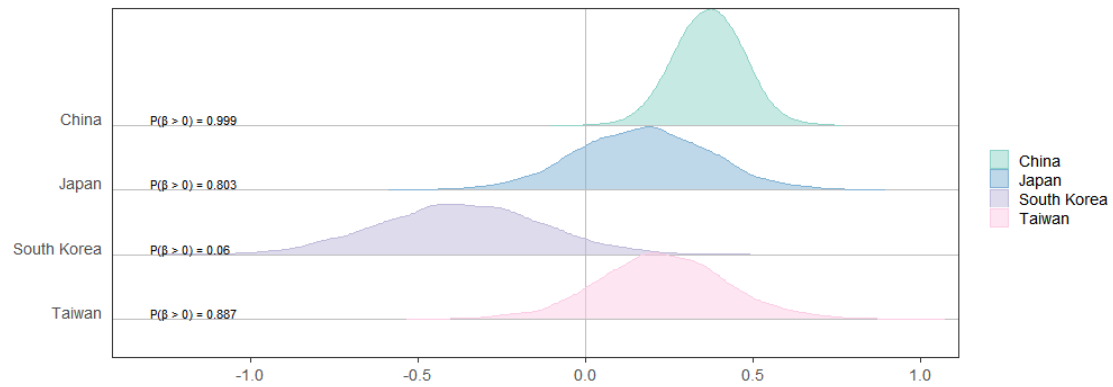
(b)

Figure B.7: Posterior predictions of a post-hoc analysis on the complete datasets including age, gender, social status and an interaction-effect for gender and social status, and controls for urbanism, traditionalism and education. Plot A shows the distributions of all included predictors for all countries. Plot B displays the effects of the interaction between gender and social status on attitudes, on the left noting the proportion of the distribution that falls in the expected direction.

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